FACTORS INFLUENCING GREY WATER USE IN BUSHBUCKRIDGE VILLAGES, MPUMALANGA PROVINCE, SOUTH AFRICA

Mini-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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DECLARATION

I, Nkata Peter Marota, solely declare that the dissertation of Master of Philosophy in Integrated Water Management at the Independent Institute of Education, IIE MSA, is submitted as my own work and has not been submitted previously for a degree at this or any institution of higher learning. All sources referred to in this study have been acknowledged satisfactorily in the text and the list.

SIGNATURES

Mr NP Marota

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DEDICATION

The mini-dissertation is dedicated with deep appreciation to my beautiful wife, Veronica Marota, for her unwavering love and support. Thank you for your understanding and encouragement during long hours spent away from home. To my children, Omphile and Tumelo Marota, and in loving memory of my late daughter, Oratile Marota, whose memories and spirit have always inspired me to work harder. Lastly, to my mother, Matipa Marota, who, despite her lack of formal education, always believed in me and encouraged me to pursue my studies further.

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DALRRD	Department of Agriculture, Land Reform and Rural Development
DWAF	Department of Water Affairs and Forestry
IIEMSA	Independent Institute of South Africa
URBWAT	Urban Informal Townships in South Africa
WMA	Water Management Area

Factors influencing greywater use in Bushbuckridge villages, Mpumalanga Province, South Africa

BY

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Degree: Master of Philosophy in Integrated Water Management

ABSTRACT

The study examined the perceptions and practices surrounding greywater use in Bushbuckridge Municipality, Mpumalanga Province, South Africa. The current research was conducted to understand how the participants in Bushbuckridge municipality perceive greywater and its potential for domestic non-potable applications, particularly in garden irrigation. The study was set out with the objectives of examining the impact of greywater use on household irrigation practices and evaluating how current treatment technologies influence the implementation and sustainability of greywater reuse in the Bushbuckridge municipality.

The study employed a descriptive survey design using structured questionnaires to collect data from 84 participants representing diverse socio-economic and demographic backgrounds for the Bushbuckridge municipality. The quantitative data were analysed using descriptive statistics with the STATA 12 program to determine the levels of knowledge, awareness, and adoption of greywater practices among the participants of the Bushbuckridge municipality.

The results showed that the majority of participants (58.33%) who were interviewed had some knowledge of greywater and its potential benefits; however, most (83.33%) were not aware of the available technologies for treating greywater before reuse. The results revealed that only a small proportion of participants reported using either chemical (9.52%) or traditional (7.14%) treatment methods to treat greywater. The data collected from the study further indicated that socio-demographic factors such as education level, marital status, income source, and household size significantly influenced awareness and willingness to reuse greywater. The majority of participants from Bushbuckridge municipality relied mostly on municipal water supplies, with smaller portions utilizing rainwater harvesting and purchasing water from tankers. The study concluded that, despite the growing recognition of water scarcity challenges faced by participants in the Bushbuckridge municipality, the lack of technological knowledge and support remains a significant barrier to sustainable greywater reuse.

The study recommended that capacitating community members in the Bushbuckridge municipality with increased education, training, and the promotion of low-cost greywater treatment technologies is essential to enhance the adoption of these technologies. The findings reported from the analyzed data have significant implications that can contribute to the broader discourse on sustainable water resource management in rural communities of Bushbuckridge municipality. The study further necessitates the importance of the Bushbuckridge municipality in emphasizing the role of social factors and community awareness in the successful implementation of domestic greywater reuse initiatives.

Keywords: Household irrigation, Water management, Technologies, Water conservation.

CHAPTER 1

GENERAL INTRODUCTION

1.1 Background

South Africa faces the enormous challenge of water scarcity, which is exacerbated by climate change, population growth dynamics, and limited infrastructure (du Plessis and du Plessis, 2017). Greywater refers to wastewater generated from household activities, including bathing, hand washing, and laundry. Greywater has since emerged as a promising resource for non-potable reuse, particularly in garden irrigation (Radingoana, 2021). This is because South Africa is a water-stressed country, with an imbalance between the demand and supply of potable water. Wastewater reuse is one of several vital strategies to strike a delicate balance between water supply and demand (Gul, 2023). The wastewater, depending on its use and any chemicals it contains, ends up as greywater (Paulo, Azevedo, Begosso, Galbiati, and Boncz, 2013; Friedler, Butler, and Alfiya, 2013; Raček, 2020). Therefore, greywater refers to wastewater from household sources that is not treated, including hand wash basins, kitchens, showers, laundry, and baths, i.e., all non-toilet uses (Khanam and Patidar, 2022; Wulan, Hamidah, Komarulzaman, Rosmalina, and Sintawardani, 2022).

Greywater is applied to supplement irrigation water on an informal basis (Radingoana, Dube, and Mazvimavi, 2020), particularly among middle- and upper-income households during droughts in gardens for food in informal settings, such as those in lower-income peri-urban areas and rural gardens (Radingoana, 2021). Greywater has the potential to contribute to food security in low-income communities by providing both sources, namely

crop plant nutrients and irrigation water (Rodda, Carden, and Armitage, 2010; Gorgich, Mata, Martins, Caetano, and Formigo, 2020). In cases where crops are produced in excess of household needs, they may be traded for additional income. Moreover, greywater has prospects for employment in the informal sector (Rodda et al., 2010; Radingoana, 2021). Globally, approximately one-fifth of freshwater consumption exceeds production capacity, and demand is expanding due to population growth and the expansion of agricultural activities and industrial areas; therefore, greywater may be a viable solution for irrigation (Al-Khatib, Al Shami, Garcia, and Celik, 2022). Demand occurs at national, cross-national, and local levels. Chartres and Varma (2010) asserted that water shortage is currently a third-world risk concern, even though water challenges differ in each country.

High evaporation levels and precipitation reduction exacerbated the water problem in South Africa, making the country water-scarce (Adom and Simatele, 2020). Adom and Simatele (2020) argued that, over the past 25 years, the use of water and its consumption have grown threefold and are estimated to continue growing for the next 50 years. There are 565 rivers in South Africa, with approximately 146 experiencing significant low flows, 105 experiencing low flows, moderate low flows (88), expected flows (104), moderate flows (51), and significant flows (63) (Donnenfeld, Crookes, and Hedden, 2018). It follows that more than 60% of rivers in the country are overutilized (Donnenfeld et al., 2018). This means that there is 339 low flow of river water. This can severely impact water quality, potentially resulting in decreased water availability for drinking purposes. The majority of the most important rivers have been over-utilized, resulting in reduced flows, ecological damage, and water quality issues. It is essential to prioritise water reuse strategies (Hansen, Bergman, Cowx, Lind, Pauna, and Willis, 2023). Some of the most critical strategies for adoption include recycling treated

wastewater, developing supplementary water sources, reducing dependence on overexploited rivers, and implementing measures to control pollution, which have been reported to be crucial for advancing sustainable water management and fostering a circular water economy (Jhansi and Mishra, 2013). The current study examines the community perceptions and practices of greywater use in the Bushbuckridge municipality. In particular, the study investigated how the participants from Bushbuckridge municipality perceive the use of greywater for domestic non-potable purposes, particularly for garden irrigation. Additionally, the study examined the extent to which the availability and performance of treatment technologies influence the adoption and management of greywater reuse within the municipality.

1.2 Research problem and justification of the study

The literature widely acknowledges the importance and potential of greywater reuse as a significant contributor to water conservation, particularly in water-scarce regions. Greywater reuse has been shown to reduce freshwater demand, alleviate pressure on wastewater treatment systems, and support household-level activities such as garden irrigation. Despite these demonstrated benefits, a notable gap remains between theoretical potential and practical implementation, especially in rural contexts of developing countries.

In South Africa, and particularly within local municipalities such as Bushbuckridge in Mpumalanga Province, the utilisation of greywater by rural communities remains largely underexplored. There is limited empirical evidence documenting existing greywater practices, community perceptions, and the environmental and public health implications associated with its informal use. This lack of context-specific research has contributed to

persistent negative public perceptions regarding greywater reuse, as well as uncertainty among households and local authorities about its safety and applicability.

Furthermore, the absence of clear and locally applicable legislative and regulatory frameworks governing the use of greywater presents a critical knowledge and governance gap. Current policies do not adequately address household-level greywater reuse, resulting in a lack of formalised adoption mechanisms. This regulatory ambiguity increases the risk of improper greywater application, which can potentially lead to environmental degradation and public health concerns. Consequently, there is a need for structured, evidence-based end-use models that promote the safe, efficient, and sustainable application of greywater, particularly for domestic garden irrigation in rural households.

To address these gaps, this research seeks to develop a holistic greywater system model tailored to the specific environmental and socio-economic conditions of communities within the Bushbuckridge Local Municipality. By integrating technical, social, and institutional considerations, the study aims to provide practical solutions that support the safe reuse of greywater at the household level.

The findings of this research offer several benefits to the municipality and broader stakeholders. The study provides recommendations to assist local authorities in identifying and addressing technical, financial, and social constraints associated with greywater management. It also highlights potential cost-saving and environmental benefits, including reduced freshwater consumption and decreased pressure on wastewater treatment infrastructure. From a policy perspective, the study contributes to the development of guidelines and policy recommendations that can inform amendments to existing regulatory

frameworks within the Water Management Area (WMA), thereby strengthening sustainable water management practices.

Ultimately, this research serves as a valuable resource for municipalities, policymakers, consultants, and community development practitioners. It supports informed decision-making, strategic planning, and capacity-building initiatives before the implementation of greywater irrigation projects. In addition, the study provides a foundation for educational programmes and training workshops aimed at improving awareness, acceptance, and implementation of safe and sustainable greywater reuse systems.

1.3 Aim and Objectives

This study focused on developing an end-use model for greywater to mitigate health risks and enhance water conservation practices in the Bushbuckridge municipality, Mpumalanga.

Specific objectives are:

- To assess the impact of domestic non-potable greywater use on garden irrigation practices in Bushbuckridge villages.
- To evaluate how current treatment technologies affect the implementation of greywater use in Bushbuckridge villages
- To analyse how residents' perceptions of greywater affect its adoption for garden irrigation in Bushbuckridge villages.

1.4 Research questions

- The primary research question is: How can an end-use greywater model mitigate health risks and enhance water conservation practices in Bushbuckridge villages?

- What are the impacts of domestic non-potable greywater use on garden irrigation practices in Bushbuckridge villages?
- What is the role of available treatment technologies in facilitating or hindering greywater use in Bushbuckridge villages?
- How do residents' perceptions of greywater affect its adoption for garden irrigation in Bushbuckridge villages?

1.5 The organization of the dissertation

- **Chapter 1: Introduction**

This chapter outlines the study's background, problem statement, purpose, objectives, and the significance of the research, as well as the definitions of key concepts, limitations, and delimitations.

- **Chapter 2: Literature review**

This chapter presents a comprehensive literature review on the topics of greywater generation, domestic non-potable use of greywater, the role of available treatment technologies, perceptions of greywater, and factors that hinder the use and understanding of greywater.

- **Chapter 3: Methodology**

In this chapter, the research methodology used in this study is explained. The chapter was based on the research approach, research design, research methodology, population, data collection methods, and ethical considerations.

- **Chapter 4: Analysis and interpretation of survey data**

In this chapter, the study's findings are discussed. The discussion started by focusing on the demographic characteristics of surveyed participants, followed by the presentation of conclusions based on the secondary aims of the research.

- **Chapter 5: Conclusions and Recommendations**

The chapter aims to detail the conclusions from the whole study, considering the research results relevant to the research objectives. The chapter concluded with recommendations and suggestions for further research.

CHAPTER 2

LITERATURE REVIEW

2.1. Introduction

This chapter presents a comprehensive review of existing literature to establish both the theoretical and contextual underpinnings of the study. The review examines central themes related to greywater generation and its domestic non-potable applications, with a particular emphasis on household and garden irrigation practices. It further analyzes the role and efficacy of available treatment technologies in improving the safety, reliability, and sustainability of greywater reuse. In addition, the chapter examines public perceptions and attitudes toward greywater utilization, as well as the social, technical, and institutional barriers that continue to impede its widespread adoption. Through this critical synthesis, the chapter seeks to enhance the understanding of greywater management within the context of water-scarce rural and peri-urban settings, while identifying both the potential opportunities and the challenges inherent in its implementation.

2.2. Importance of Greywater

2.2.1 Greywater savings: A case of households in various countries

Greywater utilization is crucial due to its potential to reduce freshwater demands and alleviate stress on water treatment systems (Al-Husseini et al., 2021). The previous report by Al-Husseini et al. (2021) indicated that the reuse of greywater for flushing toilets alone could enable households to save up to 30% of water, as well as office buildings to save up to 60%. In addition, Al-Husseini et al. (2021) emphasized that reusing greywater for garden irrigation can increase savings by approximately 40% for households. Considering the average quantities of wastewater produced in developed countries and assuming that all

greywater streams could be reused entirely, potential overall water savings of up to 80% could be theoretically achieved (Al-Husseini et al., 2021). This estimation illustrates the immense potential of greywater reuse as an alternative water resource, particularly in addressing the global challenges of water scarcity, urbanization, and climate change. Greywater reuse systems have garnered significant attention in various parts of the world, primarily due to their ability to reduce potable water demand, lower wastewater generation, and promote sustainable water management.

In developed countries, the practical implementation of greywater reuse initiatives has reported considerable success. For example, in Australia, where water scarcity and prolonged drought conditions are recurring challenges, many households have adopted recycling systems for greywater and aim to incorporate them into integrated water management strategies (Friedler and Hadari, 2006; Pidou et al., 2007). Previous studies have shown that reusing greywater for toilet flushing and garden irrigation can result in potable water savings ranging from 35% to 50%, depending on system design, household water use, and the extent of reuse (Friedler and Hadari, 2006; Pidou et al., 2007). Similarly, a study conducted in Israel, regarded as an international leader in advanced water reuse technologies, reported that greywater was extensively utilized for non-potable purposes, with household water savings estimated at up to 40% (Gross et al., 2015). The report from Spain documented the outputs of research conducted in the metropolitan area of Barcelona, showing that residential greywater reuse can decrease domestic water consumption by as much as 38%, particularly when implemented in conjunction with complementary water conservation measures (Domènech and Saurí, 2010).

According to a study conducted in Germany, it was reported that strong environmental sustainability policies have promoted the adoption of decentralized greywater systems in apartment complexes and institutional buildings, resulting in reductions of between 25% and 45% in potable water use (Nolde, 2005). Taken together, the presented examples from different developing countries underscore the significance of policy support, technological innovation, and public acceptance in translating the theoretical potential of greywater reuse into measurable conservation outcomes.

In the South African context, many regions face drought and limited access to clean water; the potential for greywater reuse is increasingly being recognized. A report from research conducted in the Western Cape and Gauteng provinces has documented that domestic greywater could reduce potable water demand by 30–50%, particularly in households that rely heavily on municipal supply for irrigation and cleaning (Rodda et al., 2011). However, increased implementation remains constrained by concerns about public health, insufficient regulation, and lack of public awareness regarding safe reuse practices (Maimon et al., 2014). The theoretical potential for water savings may approach 80% under optimal conditions; however, the actual efficiency of greywater reuse systems is influenced by several factors, including water use behavior, climate conditions, type of treatment technology, and maintenance practices. Nonetheless, observations across diverse contexts show that greywater reuse can significantly reduce pressure on potable water supplies, enhance household water resilience, and ensure sustainable urban and rural development (Al-Husseini et al., 2021; Jefferson et al., 2004).

2.2.2 Potential for irrigation

According to Rodda, Carden, Armitage, and du Plessis (2011), assessing greywater for suitability for irrigation use, constituent values should preferably comply with the target limits but certainly be within the maximum limits (except for *E. coli*). Moreover, Rodda et al. (2011) asserted that the guidelines specify that where extensive or high-technology treatment would be required to make greywater suitable for irrigation use of any kind, then off-site disposal would likely be a safer and cheaper option. A report by Radingoana, Dube, Mollel, and Letsoalo (2019) found that 66% of households in Ga-Nkwana village, Limpopo, reused their greywater for home gardening, compared to 59% in Ga-Seroka, Limpopo. This implies that greywater has potential for garden irrigation in rural areas. Bushbuckridge is situated in rural areas; thus, it is essential to assess the impact of domestic non-potable greywater use on garden irrigation practices.

2.2.3 Water savings in urban vs. rural settings

In a study by Njoku, Durowoju, Uhunamure, and Makungo (2022), it was argued that while both urban and rural settings face water scarcity challenges, urban areas often have greater potential for water conservation through technological and infrastructural improvements, while rural areas require a greater focus on community-based solutions and equitable access to resources. Water savings strategies and their effectiveness differ between urban and rural settings due to varying water needs, infrastructure, and access (Graymore and Wallis, 2010). In rural settings, water savings are achieved through the use of storage facilities, such as JoJo tanks and basins (see Figure 2.1). These storage systems enable most households to collect and store greywater for later use, thereby reducing their dependence on municipal water supplies. The stored water is often used for non-potable purposes such as garden

irrigation, cleaning, and livestock watering, which helps to conserve limited freshwater resources. Moreover, the presence of such facilities reflects an increasing awareness among rural households about sustainable water management practices and the need to adapt to recurring water shortages. Urban areas often focus on water-efficient appliances and infrastructure upgrades, while rural areas may prioritize access to clean water sources and addressing water quality issues (Graymore and Wallis, 2010).

The reuse of greywater effluent offers another means of alleviating pressure on freshwater supplies. It has been noted that greywater reuse for flushing toilets and irrigation in South Africa can reduce the consumption of clean water for those activities by up to 50% (Malaza, Magaba, and Mpungose, 2024). A study conducted by Sheridan et al. (2023) revealed that building structures with more multifunctional designs (such as water collection, washing, and channelling multiple types of water) resulted in higher usage. This study was conducted on small-scale constructed subsurface flow wetlands (CWs) in an informal settlement in Johannesburg, South Africa, where sanitation services are currently limited. Rodda et al. (2011) revealed that greywater offers the most significant potential for improvement in household nutritional status and social functioning in poor rural settlements, as well as in urban and peri-urban settlements surrounding major metropolitan areas in South Africa. The challenge, then, lies in identifying the conditions and limitations under which greywater can be used beneficially in such settlements.

A real-world example of greywater success in South Africa can be seen in the Accessible Greywater Solutions for Urban Informal Townships in South Africa (URBWAT) project, which focused on developing and implementing greywater treatment systems in the informal settlement of Alexandra, Johannesburg (Sheridan, Bode-Aluko, Kappelmeyer, Metson,

Rawhani, Stephenson, Thatcher, and Tonderski, 2023). The project involved building and monitoring small-scale constructed wetlands for greywater treatment in collaboration with residents. This iterative design process, involving residents in the design and maintenance of the systems, proved successful in identifying challenges and adapting solutions to the specific needs of the community and the site (Sheridan et al., 2023). AquaRenu is currently collaborating with contractors in Mpumalanga to install greywater units in selected local schools in areas surrounding the University of Cape Town.

Figure 2:1: Image showing the storage facilities of water under rural settings (Image by NP Marota)

2.3 Legal and Policy Landscape

2.3.1 International guidelines

Around the globe, the availability of legal guidelines to manage greywater prevents the creation and implementation of reuse wastewater processes (Rodda et al., 2010; Van de Walle, Kim, Alam, Wang, Wu, Dash, Rabaey, and Kim, 2023). Rodda et al. (2010) and World Health Organization (2022) discovered that mostly policies on greywater reuse are based on suggestions coming from inter-governmental institutions, namely, the National Sanitation Foundation (NSF/ANSI standard 350), the WHO, including the reuse of greywater for irrigation of gardens which offer quality water policies for non-potable urban practices, especially irrigation and toilets. Moreover, a report by Rodda et al. (2010) and the WHO (2022) revealed that policies on water quality are primarily based on a narrow range of aesthetic and hygienic parameters. The total coliforms measurement excludes international reuse policies for direct potable greywater reuse, which have not yet been implemented.

Available reuse policies, parameters for quality water, and classification of reuse alternatives are generally not in sync between institutions and nations, affecting comparisons between the guidelines of the two (Rodda et al., 2010; Van de Walle et al., 2023). A new European legislation has been signed regarding the elements or characteristics for the reuse of wastewater streams in agriculture, effective as of June 2023. Moreover, codes of plumbing in the United States of America, California, Australia, Queensland, and Chile already offer legalisations and policies on the installation and utilization of closed-loop reuse greywater.

2.3.2 South African Legal Framework and Gaps

A study conducted by Gul (2023) revealed that distinguished governing legalisations and regularity activities of reuse wastewater projects are: National Environmental Management Act (Act 107, 1998); National Water Act (Act 36, 1998); Mineral and Petroleum Resources Development Act (Act 28, 2002); National Environmental Management: Waste Act (Act 59, 2008); Municipal bylaws and Coastal Management Act (Act 24, 2008); Water Services Act (Act 108, 1997). Currently, in South Africa, formal policies to regulate greywater use for garden irrigation are unavailable (Rodda et al., 2010).

There is no specific reference to greywater in the National Water Act (NWA) No. 36 of 1998 (Republic of South Africa, 1998). However, the sections concerning water resource management implicitly cover greywater, particularly in the context of water-saving measures (Carden, 2006). This study will yield guidelines, policy recommendations, or modifications to existing regulations that better support sustainable water use practices. Vala and Malaza (2024) conducted a critical analysis of the legalisation framework. They identified gaps and problems in the law, involving a lack of clarity, enforcement limitations, mechanisms, and inconsistencies.

2.4 Barriers to Greywater Reuse

2.4.1 Technology dimension

In Middleburg of Mpumalanga, users of greywater made complaints about maintenance problems related to the technology and evaluations conducted by an independent professional. A pilot study was conducted for individuals using greywater in rural areas, focusing on flush sanitation in the Steve Tshwete Local Municipality (2020/2021). The

available equipment in the plants to treat water is outdated, resulting in a significant maintenance cost (Steve Tshwete Local Municipality, 2020/2021). In Bushbuckridge, Mpumalanga Province, greywater reuse is primarily emphasized for flushing toilets and gardening (Mafuwane, Muchie, and Nenzhelele, 2023).

2.4.2 Social dimension

In Mpumalanga, domestic water use is allocated 42% and 23%. In contrast, irrigation accounts for 55% of both water use in the Olifants Water Management Area (WMA) and water use in the Inkomati-Usuthu WMA, respectively. The province, as well as its municipalities, faces drought challenges. The province could save 55% of water if greywater were considered for irrigation (Co-operative Governance and Traditional Affairs, 2022).

Factors that affect water reuse or greywater include issues of quality, greywater characteristics, a lack of a legal framework to manage greywater, environmental and human health risks, a guarantee of acceptable monitoring practices to ensure customer safety, and adverse customer views on greywater reuse. These factors are prevalent in Bushbuckridge, Mpumalanga province communities, and there is no end-use model for greywater to mitigate health risks and enhance water conservation practices. Given the critical water shortage in South Africa and the potential of greywater reuse to minimize this, understanding the technological, social, and environmental dimensions of greywater use becomes imperative.

To ground this study, a decision tree for establishing appropriate greywater management alternatives is presented, connected to the greywater generation rate framework developed by Carden, Armitage, Winter, Sichone, and Rivert (2007). Carden et al. (2007) estimated the average daily water usage, dwelling unit density, and calculated the greywater generation

rate across non-sewered settlements. An end-use model, as reported by Jacobs and Haarhoff (2004), and theories relevant to understanding the public's perception of acceptance of recycled wastewater, such as the Theory of Planned Behaviour and the Theory of Reasoned Action, the Health Belief Model, the Transtheoretical Model, as well as Social and Technological theories of behaviour. In addition, this study will serve as a basis for research to assess whether people's perception of grey water influences its use (Nel, 2022). The focus in terms of end-uses was on garden irrigation, as it is the primary use area for water from greywater (Ilemobade, Olanrewaju, and Griffioen, 2009; Dobrowolsky, Mannel, de Kwaadsteniet, Prozesky, Khan, and Cloete, 2014). The management of risks associated with the irrigation use of greywater after minimum analysis (Figure 2.2). Figure 2.2 below illustrates a significant contribution to the initiation and management of greywater irrigation implementations in South Africa.

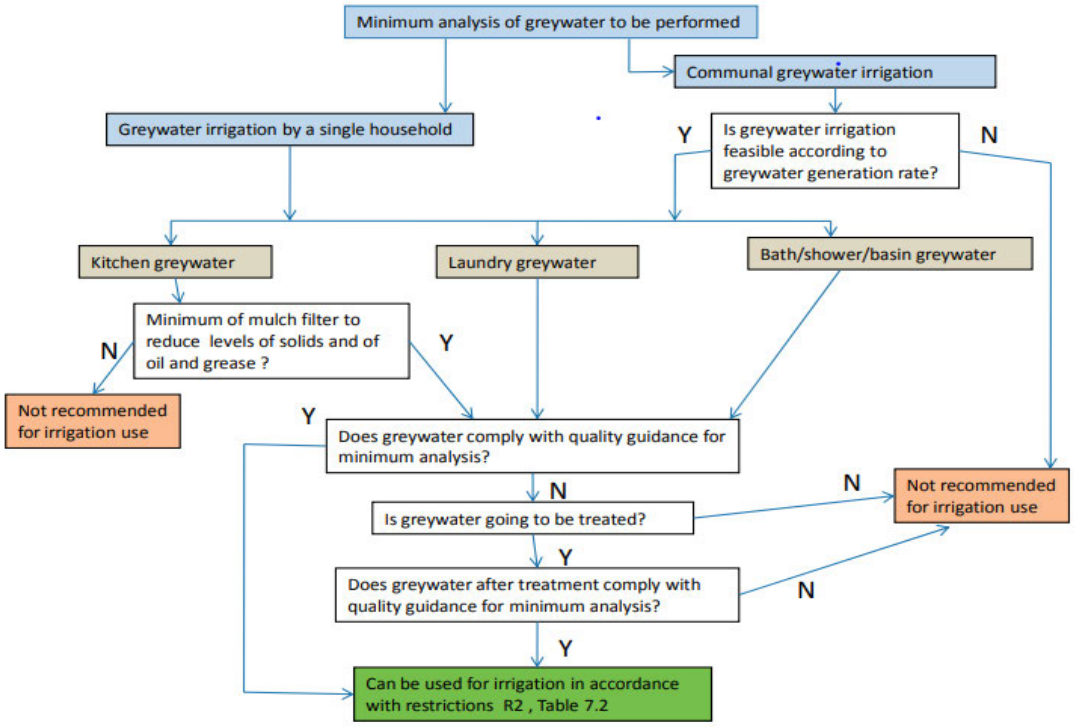

Figure 2:2: The management of risks associated with the irrigation use of greywater after minimum analysis. (Source: Rodda et al. 2011).

2.5. Concluding remarks

In conclusion, the reviewed literature highlights the significant potential of greywater reuse as a sustainable water management strategy, particularly in water-scarce rural and peri-urban contexts. While various treatment technologies and non-potable applications, such as garden irrigation, offer promising benefits, regulatory gaps and negative public perceptions. The literature further reveals a need for context-specific frameworks that integrate social, institutional, and environmental considerations. These identified gaps underscore the importance of the present study in contributing empirical evidence and practical insights to support the safe, acceptable, and effective implementation of greywater reuse systems.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

In this chapter, the research methodology adopted for this study is explained in detail. The chapter outlines the research approach, research design, methodology, target population, data collection methods, and ethical considerations. The study was conducted in Bushbuckridge Local Municipality, situated in the Ehlanzeni District of the Mpumalanga Province, South Africa (Figure 3.1). Bushbuckridge lies between 24°50′S latitude and 31°03′E longitude, covering an estimated total land area of approximately 7,152 km².

3.2 Description of the study area: Bushbuckridge Local Municipality

Bushbuckridge is one of the largest municipalities in Mpumalanga Province (see Figure 3.1) and forms part of the Kruger to Canyons Biosphere Region, bordering the Kruger National Park to the east and the Maruleng Municipality in Limpopo Province to the north. The municipality was named after the extensive bushveld and ridges characteristic of the region. It serves as a key administrative and service centre for several surrounding rural settlements.

3.3 Climatic conditions

The area is characterized by a semi-arid to subtropical climate, with hot summers and mild winters. The average annual rainfall ranges from 500 to 800 mm, with the majority falling between November and March. The topography is mainly flat to gently undulating, with some hilly areas in the north. Bushbuckridge’s land cover is dominated by rural settlements, natural

vegetation, and agricultural lands, with communal tenure systems prevalent throughout most villages.

A

B

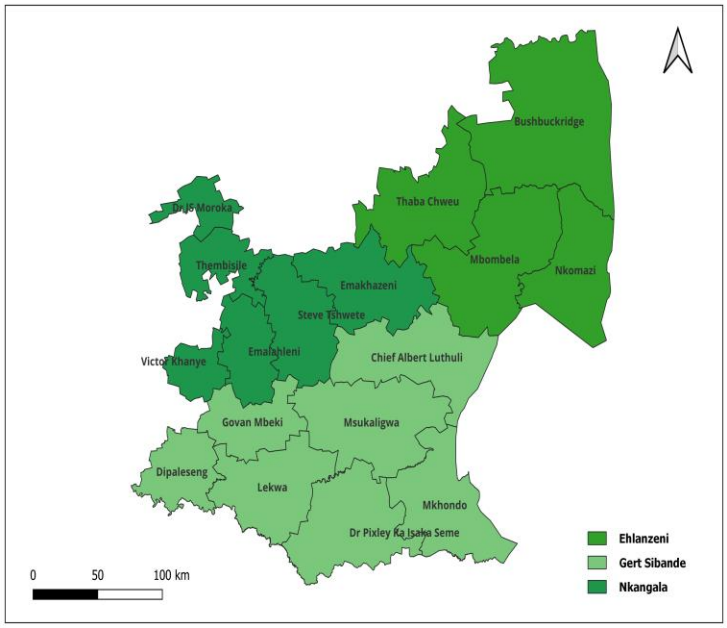

Figure 3:1*:* Map showing South African provinces (A) and the different districts of Mpumalanga Province (B), including the location of Bushbuckridge Local Municipality within the Ehlanzeni District.

The Department of Agriculture, Land Reform and Rural Development (DALRRD, 2020), has reported that a large proportion of the land is under communal ownership, administered by traditional authorities, which influences patterns of land use and agricultural investment.

3.4 Water Resources

Water availability remains a critical issue in Bushbuckridge Local Municipality. The municipality heavily relies on surface water from nearby rivers, including the Marite, Sand (Manyeleti), and Sabie Rivers, which are part of the larger Inkomati-Usuthu Water Management Area. The groundwater serves as a supplementary source, particularly in remote villages where access to piped water is limited. The municipality is facing water supply challenges due to erratic rainfall, high evaporation rates, and limited infrastructure. The limited water sources affect domestic and agricultural activities (DWAF, 2018). Greywater reuse and rainwater harvesting are gaining attention as potential strategies to enhance household water security and support small-scale irrigation, particularly in villages where municipal water supplies are intermittent.

3.5 Agricultural activities

Agriculture plays a central role in the livelihoods of many Bushbuckridge residents in Mpumalanga. The agricultural sector is primarily encompassed by smallholder and subsistence-based farming, with households engaging in both crop and livestock production. Bushbuckridge has several irrigation schemes, including the New Forest, Manyeleti, and Amashangana schemes, which the Department of Agriculture and Rural Development supports. Most schemes operate below capacity due to poor infrastructure maintenance, limited technical support, and an unreliable water supply (DAFF, 2017).

3.6 Socio-Economic context

Bushbuckridge is home to approximately 541,000 residents (Stats SA, 2022), most of whom live in rural villages and depend on social grants, remittances, and subsistence agriculture.

The area experiences high unemployment levels and limited access to reliable infrastructure, which intensifies vulnerability to poverty and food insecurity. These conditions make Bushbuckridge an essential site for exploring innovative water management strategies, such as domestic greywater reuse for garden irrigation, which could contribute to household food production and improved water use efficiency.

3.7 Qualitative approach

The qualitative approach employed in this study aligns closely with its objectives, which included facilitating a comprehensive exploration of greywater use in Bushbuckridge villages. The qualitative approach employed in this study enabled the researcher to gather in-depth, narrative data from community members and leaders through semi-structured interviews, providing valuable insights into local perceptions, practices, and challenges associated with the utilization of greywater. This approach enabled the researcher to examine not only the behaviors and attitudes surrounding greywater use but also to identify contextual factors influencing its adoption, thereby directly addressing the objective of assessing the impact of greywater on garden irrigation practices (Griffin, 2013).

In addition, the qualitative approach enables the development of context-specific theories regarding the effects of current treatment technologies on greywater utilization, supporting the objective of evaluating technological influences (Creswell and Creswell, 2018). Similarly, the verbal data collected illuminated residents' perceptions and beliefs about greywater, which are crucial for understanding its acceptance or resistance, thereby directly informing the objective to analyze how perceptions affect its adoption. Overall, the qualitative, flexible

data collection approach provided insight into the social, technological, and perceptual dimensions relevant to greywater use in the study area.

3.8 Research strategy

This study employed an exploratory qualitative strategy, which involved an in-depth investigation of greywater use, treatment technologies, and resident perceptions within the Bushbuckridge villages in Mpumalanga Province. The research strategy employed in this study aligns with the interpretivist paradigm, which guides the understanding of social phenomena from the perspectives of community members and leaders. The approach was comprehensive, as evidenced by the verbal data collected through in-depth interviews and semi-structured questionnaires; it allowed the researcher to uncover nuanced insights into behaviors, attitudes, and contextual factors influencing greywater practices. This approach directly supports the study's objectives of assessing the impact of greywater on garden irrigation, evaluating the influence of treatment technologies, and analyzing residents' perceptions from exploring the social reality as experienced by those involved in greywater use.

3.9 Time horizon

A cross-sectional research design was employed in this study, and data were collected in January and April 2025. This approach involved collecting data from a population in the Bushbuckridge municipality at a single point in time. The design used in this study was appropriate because it allowed the researcher to assess perceptions, attitudes, and practices related to greywater use among households in the Bushbuckridge municipality. The approach provided sufficient time for data collection, as information was captured in the

questionnaires, making it easier for the researcher to avoid repeated follow-ups.

The choice of a cross-sectional approach in this study was motivated by several practical and methodological considerations. The first point of consideration was the nature of the research project, which necessitated the use of a design. The current study is being submitted as a mini-dissertation, so the current approach assisted in capturing relevant information within a limited timeframe. The approach used did not allow for monitoring of changes over time because the study's scope was not feasible due to resource constraints and duration limitations. The second point captured the existing conditions and behaviors rather than tracking changes over time. The cross-sectional design approach made it suitable for identifying the current state of greywater generation, utilization, and treatment practices in the selected communities within the Bushbuckridge municipality. The approach has been utilized in other studies related to environmental and social sciences to explore relationships between variables such as knowledge, attitudes, and practices at a single point in time (Creswell and Creswell, 2018). The approach enabled the researcher to examine how factors such as awareness, access to water, and socio-economic status influence the use of greywater for domestic irrigation in communities of the Bushbuckridge municipality.

The approach's ability to concurrently analyze relationships provided valuable insights into current behavioral patterns and constraints that shape greywater management practices in the Bushbuckridge municipality. Although the cross-sectional design approach does not permit the establishment of causality, it provides reliable descriptive insights that are important for understanding the study. The findings obtained from this research, conducted using a cross-sectional approach, can serve as a foundation for future longitudinal and intervention-based studies. These studies could examine changes in

greywater use over time to assess the impact of awareness and policy interventions.

3.10 Research design

The study employed a case study research design, which allowed for an in-depth and contextual exploration of greywater reuse practices within rural communities in the Bushbuckridge municipality, Mpumalanga Province. The case study design used in the study was suitable as it provided an understanding of the contemporary phenomenon within the aspect of grey water utilization. In this study, the case study approach provided an opportunity to examine how environmental conditions, social dynamics, and household behaviors collectively shape greywater generation and reuse practices in the Bushbuckridge municipality communities. This design was chosen because it enabled a comprehensive investigation, allowing the researcher to capture both the complexity and diversity of factors influencing greywater management in a natural setting. The focus of the geographical area in our study provided comprehensive insights into how Bushbuckridge community members utilized water, community perceptions, and the socio-economic conditions that determine the feasibility of greywater reuse in different areas.

The in-depth understanding of the data collected through the case study research design would not have been possible through large-scale survey approaches, which often overlook the contextual subtleties of community-based practices. The case study design, in the context of the current research, supported the integration of multiple data sources, including household surveys, interviews, and direct observations. The case study design enhanced the validity and reliability of the findings achieved in this study by providing a more detailed understanding of how households perceive, treat, and use greywater in the Bushbuckridge.

The case study approach further enabled the identification of both barriers and opportunities for promoting sustainable greywater reuse in rural settings, providing insights that could inform local water management policies and community awareness initiatives. Additionally, the approach chosen for the case study design aligned with the study's applied research orientation, which aimed to describe existing practices and contribute to problem-solving and decision-making within the Bushbuckridge municipality. The study generated findings that are locally relevant and can serve as a model for similar rural areas facing water scarcity challenges across South Africa.

3.11 Population

The study population comprised different households within the Bushbuckridge municipality that actively engage in home gardening and may utilize greywater for informal irrigation practices, as well as a community leader knowledgeable about local water-related issues. This population was purposefully selected for this study due to its direct relevance to the study's objectives, which investigated domestic greywater generation, reuse practices, and the socio-environmental factors influencing such practices in a rural South African context. The households in the Bushbuckridge municipality served as the focus group for the investigation, as they represent the primary unit of domestic water use and management in the communities. The majority of the households in Bushbuckridge relied on limited and often unreliable water supplies for their daily needs, including home gardening, which serves as an essential source of food security and supplementary income.

The reuse of greywater in the communities, whether intentionally or out of necessity, forms an integral part of household water management practices. The focus on these households

in this study captured the experiences and behavioral patterns that illustrate how residents adapt to water scarcity through greywater reuse. The population included the community leader in the study, which added depth and context to the research. However, because most communities only have one community leader, the in-depth information acquired can only be utilized as observations in the study. This is because most community leaders possess valuable insights into local governance structures, collective water management initiatives, and historical patterns of water access and utilization. Information from community leaders and community members can help contextualize household-level practices within the broader socio-political and environmental framework of the Bushbuckridge municipality. This inclusion of community leaders in the population also ensured that the findings relied not only on individual behavior but also on the community's collective understanding and response to water scarcity challenges.

The population, comprising different inhabitants (community leaders or individuals), played a significant role in this study, as it created a strong link between domestic water usage, household irrigation, and community knowledge in rural settings, such as the Bushbuckridge municipality. Understanding how households perceive and use greywater provides essential insights into local adaptation strategies for coping with limited freshwater availability. Additionally, the capability to analyze practices within their socio-cultural context enabled the researcher to identify opportunities for improving water efficiency, promoting safe greywater reuse, and informing community-based awareness and intervention programs aimed at sustainable water management.

The selection of individuals and community leaders as part of the population was closely aligned with the study's purpose to ensure that the impacts, perceptions, and challenges associated with domestic greywater use were assessed. The collected data from the population ensured that it was contextually grounded and practically relevant to policy and community development in the Bushbuckridge municipality.

3.12 Sampling size

A total of 84 households were selected to participate in the study using a convenience sampling technique, which was complemented by purposive sampling, including one community leader. Convenience sampling was selected due to its practicality and suitability for field-based research in rural settings, such as the Bushbuckridge municipality. Additionally, logistical constraints, time limitations, and varying levels of household accessibility were taken into account, as they can impact data collection. This approach enabled the researcher to engage readily available participants who were willing to participate and actively involved in answering questions on aspects of household gardening or greywater utilization.

The purposive sampling of community leaders ensured that they were included as participants, providing the researcher with in-depth knowledge and authority on local water management practices, community challenges, and informal adaptation strategies. The community leaders provided a broader contextual understanding that complemented the household-level data collected by the researcher. Additionally, they made significant contributions to linking micro-level practices to macro-level community perspectives and policy awareness. Both practical and methodological considerations guided the decision to

limit the household sample to 84 participants. The qualitative research perspective guides the focus of depth of understanding rather than statistical generalization. The aim was to gather rich, detailed, and context-specific insights into household perceptions, attitudes, and practices related to the utilization of greywater. In qualitative studies, such as the current one, smaller sample sizes, as presented in this study with 84 participants, are considered appropriate, as they allow for comprehensive engagement with participants and detailed exploration of their lived experiences (Creswell and Creswell, 2018; Guest, Bunce, and Johnson, 2006).

The chosen sample size was justified by the principle of data saturation, which is the point at which no new information, themes, or insights emerge from additional data collection (Fusch and Ness, 2015). As part of the interviews, it was visible that responses from the participants began to overlap and reinforced previously identified themes after more than 50 participants were interviewed, indicating that saturation had been achieved. This confirmed that the sample size of 84 households was sufficient to capture the diversity and consistency of experiences regarding greywater utilization within the Bushbuckridge communities. The sample size was actually larger than that previously conducted in exploring domestic water reuse and environmental practices in similar rural and peri-urban settings, where participant numbers ranged from 15 to 30 households (Sefike, 2004; Al-Husseini et al., 2021).

The sample size used for the current study ensured a balance between data richness, feasibility, and representativeness within the qualitative framework of the study. Overall, the sampling strategy employed in this study, which combined convenience and purposive methods, provided a detailed and contextually relevant dataset, capturing both the individual household dynamics of greywater reuse and the broader community perspective necessary

for a comprehensive understanding of local water management practices in the Bushbuckridge municipality.

3.13 Data collection techniques

Data collection for this study was conducted through semi-structured interviews and one focus group discussion, guided by an interview plan designed to explore the research project's objectives. The interview process and guidelines were developed through a thorough review of relevant literature on household water use, greywater management, and environmental behavior (Sefike, 2004). The data collection questionnaire included a combination of open-ended and probing questions that allowed the participants to share their experiences, perceptions, and practices regarding the use of greywater for household gardening. The questionnaire was structured around key themes, including water availability, greywater utilization, treatment methods, perceived risks, and community attitudes.

The researcher conducted a mini-pilot survey with ten participants from a nearby community to assess the clarity and flow of the questions. Some minor adjustments were made to ensure the questions were culturally appropriate, understandable, and aligned with the participants' everyday experiences. The data collection took place between January to April 2025 within the Bushbuckridge municipality. The primary homes of participants and community meeting spaces were reserved to ensure comfort and convenience. The interview lasted approximately 30 to 45 minutes with the participants; however, participants' willingness to elaborate on specific issues took more time. The focus group discussion, which consisted of eight participants, ran for approximately 90 minutes and provided an opportunity for participants to engage collectively, compare their experiences, and reflect on community-

level perspectives. Six of the groups utilized in this study aligned with the recommended literature, which suggests that focus groups with 6 to 8 participants allow for meaningful interaction without overwhelming the discussion (Krueger and Casey, 2015; Nyumba et al., 2018).

The researcher received consent to audio-record the interviews to ensure that data accuracy and reliability were maintained. The recordings enabled the researcher to capture the tone, emphasis, and emotional elements that are often lost in written summaries. There was one community leader who declined to be audio-recorded due to personal preference. In this case, the researcher took comprehensive and contemporaneous field notes to ensure that the full content and context of the discussion were accurately preserved. To get the best data, the researcher ensured that the participants' preferred language (isiSwati) was used, and where necessary, the responses were translated into English during transcription. The notes taken during and after each interview included observational comments, such as non-verbal cues, the physical setting, and contextual details, which enriched the interpretation of the data during analysis. The combination of the individual interviews and focus group discussions provided both depth and breadth of understanding of the challenges faced.

The individual interviews offered private, reflective insights into personal practices and household challenges. At the same time, the focus group facilitated a more collective dialogue, revealing shared values, social norms, and communal attitudes toward greywater reuse. The same approach used in this study was also applied in previous studies on domestic water management in rural communities (O'Connor et al., 2019; Tumbo et al., 2022), highlighting the value of using multiple qualitative methods to enhance the credibility and validity of the findings.

3.13 Data analysis

In this study, Creswell's (2014) six-step process for thematic analysis was followed to ensure accurate data analysis. The steps included organizing the data, reading through it carefully to gain a sense of its overall meaning, coding significant statements, identifying and reviewing emerging themes, defining each theme clearly, and finally presenting the findings in written form. The process of coding the data included the meaning of the codes and themes that emerged directly from the participants' own words, rather than being imposed beforehand. The themes were also aligned with the study objectives, allowing the researcher to connect with the lived experiences and perspectives on greywater utilization. In practice, this involved reading the transcripts and notes, grouping similar ideas, and developing categories that captured patterns in the data.

The process described the setting, people, and their shared meanings around greywater reuse within the Bushbuckridge municipality. In addition to the qualitative analysis, the descriptive statistics in STATA 12.1 were used to provide a clearer picture of the community's characteristics and the challenges they face in utilizing greywater. Basic measures, such as frequencies and percentages, were calculated to summarize responses and identify common trends. The results of this analysis were presented in tables and graphs to enhance clarity and facilitate easy, straightforward interpretation of the data. The combination of the thematic and descriptive approaches provided comprehensive and context-capturing experiences through themes while also presenting an overall view of greywater practices within the communities.

3.14 Trustworthiness of the study

The study employed qualitative research to ensure the trustworthiness, as this is important for establishing the quality and integrity of the findings. According to Abbas (2024), trustworthiness is demonstrated through four key criteria: credibility, dependability, confirmability, and transferability. In this study, each of these criteria was carefully addressed to enhance the consistency and reliability of the research process.

3.14.1 Credibility

Credibility refers to the confidence in the truth of the findings and whether the results accurately represent participants' views and experiences. In this study, multiple strategies were employed. This included prolonged engagement with participants during interviews and focus group discussions, which allowed for a comprehensive exploration of issues surrounding greywater use and household irrigation.

The data sources were achieved through interviews with households, discussions with a community leader, and observation notes, which helped to validate the consistency of the information gathered. Also, the researchers were able to summarize the key points at the end of each interview to confirm participants' understanding and ensure their perspectives were accurately captured.

3.14.2 Dependability

Dependability refers to offering stability and consistency of data over time and across various conditions encountered during data collection. The best way to ensure reliability is to carefully document and transparently record the research process, including detailed records of sampling decisions, interview procedures, and data analysis steps. The record-keeping and

detailed information assist in maintaining the methodological choices, raw data, and coding processes, which would allow another researcher to trace the logic of the study. Additionally, researcher debriefing sessions were held with academic colleagues to discuss the emerging themes and interpretations, thereby enhancing the reliability of the analysis.

3.14.3 Confirmability

Confirmability focuses on ensuring that the study's findings are shaped by the participants' experiences, rather than the researcher's, which can introduce bias or personal motivation. In this study, confirmability was achieved through reflexivity, where the researcher kept reflecting on their positionality and potential influence on data collection and interpretation. The use of verbatim transcripts, field notes, and recorded interviews provided a clear record-keeping trail demonstrating how findings were grounded in participants' actual narratives.

3.14.4 Transferability

Transferability relates to the extent to which the findings can be applied in other contexts. Although the study focused specifically on Bushbuckridge municipality, it was clear that the rich, thick descriptions of the research context, participant characteristics, and environmental setting were provided to enable readers to determine whether the findings may be relevant to similar rural communities facing water scarcity and household greywater use challenges.

The report by Abbas (2024) suggests that it is the researcher's role to ensure generalizability while providing sufficient contextual detail to allow others to make informed judgments about the applicability of the findings. If the researcher adheres to the four trustworthiness criteria, this study ensures that its findings are credible, consistent, objective, and contextually

meaningful, thereby reinforcing its overall validity and contribution to understanding greywater reuse practices.

3.15 Study limitations

The study provided valuable insights into household greywater reuse practices in the Bushbuckridge municipality; however, several limitations should be acknowledged. Firstly, the sample size was relatively small, comprising 84 households and one community leader. The sample size is compared with the population of the communities that are within the Bushbuckridge municipality. This limitation was primarily due to time and resource constraints, as the data collection period was limited to four months (January to April 2025). Although the small sample allowed for in-depth engagement with participants, it may limit the generalizability of the findings to other communities.

The second part is that the study relied on convenience sampling, which was chosen to ensure accessibility and feasibility within the given time frame. However, this non-probability sampling approach may have introduced selection bias, as participants who were more readily available to participate might not fully represent the broader population of households in the Bushbuckridge municipality. Consequently, the findings should be interpreted as reflective of the selected participants rather than the entire community.

The third aspect is that one interview with the community leader was not audio-recorded at the participant's request. Although detailed field notes were taken during and immediately after the discussion to capture key insights, the absence of a recording may have reduced the richness and completeness of the data obtained from that interview. Lastly, the study was conducted within a specific temporal context, providing a snapshot of greywater use and

perceptions at a single point in time. Seasonal variations, such as policy developments occurring after data collection, may influence household practices and attitudes in ways not captured by this research. Although there are challenges as narrated by the limitations, it should be noted that the study offered an essential contextual understanding of domestic greywater reuse in a rural South African setting and provides a foundation for further research with larger and more diverse samples.

3.16 Conclusions

This chapter describes the qualitative research methodology used to explore greywater reuse practices in Bushbuckridge municipality. The interpretivist paradigm and case study design enabled rich insights into community experiences, while thematic analysis supported the identification of patterns. The study ensured that the ethical principles and strategies for ensuring trustworthiness were applied throughout. The next chapter presents the research findings.

CHAPTER 4

RESEARCH FINDINGS AND DISCUSSIONS

4.1 Introduction

This chapter presents and interprets the study's findings, which were derived from qualitative data collected through interviews with individual participants and a community leader, as well as focus group discussions conducted in the Bushbuckridge municipality. The purpose of this chapter is to provide a comprehensive discussion of the perceptions, practices, and challenges related to domestic greywater use and reuse within the Bushbuckridge municipality. The collected qualitative data were systematically analyzed using STATA 12, described, and interpreted to report on the meaningful insights of the research. The process of interpretation involved identifying patterns within participants' narratives and transforming them into themes and sub-themes that reflect the lived experiences of the study participants.

These themes were not only descriptive but also interpretive, providing a deeper understanding of the environmental, social, and behavioural dimensions shaping greywater reuse in the Bushbuckridge municipality. In addition, this chapter integrates the immediate results with broader theoretical and empirical perspectives. The current findings were compared with the previous studies, both within South Africa and internationally. The research seeks to identify areas of convergence, divergence, and novelty. This comparative approach ensures that the findings are contextualized within the existing body of knowledge, thereby contributing to a greater understanding of domestic greywater management practices. The chapter aims to demonstrate how the data collected address the study's

objectives and to highlight new insights that may inform future policies, community engagement, and sustainable water management strategies.

4.2. Results and Discussion

4.2.1 Gender distribution of participants

The gender composition of the participants, as shown in Figure 4.1, indicates that females constituted the majority (57.14%) of the respondents, while males represented 42.86%. This distribution suggests that women were more actively involved in the household and gardening activities within the study area in Bushbuckridge municipality, which aligns with existing research emphasizing the prominent role of women in domestic water management and home-based agricultural practices in rural South Africa (Chitja, 2016; Radingoana, 2021).

The higher representation of women in this study may also reflect their direct engagement in water reuse activities and decisions, particularly in the utilization of greywater for home gardens and household purposes. The participation of more females is valuable, as it provides insights into practical experiences, attitudes, and challenges surrounding sustainable greywater use.

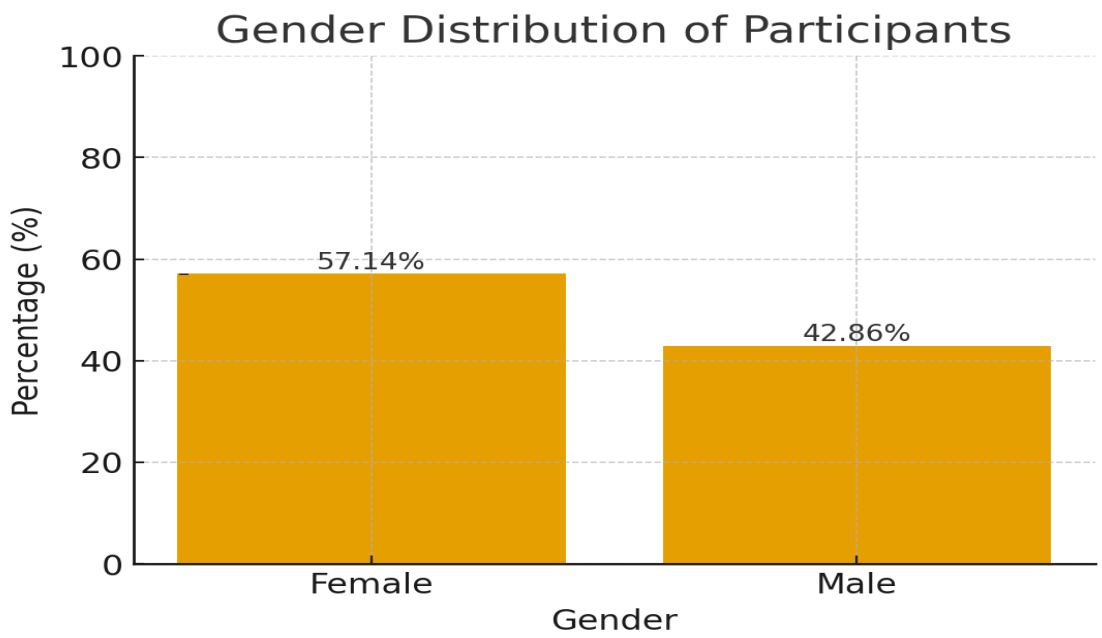

Figure 4:1: Gender distribution of participants from Bushbuckridge municipality.

4.2.2 Age distribution of participants

The age distribution of participants in the study ranged from 14 to 83 years old (Figure 4.2). The candidates aged 14 years old were a very small proportion of those who are in child-led households without parents. Figure 4.2 illustrates that the majority of participants (33.2%) were aged between 54 and 63 years, followed by those aged 24–33 years (19.05%), while the lowest representation was from the 74–83 age group (2.2**%)**.

The high percentage observed for individuals between 54 and 63 years old is not surprising, as the majority of older people within that age range are those who are primarily at home and participate in activities such as greywater utilization and related domestic practices, including greywater reuse. Several studies support the idea that household behaviors, including water reuse and non-potable reuse of household wastewater, are influenced by factors such as

lifestyle, home occupancy, and demographic characteristics (Oteng-Peprah, Acheampong, and de Vries, 2018).

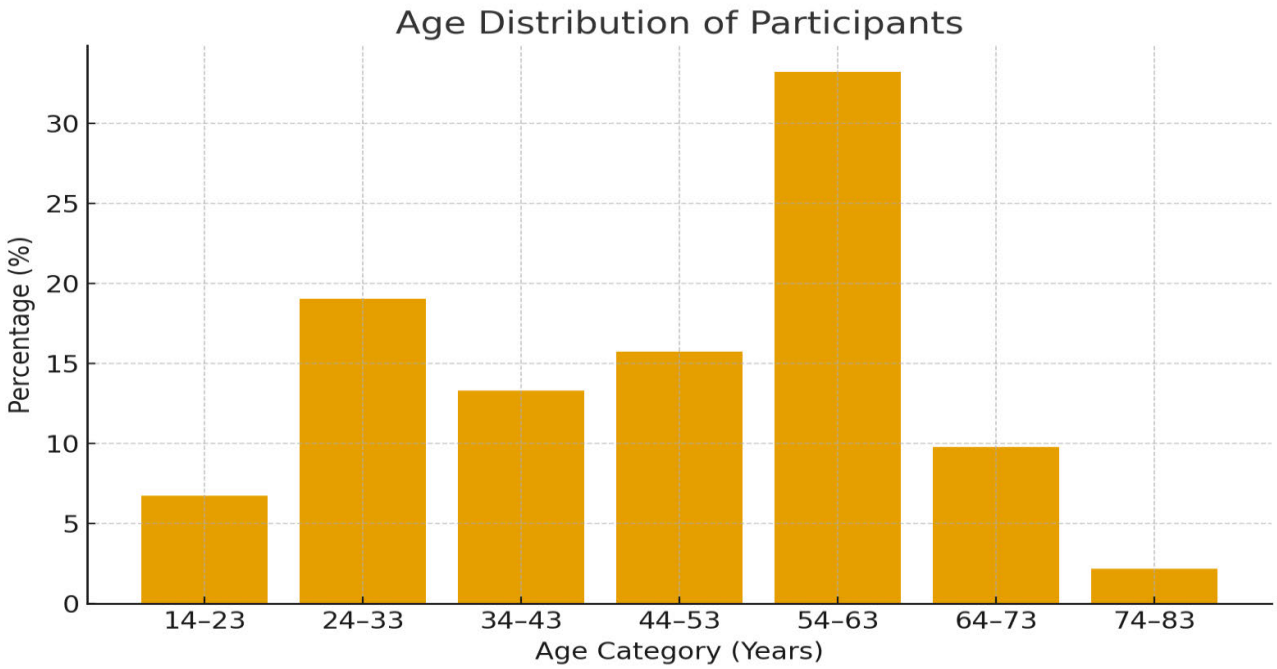

Figure 4:2: Gender distribution of participants from Bushbuckridge municipality

4.2.3 Marital status of participants

The marital status of participants is presented in Figure 4.3. The largest group is represented by the single participants (46.43%), followed by married (25%), while the smallest group is divorced (7.14%). The marital status presented in Figure 4.3 helps illustrate the diversity of household structures among the study participants. In households where individuals are married, stability is often present, along with shared decision-making and possibly a higher resource-pooling capacity, such as the adoption of grey-water reuse practices (e.g., for irrigation or toilet flushing). In contrast, single-person households may face lower incentives for coordinated efforts for such systems.

The system that promotes the recognition of marital status as a socio-demographic factor enables municipalities to tailor grey-water programs to different household types and better design outreach, financing, and technical support (Moghayedi, 2024).

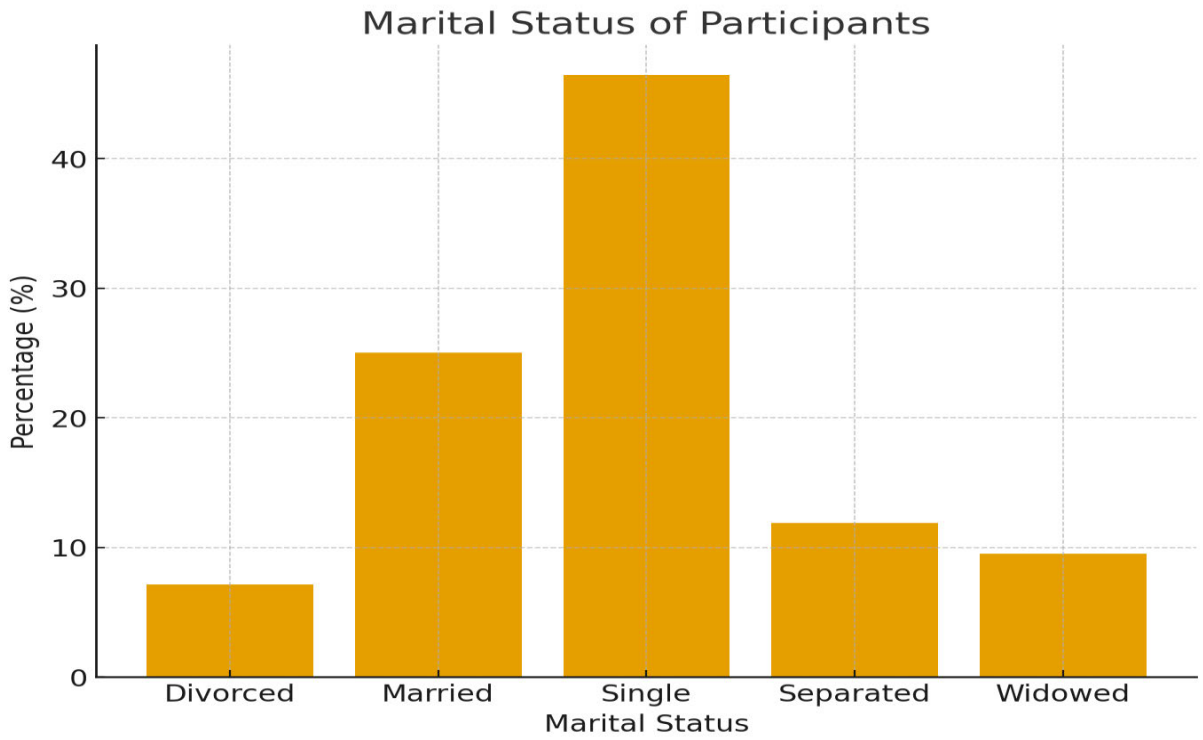

Figure 4:3: Gender distribution of participants from Bushbuckridge municipality

4.2.4 Level of education of participants

The level of education within a household in the Bushbuckridge municipality played a significant role in the uptake and effective utilization of grey-water systems. The majority of the participants had a secondary school education (60.71%), followed by candidates with certificates and diplomas (13.10%). Individuals with higher education are more likely to understand the technical, environmental, and health implications of grey-water reuse, making them more receptive to adopting the practices. While the survey reported a postgraduate

degree as the highest qualification, with 3.57%, the study is contradictory, as individuals with secondary school education were found to have a higher level of education.

The high education level and literacy position the participants at a better level to evaluate and interpret information about and engage with municipal programmes (Table 4.1). The reported lower level of education, such as primary school (8.33%) and those without any education (8.33%), may limit awareness and reduce confidence in implementing grey-water utilization strategies, thereby slowing adoption rates. Education becomes a key enabling factor that municipalities and planners should address when promoting grey-water reuse initiatives (Gul, 2023; Bakare et al., 2016).

Table 4:1: Level of education for the participants from Bushbuckridge municipality

Level of education	Percentages
Certificate/diploma	13.10%
None	8.33%
Postgraduate degree	3.57%
Primary school	8.33%
Secondary school	60.71%
Undergraduate degree	5.95%

4.2.5 Source of income for the participants from the Bushbuckridge municipality

The primary source of income within a household significantly influences the likelihood of adopting and utilizing grey-water systems. Table 4.2 reports that the highest source of income for the people of Bushbuckridge municipality is from government grants (29.76%).

Households that receive pensions (22.62%) or part-time employment income (15.48%) often have more stable and predictable financial resources, enabling them to consider and implement alternative water-reuse practices. Households whose income is derived from students and unemployment (both at 1.19%) are likely to have a minimal disposable income and may find it more challenging to maintain grey-water reuse systems.

The importance of recognizing the source and stability of income can therefore help municipal programs tailor outreach, subsidies, and financing mechanisms for grey water reuse to different household income profiles. Previous studies have agreed with the findings of the current research on attitudes and perceptions towards greywater reuse in a low-cost housing development in Durban, South Africa (Bakare, Mtsweni, and Rathilal, 2016). Although the source of income does not focus on the income source, the categories, such as grants and pensions, provide socio-demographic data relevant to reuse decisions.

Table 4:2: Source of income for participants for Bushbuckridge municipality

Type of employment	Percentages
Full-time paid job	9.52%
Government grant	29.76%
None	8.33%
Own business	11.90%
Part-time job	15.48%
Pension	22.62%
Student	1.19%
Unemployed	1.19%

4.2.6 Number of individuals per household in Bushbuckridge municipality

The number of individuals per household in this study significantly influenced the determination of grey-water generation and reuse in the Bushbuckridge municipality. Households with more individuals typically produce more grey water daily, increasing the potential volume available for non-potable reuse (such as gardening, flushing, and cleaning), while also raising the likely demand for such recycled water within the household. The smaller households generate less greywater and may perceive lower benefits from investing in on-site reuse systems.

The highest percentage of household individuals was reported at 66.67% for those in the 5- to 8-year-old range (Figure 4.4). Previous studies have reported interactions with labour and decision-making dynamics (Mashabela, 2015). For example, studies have revealed that larger households may have more members available to maintain simple reuse systems, but they may also have more complex preferences about water use (Sekgobela, 2023). It becomes the role of municipalities to design outreach and technical programmes that tailor approaches to grey-water use, taking into consideration the household size.

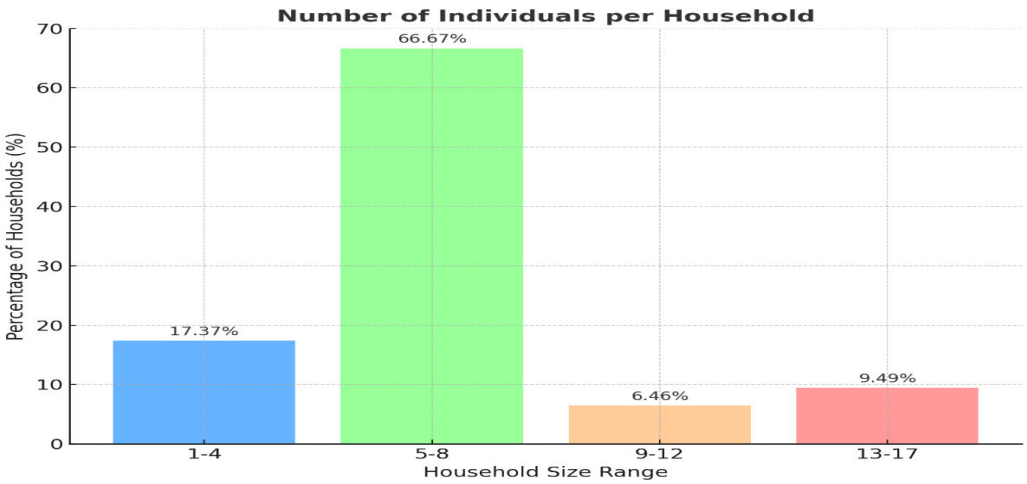

Figure 4:4: No of individuals per household from Bushbuckridge municipality

4.2.7 Water use by participants in the Bushbuckridge municipality

The data presented in Figure 4.5 indicate the number of participants utilizing water per day in the Bushbuckridge municipality. Approximately 6% of the participants reported using 20 litres per day. The majority of participants (up to 42.86%) were categorized in group 2, which includes candidates who use more than 60 litres per day. Households consuming more than 60 L/day produced larger volumes of grey water (from laundry, bathing, and washing), which has implications for the potential benefits of on-site reuse (e.g., garden irrigation, toilet flushing).

The Bushbuckridge municipality has to prioritize demonstrations and low-cost reuse kits in areas with high per-capita consumption to maximise immediate water savings. The increased daily use of water in households may reflect the presence of more people at home (larger households) and households with specific water-using approaches. The Bushbuckridge local municipality has a policy on tariffs that allows domestic consumers registered in their database to receive the first six kilolitres (6 kL = 6,000 litres) of water free of charge per month. Households that consume water in excess of 6,000 litres are then charged according

to the applicable stepped tariff. This six kL/month figure is also the commonly used national free fundamental water benchmark in South Africa.

Bakare et al. (2016) suggested that households using more than six kL/month can rely on grey water reuse, as permitted by South African National legislation, which does not prohibit the reuse of greywater. Bakare et al. (2016) noted that the use of greywater must not contravene the National Health Act and must not create a nuisance. It becomes vital to ensure that the source of storing grey water is not polluted. Even though large grey-water volumes are available for households with more participants, households with limited income may lack the resources to install and maintain simple reuse systems. The support from the municipality becomes crucial in ensuring that training, grants, and subsidies are offered to communities to promote the adoption of grey water among households.

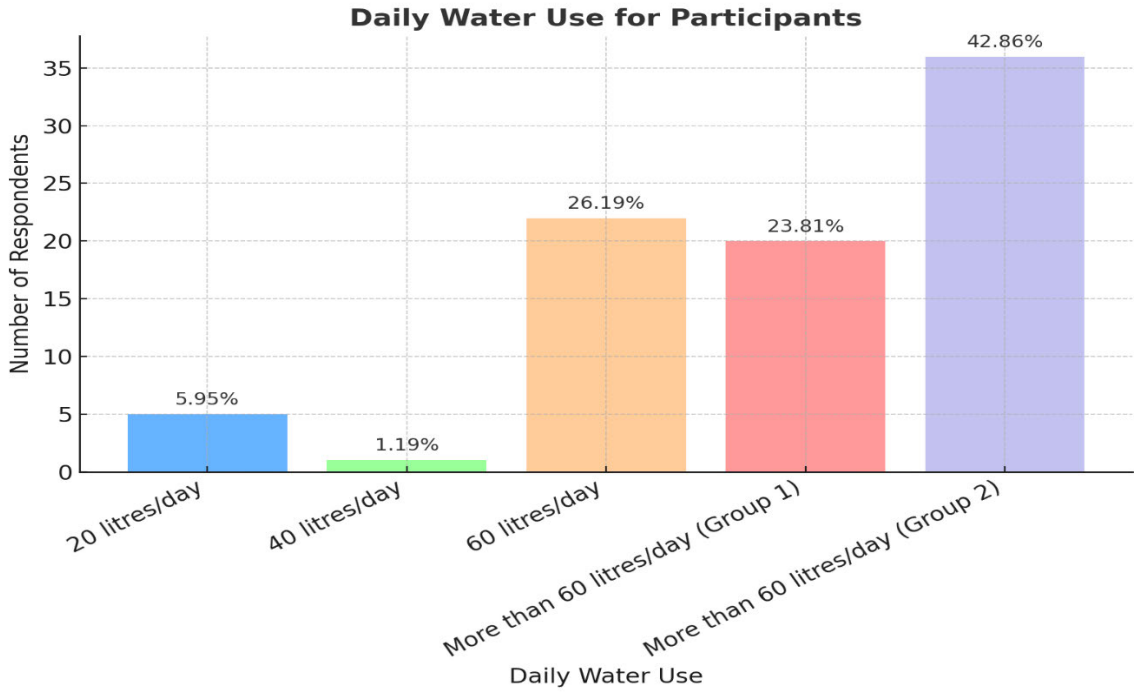

Figure 4:5: Daily water use in households of Bushbuckridge municipality

4.2.8 The source of potable water in the Bushbuckridge municipality

The data presented in Figure 4.6 indicate that the highest percentage of the participants relied on the municipality for the supply of their water. The small portion, at 9.52%, and the smallest, at 1.19%, utilized rainwater harvesting and buying from tankers as their sources of water, respectively. The increased reliance on the municipal water supply reflects the Bushbuckridge municipality's central role in providing basic services. The households connected to piped municipal water typically have more consistent access and, consequently, generate more greywater from domestic activities such as bathing, laundry, and dishwashing.

The consistency in the supply of water can enhance the feasibility of greywater reuse, as it ensures the regular availability of greywater for secondary uses, such as irrigation and cleaning. Households that rely on rainwater harvesting and tanker deliveries may experience fluctuating water availability in the Bushbuckridge municipality. The households that generate smaller and less predictable volumes of greywater limit their potential for sustained reuse. Additionally, the cost of purchasing water from tankers may encourage users to reduce their consumption, thereby decreasing greywater output. Bushbuckridge municipality is primarily affected by seasonal water shortages, making it crucial to strengthen other potable water sources. This includes sources such as rainwater harvesting, which can be combined with the municipal supply to increase water security, while also creating opportunities for safe greywater reuse, particularly in water-stressed communities.

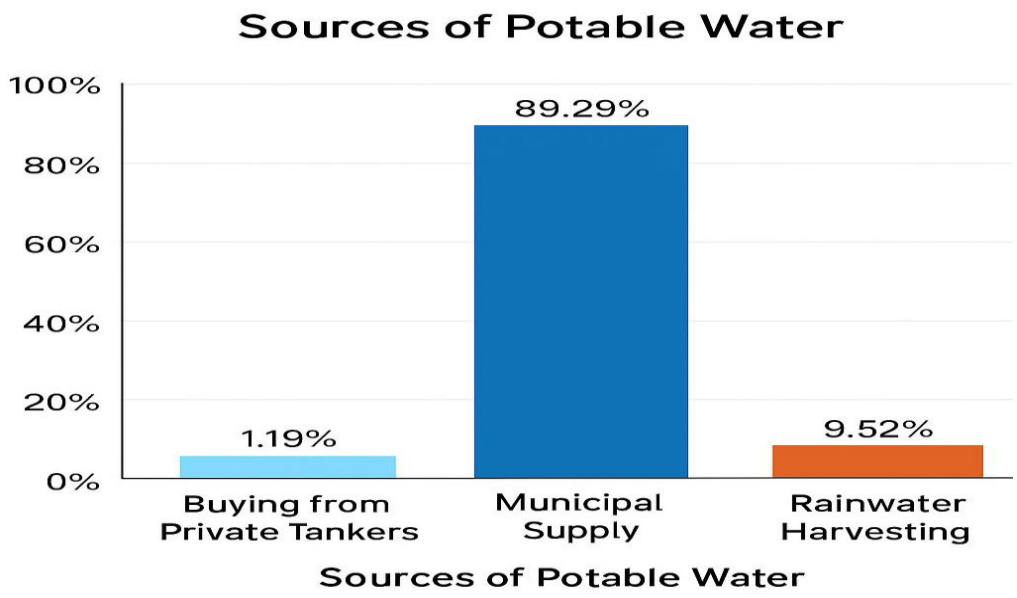

Figure 4:6: Source of potable water supply in Bushbuckridge municipality

4.2.9 The knowledge of grey water by participants in the Bushbuckridge municipality

The data on grey water knowledge indicate that the participants were aware of grey water utilization in the Bushbuckridge municipality. Approximately 58.33% of the participants were aware of grey water, while 41.67% lacked information about it (Figure 4.7). The Bushbuckridge municipality is characterized by water scarcity and service delivery challenges, making the concept of greywater reuse particularly important. This understanding is crucial for determining how greywater can be safely reused and for assessing whether households are willing and able to adopt reuse systems. Households with knowledge about grey water are more likely to perceive it as a resource rather than waste. Households can also utilize this knowledge to apply proper treatment and filtering methods that reduce environmental and health risks associated with unsafe reuse.

The limited knowledge and awareness of 41.67% of the participants may lead to the underutilization of greywater and improper disposal practices that can pose sanitation

hazards. The report by Bakare (2016) examined how socio-demographic characteristics, such as greywater utilization and household composition, influenced knowledge, attitudes, and acceptance of greywater reuse. The findings highlight that households with greater awareness of the benefits of greywater reuse are more likely to adopt reuse practices. It is also important to note that the Bushbuckridge municipality engages in public knowledge that can be enhanced through education campaigns, community workshops, and municipal outreach. The outreach programs outlined are essential in increasing acceptance and safe adoption of greywater reuse in Bushbuckridge and similar municipalities.

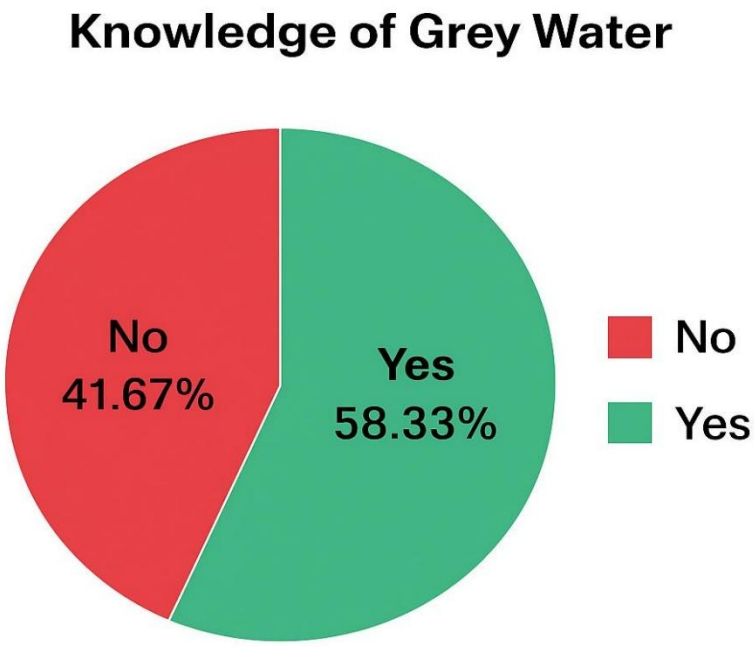

Figure 4:7: Knowledge of grey water by participants in Bushbuckridge municipality

4.2.10 The ability to clean grey water by participants in the Bushbuckridge municipality

The data presented in Figure 4.8 clearly indicate that 91.67% of the participants from Bushbuckridge municipality lacked the knowledge to clean grey water for various purposes within their households. The ability to treat greywater is crucial for promoting safe reuse and sustainable water management, especially for a municipality like Bushbuckridge, which is known to struggle with water resources. Although many households may understand what greywater is, a smaller proportion (8.33%) possess the technical know-how to treat it effectively before reuse.

The lack of practical knowledge can limit the adoption of greywater utilization practices. In the Bushbuckridge municipality, where water scarcity remains a persistent challenge, equipping residents with knowledge about cleaning greywater can increase water reuse efficiency, reduce reliance on municipal water supplies, and enhance household resilience during drought periods. To reduce the high number of participants who cannot clean grey water, the Bushbuckridge municipality plays a critical role in disseminating knowledge.

The priority should include stakeholders such as the local environmental NGOs, community-based organizations, the municipality, and the community members for training workshops, demonstration projects, and public information campaigns that can empower households to adopt safe and sustainable reuse systems.

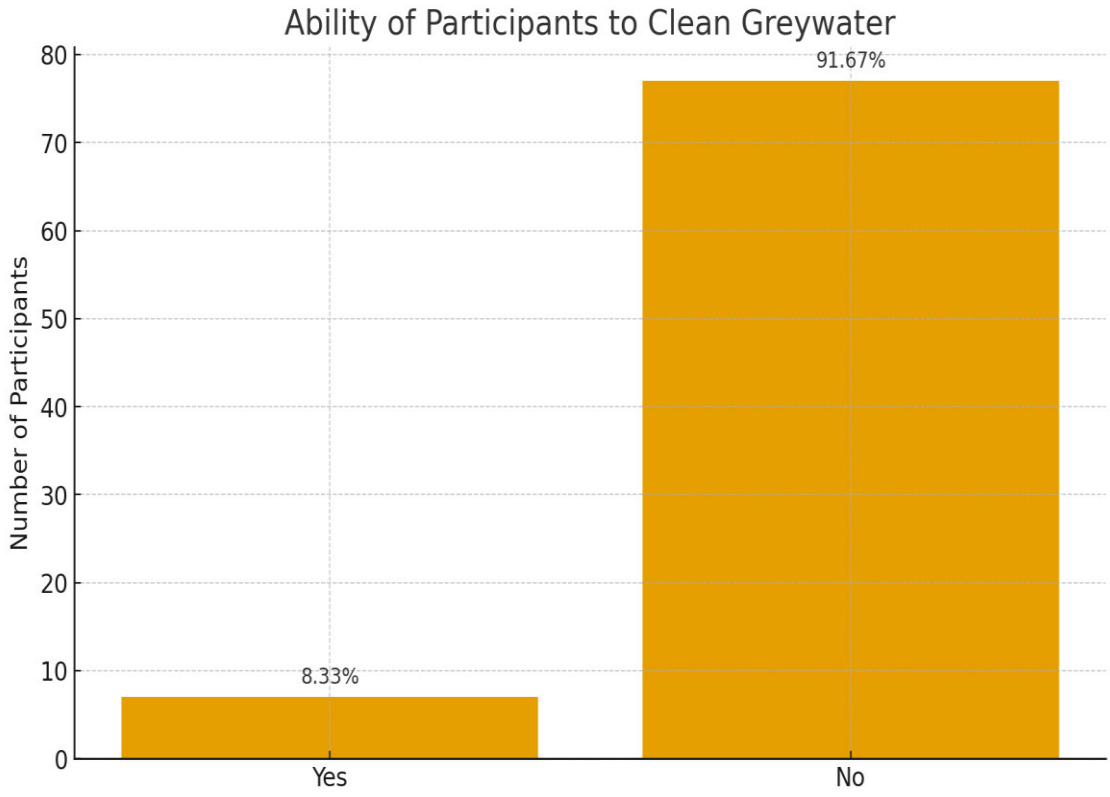

Figure 4:8: The ability of participants in Bushbuckridge to clean greywater

4.2.11 Technologies used to clean water in the Bushbuckridge municipality

Greywater contains contaminants such as soap residues, fats, and microorganisms that can pose health risks if not adequately treated. It is essential to have a comprehensive understanding of simple, low-cost treatment methods (e.g., sedimentation and filtration) that are crucial for households seeking to reuse water for irrigation or cleaning purposes safely. The data presented in Table 4.3 indicate that the highest percentage (83.33%) of participants were unaware of any technology that can be used to treat grey water. The data presented in Table 4.3 is well aligned with the data (Figure 4.8), which indicates that the participants do not have any knowledge of how to treat grey water. A small proportion of the participants stated that they utilized the chemical method (9.52%) and the traditional method (7.14%).

The limitation in the awareness and adoption of greywater treatment technologies highlights a key challenge in promoting sustainable water management in the Bushbuckridge municipality. The lack of knowledge about simple strategies, such as low-cost bio-sand filters, sand filtration systems, and settling tanks, makes it difficult for communities in the Bushbuckridge municipality to safely reuse greywater. The Bushbuckridge municipality needs to promote suitable greywater technologies that can support both water conservation and public health objectives. The collaboration of stakeholders, including the local municipality, NGOs, and the Department of Water and Sanitation, should prioritize community education, demonstration projects, and technical training to build local capacity in low-cost treatment solutions suitable for rural and semi-urban areas, such as the Bushbuckridge municipality.

Table 4:3: Technologies used to treat greywater

Treatment methods	Percentage
Chemical method	9.52%
None	83.33%
Traditional method	7.14%

CHAPTER 5

SUMMARY, CONCLUSION, AND RECOMMENDATIONS

5.1. Summary

The study conducted a survey in the Bushbuckridge municipality to assess community perceptions and practices related to greywater use. The primary aim was to understand how participants from the Bushbuckridge municipality perceive and manage greywater, with a focus on its domestic and non-potable uses. The specific objectives included evaluating the influence of existing greywater treatment technologies on the adoption and implementation of reuse practices within the villages of Bushbuckridge. Data were collected through structured surveys administered to 84 participants. The data analysis reported on socio-demographic factors, including education level, marital status, income, and household size. The data showed that the socio-demographic factors influenced knowledge, attitudes, and willingness to adopt greywater reuse systems. Many participants associated greywater primarily with garden irrigation, indicating an opportunity to expand its safe reuse in domestic contexts.

The findings further showed that the majority of respondents were aware of greywater and its potential benefits; however, a significant proportion lacked technical knowledge on how to treat and safely reuse it. The majority (80%) of participants reported that they lacked access to information and awareness approaches that would equip them to treat greywater effectively, resulting in improved use. The findings indicated a small minority mentioned using chemical (9.52%) or traditional (7.14%) methods. The majority of the participants who were interviewed relied primarily on the municipal water supply as their primary source of

potable water, with smaller groups relying on rainwater harvesting (9.52%) or tanker deliveries (1.19%).

5.2 Conclusions

The study highlights the importance of social and economic factors, such as education and marital status, in shaping perceptions and decisions about greywater reuse. Married households and those with higher education levels tend to show greater interest and confidence in using or cleaning greywater, likely due to collaborative decision-making and better access to information. The study concludes that greywater reuse remains underdeveloped in the Bushbuckridge municipality, primarily due to limitations associated with awareness, inadequate access to affordable and straightforward treatment technologies, and a lack of structured municipal support. Although the majority of community members recognize the importance of water conservation and demonstrate a willingness to reuse greywater, their participation is constrained by insufficient technical knowledge and guidance from the Bushbuckridge municipality.

As a way forward, the Bushbuckridge municipality should engage relevant stakeholders to integrate community education, technical training, and the dissemination of low-cost technology into its local water resource management strategies.

5.3. Recommendations and future research agenda

The study recommends that the Bushbuckridge municipality should conduct regular community workshops and public education campaigns to improve knowledge about greywater sources, potential uses, and safe treatment methods. The initiatives should involve community members at all times and utilize the local languages for accessibility and

understanding. The municipality can utilize the platforms to promote low-cost treatment technologies for grey water, as well as provide guidance on those that are simple to manufacture by community members. The municipality can also collaborate with institutions of higher learning to research the quality of untreated and treated greywater used in households and gardens, establishing safety standards and developing monitoring guidelines for sustainable reuse. The municipality can also establish local partnerships with universities, the Department of Water and Sanitation, and NGOs to provide technical training to strengthen the capacity of community members.

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ANNEXURE A

PERMISSION TO CONDUCT RESEARCH STUDY

R533 Graskop Road.
Opp Mapulaneng DLTC
Bushbuckridge
Co-ordinates: 31°3'59.796"E 24°50'24
Tel: 013 004 0291/92/95

BUSHBUCKRIDGE
LOCAL MUNICIPALITY

Private bag x 9308
Bushbuckridge
1280
Email:info@bushbuckridge.gov.za
Website: www.bushbuckridge.gov.za

Enquiries: Mnisi M.M (Skills Development Facilitator)
Ref No: 4/4/2
Email: [redacted]

19 November 2024

Mr Marota N P
[redacted]

Cell No: [redacted]
Email: [redacted]

Attention: Mr Marota

RE: PERMISSION TO CONDUCT RESEARCH STUDY

A permission is granted to conduct research study in our Municipality under the topic: **Factors influencing grey water use in Doornkop and Bushbuckridge Villages, Mpumalanga South Africa."**

While conducting your study, you need to take into consideration that all your actions will be subjected to the policies and procedures approved by the Municipal Council.

The Municipality wish you best of luck in your research endeavor. The Skills Development Facilitator, Ms. Mnisi MM contact [redacted] will be the person to liaise with when need arises.

Kind regards

[redacted]

Mr J Ngobeni
Municipal Manager

ANNEXURE B

ETHICS CHECKLIST

ETHICS CHECKLIST

FOCUS GROUP INTERVIEW SCHEDULE COMMUNITY

PARTICIPANT INFORMATION SHEET
(FACTORS INFLUENCING GREY WATER USE IN BUSHBUCKRIDGE VILLAGES, MPUMALANGA, SOUTH AFRICA)

Ethics clearance reference number:
Research permission reference number:

28 February 2025

Title: **factors influencing grey water use in Bushbuckridge villages, Mpumalanga, South Africa.**

Dear Prospective Participant

My name is Nkata Peter Marota. I am inviting you to participate in a study entitled **factors influencing grey water use in Bushbuckridge villages, Mpumalanga, South Africa.**

WHAT IS THE PURPOSE OF THE STUDY?

We are conducting this research to find out the impact of domestic non-potable greywater use on garden irrigation practices in Bushbuckridge villages.
OR
This study is expected to collect important information that could make suggestions to assist municipalities with cost savings and environmental benefits such as reduced freshwater demand and lower wastewater treatment loads. Other stakeholders and policy makers in Water Management Area (WMA) will benefit from reading this study before they engage with the use of greywater.

WHY AM I BEING INVITED TO PARTICIPATE?

I received your contact details from the heads of the Bushbuckridge. You have been selected to participate in this study because of your experiences in grey water use. Approximately five participants will be involved in this study.

WHAT IS THE NATURE OF MY PARTICIPATION IN THIS STUDY?

If you decide to take part in the study, you will be required to do the following:
The study involves *audio taping and semi-structured interviews*. You will be asked about biographical information namely, age group, gender, religion, highest level of education, occupation, income, and general questions about the impact on grey water. This include: In your opinion, what impact of domestic non-potable greywater use on garden irrigation practices?; What is a role of available treatment technologies in facilitating or hindering greywater use?; how is your or residents' perceptions of greywater to affect its adoption for garden irrigation? If you choose to participate in this study. it will take no more than 30 minutes of your time.

CAN I WITHDRAW FROM THIS STUDY EVEN AFTER HAVING AGREED TO PARTICIPATE?

Participating in this study is voluntary and you are under no obligation to consent to participation. If you do decide to take part, you will be given this information sheet to keep and be asked to sign a written consent form. You are free to withdraw at any time and without giving a reason. You will not be able to withdraw from the study once you have submitted, based on the anonymous nature of the study.

WHAT ARE THE POTENTIAL BENEFITS OF TAKING PART IN THIS STUDY?

The study will make suggestions to assist municipalities in understanding the specific constraints in greywater and recommended actions to improve the use of greywater on garden irrigation. This means that the study will assist municipalities overcome technical, financial, or social barriers to implementing greywater systems. Moreover, the study will assist municipalities with cost savings and environmental benefits such as reduced freshwater demand and lower wastewater treatment loads. Other stakeholders and policy makers in Water Management Area (WMA) will benefit from reading this study before they engage with

the use of greywater. This implies that the study will result in guidelines, policy recommendations, or modifications to existing regulations to better support sustainable water use practices. Lastly, this study will be used by stakeholders such as consultants for strategic planning, infrastructure development, or community engagement strategies in WMA to advise government before they start implementing the use of greywater on garden irrigation. The study will contribute to educational programs and workshops aimed at improving, understanding and implementation of greywater systems.

ARE THEIR ANY NEGATIVE CONSEQUENCES FOR ME IF I PARTICIPATE IN THE RESEARCH PROJECT?

I do not foresee that you will experience any negative consequences by participating in this study. The researcher will always try to prevent any risk, discomfort or inconvenience during and after the semi-structured interview.

WILL THE INFORMATION THAT I CONVEY TO THE RESEARCHER AND MY IDENTITY BE KEPT CONFIDENTIAL?

Your name will not be recorded anywhere and that no one, apart from the researcher and identified members of the research team, will know about your involvement in this research. OR your name will not be recorded anywhere and no one will be able to connect you to the answers you give. Your answers will be given a code number or a pseudonym and you will be referred to in this way in the data, any publications, or other research reporting methods such as conference proceedings.

Only researcher will have access to the data and these researcher will maintain confidentiality *by signing a confidentiality agreement.* Your answers may be reviewed by people responsible for making sure that research is done properly, including the transcriber, external coder, and members of the Research Ethics Review Committee. Otherwise, records that identify you will be available only to people working on the study, unless you give permission for other people to see the records.

Your anonymous data may be used for other purposes, such as a research report, journal articles and/or conference proceedings. *A report of the study may be submitted for publication, but individual participants will not be identifiable in such a report.*

While every effort will be made by the researcher to ensure that you will not be connected to the information that you share during the focus group, I cannot guarantee that other participants in the focus group will treat information confidentially. I shall, however, encourage all participants to do so. For this reason I advise you not to disclose personally sensitive information in the focus group.

HOW WILL THE RESEARCHER(S) PROTECT THE SECURITY OF DATA?

Hard copies of your answers will be stored by the researcher for a period of five years in a locked cupboard/filing cabinet in Nelspruit for future research or academic purposes; electronic information will be stored on a password protected computer. Future use of the stored data will be subject to further Research Ethics Review and approval if applicable. *Hard copies will be shredded and/or electronic copies will be permanently deleted from the hard drive of the computer through the use of a relevant software programme*.

WILL I RECEIVE PAYMENT OR ANY INCENTIVES FOR PARTICIPATING IN THIS STUDY?

You will not be reimbursed or receive any incentives for your participation in the study.

HAS THE STUDY RECEIVED ETHICS APPROVAL

This study has received written approval from the Research Ethics Review Committee of the the IIE. A copy of the approval letter can be obtained from the researcher if you so wish.

HOW WILL I BE INFORMED OF THE FINDINGS/RESULTS OF THE RESEARCH?

If you would like to be informed of the final research findings, please contact Mr Nkata Peter Marota on [redacted] or [redacted].
The findings are accessible for five years.
Should you require any further information or want to contact the researcher about any aspect of this study, please contact Mr Nkata Peter Marota on [redacted] or [redacted]

Should you have concerns about the way in which the research has been conducted, you may contact the research ethics chairperson on research@iie.ac.za if you have any ethical concerns.

Thank you for taking time to read this information sheet and for participating in this study.
Thank you.

Mr Nkata Peter Marota

CONSENT TO PARTICIPATE IN THIS STUDY

I, _____ (participant name), confirm that the person asking my consent to take part in this research has told me about the nature, procedure, potential benefits and anticipated inconvenience of participation.

I have read (or had explained to me) and understood the study as explained in the information sheet.

I have had sufficient opportunity to ask questions and am prepared to participate in the study.

I understand that my participation is voluntary and that I am free to withdraw at any time without penalty (if applicable).

I am aware that the findings of this study will be processed into a research report, journal publications and/or conference proceedings, but that my participation will be kept confidential unless otherwise specified.

I agree to the recording of the focus group interviews.

I have received a signed copy of the informed consent agreement.

Participant Name & Surname…… (please print)

Participant Signature……..Date……

Researcher's Name & Surname……(please print)

Researcher's signature……..Date……

ANNEXURE C

OUTCOME OF ETHICS CLEARANCE APPLICATION

THE INDEPENDENT INSTITUTE OF EDUCATION

Our Ref: M. 350824
Enquiries: research@iie.ac.za

14 August 2024

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

Student name: Nkata Peter Marota
Student number: [redacted]
Brand and campus: IIEMSA

Dear Nkata,

We are pleased to inform you that the Higher Degrees Committee considered and approved your research proposal titled: **Factors Influencing grey water use in Doornkop and Bushbuckridge villages, Mpumalanga, South Africa** with major revisions.

You are requested to critically reflect on the feedback provided by the Academic Seminar panel members (attached to this letter) and address the recommendations, in Annexure E, under the guidance and to the satisfaction of your supervisor. We are confident that the feedback will improve the quality of your work and will assist you in navigating the process to successful completion.

This study has been granted conditional ethics clearance. This means that you must submit the revised research proposal (with an expanded research methodology section) together with the data collection instrument, participant consent form and if applicable gatekeepers' letter to the Programme Coordinator for ethics clearance. Please note that the Higher Degrees Committee meets each month and review all applications submitted by the 1st Thursday of each month. You may only proceed with data collection once you have received an Ethics Clearance Letter from the Higher Degrees Committee.

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

All the best with your research studies.

[redacted]
Dr Willy Engelbrecht
Chair: Higher Degrees Committee

ANNEXURE D

RESEARCH QUESTIONNAIRE

THE INDEPENDENT INSTITUTE OF EDUCATION

Section A: Demographic profile of respondents

A1. Gender (do not ask)

1. Male	2. Female

A2. Age (years) ____

A3. Are you the head of the household?

1. Yes	2. No

A4. Marital status

1. Married	2. Single	3. Divorced	4. Widowed	5. Other(specify)

A5. What is your highest level of education completed?

1. None	2. Primary school	3. Secondary school	4. Certificate / diploma	5. Undergraduate degree	6. Postgraduate degree	7. other (specify)

A6. What is your religion?

1. None	2. Ancestral beliefs	3. Islam	4. Christianity	5. other (specify)

A7. What is your occupational status?

1. Labourer	2. Sales/ marketing	3. Administration	Business person	Professional	Other (specify)

A8: Household income?

1. Government grant	2. Pension	3. Full-time paid job	4. Part-time job	5. Own Business	6. Other specify)

A9: Range of income at the household level?

1. R1-R400	2. R401-R800	3. R800-R1600	4. R1601-R3200	5. >R3201	6. None

A10. How many people currently reside in your household?

_____

A11: The type of household that you stay in.

1. RDP house/bricks structure	2. Informal dwelling	3. Modern dwelling	4. Underdeveloped dwelling (corrugated iron structure)	5. Other (specify)

A12: How long have you lived in the present household?

1. 1 to 3 years	2. 3 to 5 years	3. 5 to 10 years	4. More than 10 years	5. Other (specify)

Section B: Greywater use and management

B1: Indicate the daily water use in your household.

1. 20 Litres per day	2. 60 Litres per day	3. More than 60 Litres per day	4. None	5. Other (specify)

B2: How often do you wash clothes?

1. Every two days	2. Every three days	3. Weekly	4. None	5. Other (specify)

B3: How often do you/members of the family take baths?

1. Daily	2. Twice a day	3. Three times a day	4. None	5. Other (specify)

B4: What is the source of your potable water?

1. Rainwater harvesting	2. Municipal supply	3. Buying from the private tankers	4. None	5. Other (specify)

B5: Indicate the type of containers used to store potable water.

1. Small drums (20L water bottles)	2. Jojo tanks	3. Cultured stone (water-well)	4. None	5. Other (specify)

B6: Do you know about greywater?

1. Yes	2. No

B7: What do you do with greywater?

1. Garden use	2. Car wash	3. Ablution facility (flushing)	4. None	5. Other (specify)

B8: Can you treat greywater?

3. Yes	4. No

B9: Do you know of any treatment methods/technologies for greywater?

1. Yes	2. No

B10: If yes, which methods/technologies?

1. Traditional method	2. Chemical method	3. Modern technologies (use of filters, reverse osmosis)	4. None	5. Other (specify)

B11: What is your perception of greywater use?

1. Valuable for recycling water	2. Water saving measure	3. Can be harmful	4. Against cultural beliefs	5. Other (specify)

THE END!!!!

ANNEXURE E

CERTIFICATE OF RELEASE (IIE007)

ANNEXURE F – CERTIFICATE OF RELEASE (IIE007)

Select the relevant category for which the Certificate of Release is submitted for.

1. Academic Seminar	☐
2. Proposal submission to the Higher Degrees Committee	☐
3. Submission of Dissertation or Thesis for examination.	☒

Students submitting a Master's or Doctoral Proposal, Dissertation, or Thesis should complete Part 1 of this form and send an electronic copy to their supervisor and co-supervisor, who then have to share it with the National Higher Degrees Programme Manager.

PART 1	Student
Names:	Nkata Peter
Surname:	Marota
Student number:	[redacted]
Email:	[redacted]
Contact number:	[redacted]
Degree:	Master of Philosophy in Integrated Water Management
Title of Study:	FACTORS INFLUENCING GREY WATER USE IN DOORNKOP AND BUSHBUCKRIDGE VILLAGES, MPUMALANGA, SOUTH AFRICA

I confirm that my proposal has been prepared in accordance with the guidelines of The Independent Institute of Education on the submission of a Master's / Doctoral proposal.

[redacted]	29/10/2025
Signature of candidate	**Date**

PART 2	Supervisor and co-supervisor
Supervisor title, first and last names:	Dr Yolandi Schoeman
Co-supervisor title first and last names:	Not applicable

I confirm that the candidate's proposal has been prepared to my satisfaction and in accordance with the guidelines of The Independent Institute of Education on the submission of a Master's / Doctoral proposal.

[redacted]	YES
Signature of supervisor	**Date 30/10/2025**
Not applicable	-
Signature of co-supervisor	**Date**

ANNEXURE F

FORM K ACKNOWLEDGEMENT OF EXAMINER FEEDBACK

ANNEXURE K– ACKNOWLEDGEMENT OF EXAMINER'S FEEDBACK (IIE007)

EXAMINATION OF MASTER'S DISSERTATION / DOCTORAL THESIS

Students having received feedback from the examiners with typographical, minor revisions, or resubmission must populate the below table with the examiner's feedback and showcased how the feedback has been addressed. Should you need more lines kindly add on to the table and ensure that all examiner feedback is addressed accordingly.

Examiners' feedback (List key recommendations/ concerns of Examiner)	Student's reflection on recommendations/ concerns and understanding of action steps to be taken	Student's indication of how and where changes were implemented in the dissertation/ thesis.	Supervisor(s) reflections and feedback on the implementation of student's representation on examiners feedback.
Reviewer ONE: **Introduction section: Locate Reference Friedler, Butler, and Alfiya, 2013.** The heading is different, compare with heading on page 36	**Reference added in the reference list:** Friedler, E., Butler, D., & Alfiya, Y. (2013). *Wastewater composition.* In T. A. Larsen, K. M. Udert, & J. Lienert (Eds.), Source separation and decentralization for wastewater management (pp. 241–257). IWA Publishing. The heading on Page 36 has been corrected to reflect the headings of the other pages for consistency. Track changes applied in the thesis document.	The changes have been implemented inside the main document through track changes.	Student has addressed the examiners feedback as required.
The problem statement/information gap The problem statement does clearly describe a problem (identify a knowledge gap, or raise	The problem statement has been revised to outline the knowledge gaps associated with the study.		No comment

Examiners' feedback (List key recommendations/ concerns of Examiner)	Student's reflection on recommendations/ concerns and understanding of action steps to be taken	Student's indication of how and where changes were implemented in the dissertation/ thesis.	Supervisor(s) reflections and feedback on the implementation of student's representation on examiners feedback.
unanswered questions)			
The research objectives, research questions, the hypothesis or proposition The research objectives are clear and precise and are arranged in logical order.	We acknowledge these positive comments from the reviewer.		No comment
Chapter 2: Literature review o The literature review is relevant and logically aligned with the title, problem statement and research questions/objectives. o There are errors that need attention, see below. Friedler Hadari (Insert and) Gross et al. 2015 (Missing reference) Nolde, 2005 (Missing reference) AquaRenu is currently working with contractors in Mpumalanga and installing their greywater units in some local schools in the area surrounding the University of Cape Town (Rewrite the sentence)	We acknowledge these positive comments from the reviewer. "and" has been added to the reference. The corrected version is on page 8 of the literature review. Nolde, E. (2005). Greywater recycling systems in Germany—Results, experiences and guidelines. Water Science and Technology, 51(10), 203–210. https://doi.org/10.2166/wst.2005.0368 Revised sentence: AquaRenu is currently collaborating with contractors in Mpumalanga to install greywater units in selected local schools in areas surrounding the University of Cape Town.		Student has addressed the examiners feedback as required.

Examiners' feedback (List key recommendations/ concerns of Examiner)	Student's reflection on recommendations/ concerns and understanding of action steps to be taken	Student's indication of how and where changes were implemented in the dissertation/ thesis.	Supervisor(s) reflections and feedback on the implementation of student's representation on examiners feedback.
Malaza and Vala (2024) – Missing Reference Dobrowolsky – Check the spelling Insert 2.5 Concluding remarks- Add summary of review of literature	The reference is in the text and the reference list. It is referred as : Vala, B., & Malaza, N. (2024). *Examining the efficacy of the legal framework governing the management of greywater in South Africa's informal settlements.* Journal of Water and Health, 22(5), 842. https://doi.org/10.2166/wh.2024.312 The reference name has been corrected to Dobrowksy. The concluding remarks for the literature review has been added on page 18.		
Chapter 3: Research methodology o The research methodology is relevant and logically aligned with objectives. o There are errors that need attention, see below. Figure 3.1 study location - Insert a small map of South Africa	We acknowledge the positive comment by the reviewer. The Map of South Africa has been added to Figure 3.		Student has addressed the examiners feedback as required.

Examiners' feedback (List key recommendations/ concerns of Examiner)	Student's reflection on recommendations/ concerns and understanding of action steps to be taken	Student's indication of how and where changes were implemented in the dissertation/ thesis.	Supervisor(s) reflections and feedback on the implementation of student's representation on examiners feedback.
DWAF, 2018 - Check if year is 2004 January and April - Delete and insert to	The reference DWAF, 2018 is correct, we have checked. The comment is acknowledged, and it has been deleted.		
Chapter 4: Research findings and discussion o The research findings and discussion are relevant and logically aligned with the title, problem statement and research questions/objectives. o There are errors that need attention, see below. RESEARCH FINDINGS REPORTING AND DISCUS- SIONS- This heading is NOT appearing on Table of Contents RESEARCH FINDINGS REPORTING AND DISCUS- SIONS- Delete REPORTING Table 4.1 is not cited in discussion - Insert Table 4.1	We acknowledge the positive comment by the reviewer. The heading has been added to the Table of Contents. Reporting has been deleted. Table 4.1 has been added inside the discussion text. Bakare has been renamed to Bakare et al., 2016.		Student has addressed the examiners feedback as required.

Examiners' feedback (List key recommendations/ concerns of Examiner)	Student's reflection on recommendations/ concerns and understanding of action steps to be taken	Student's indication of how and where changes were implemented in the dissertation/ thesis.	Supervisor(s) reflections and feedback on the implementation of student's representation on examiners feedback.
Bakare (2016) - Insert Table 4.1- More than 3 authors, insert et al. Table 4.5 - Delete 4.5 Insert Table 4.3	Table 4.5 is corrected to Table 4.3.		
Chapter 5: Summary, Conclusion & Recommendation o The summary is relevant and up to point. o The conclusion is relevant and logically aligned with the title, problem statement and research questions/objectives. o The recommendations are based on research findings There are errors that need attention, see below. Add Future research agenda- Add Future research agenda.	We acknowledge the positive comment by the reviewer. Future Research Agenda added		Student has addressed the examiners feedback as required.
Reviewer TWO: Dobrowksy - Check spelling DWAF, 2004 - Check is year is 2018 Gorgich, M., Mata, T.M., Martins, A., Caetano, N.S.,and Formigo, N. 2020. Application of domestic greywater for irrigating agricultural products: A brief	Spelling is corrected The reference is corrected. The second (duplicate) reference has been deleted.		Student has addressed the examiners feedback as required.

Examiners' feedback (List key recommendations/ concerns of Examiner)	Student's reflection on recommendations/ concerns and understanding of action steps to be taken	Student's indication of how and where changes were implemented in the dissertation/ thesis.	Supervisor(s) reflections and feedback on the implementation of student's representation on examiners feedback.
study. Energy Reports, 6, 811-817.- Delete the other Gorgich as it is a repetition	The reference is corrected to 2009.		
Ilemobade, A.A., Adewumi, J.R., and Van Zyl, J.E. 2009. - Check year 2013?	The reference is corrected to 2014. The second reference (duplicate) has been deleted.		
Maimon, A., Tal, A., Friedler, E., and Gross, A. 2010 - Check year 2014?			
Radingoana, M.P. 2021. Greywater reuse assess-ment of health and nutritional quality of home gar-dens produce in rural South Africa: Unpublished thesis. Cape Town: University of the Western. - Delete as this is repetition	The reference has been corrected. The a and b have been added to the references.		
Rodda, N., Carden, K., and Armitage, N. 2011. Sus-tainable and appropriate greywater reuse for South Africa: A case study. Water SA, 37(1), 7-14.	The year has been added.		
Rodda, N., Carden, K., Armitage, N. and Du Plessis, H.M. 2011. Development of			

Examiners' feedback (List key recommendations/ concerns of Examiner)	Student's reflection on recommendations/ concerns and understanding of action steps to be taken	Student's indication of how and where changes were implemented in the dissertation/ thesis.	Supervisor(s) reflections and feedback on the implementation of student's representation on examiners feedback.
guidance for sustaina-ble irrigation use of greywater in gardens and small-scale agriculture in South Africa. Water SA, 37(5): 727-738.- Insert a after year 2011 example 2011a Insert b after year 2011 example 2011b This will allow to differentiate the author and citation correctly Sefike - Insert year Wulan, D.R., Hamidah, U., Komarulzaman, A., Rosmalina, R.T., and Sintawardani, N. 2022. Domes-tic wastewater in Indonesia: Generation, character-istics, and treatment. Environmental Science and Pollution Research International, 29(22): 32397. Widyarani, W., Wulan, D.R., Hamidah, U., Komarul- zaman, A., Rosmalina, R.T., and Sintawardani, N. 2022. Domestic wastewater in Indonesia: Genera-tion, characteristics, and treatment.	Widyarani has been deleted. The reference has been deleted.		

Examiners' feedback (List key recommendations/ concerns of Examiner)	Student's reflection on recommendations/ concerns and understanding of action steps to be taken	Student's indication of how and where changes were implemented in the dissertation/ thesis.	Supervisor(s) reflections and feedback on the implementation of student's representation on examiners feedback.
Environmental Science and Pollution Research, 29, 32397-32414. https://doi.org/10.1007/s11356-022-19057-6.- These two references appear to be similar. Check which is the correct one?- These two references appear to be similar. Check which is the correct one? Zikmund, W.G., Babin, B.J., Carr, J.C., and Griffin, M. 2013. Business research methods. 9th edn. Mason: Thomson Learning South-Western. - It appears this is not found in the document			

I confirm that I addressed the feedback of examiners accordingly and provided correct details on where the updated changes can be found within the dissertation/ thesis.	
[redacted]	19/01/2026
Signature of Student	**Date**

[redacted]	19/01/2026
I confirm that the student addressed the feedback of examiners accordingly and provided correct details on where the updated changes can be found within the dissertation/ thesis.	
Signature of Supervisor	**Date**
Signature of co-supervisor	**Date**

ANNEXURE G

FORM L ACKNOWLEDGEMENT OF CHANGES

ANNEXURE L – ACKNOWLEDGEMENT OF CHANGES (IIE007)

Supervisors and co-supervisors, where applicable, as well as the National Higher Degrees Programme Manager (NHDPM) must acknowledge the changes made by the student. No student signature is required on this document.

Part 1 – Student	
First name:	Nkata Peter
Last name:	Marota
Student number:	[redacted]
Degree registered for:	Master of Philosophy in Integrated Water Management
Title of research:	FACTORS INFLUENCING GREY WATER USE IN BUSHBUCKRIDGE VILLAGES, MPUMALANGA PROVINCE, SOUTH AFRICA

Part 2 – Supervisor, co-supervisor, and NHDPM	
Supervisor: Title, first and last names:	Dr. Y. Schoeman
Co-supervisor: Title, first and last names:	Not applicable
NHDPM: Title, first and last names:	
I, the supervisor of the student, hereby confirm that the student has effected the changes that were required by the external examiners.	
[redacted]	19/01/2026
Signature of supervisor	**Date**
I, the co-supervisor of the student, hereby confirm that the student has effected the changes that were required by the external examiners.	
Not applicable	
Signature of the co-supervisor	**Date**
I, the NHDPM, acknowledge that I take note of the changes recommended by the supervisor and co-supervisor, where applicable, and affected by the student.	
Signature of the NAC	**Date**