



Human rights and proper potable water and sanitation infrastructure management at schools in a Rustenburg sub-district

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DECLARATION

I, Daniel Kagiso Mosime, hereby declare that this research study, titled “*Human rights and proper potable water and sanitation infrastructure management at schools in a Rustenburg sub-district*”, is my original work, and that all sources quoted in the research study have been correctly acknowledged in the form of references. I also confirm that this research study has not been submitted for the purpose of this degree at any other university.

A handwritten signature in black ink, appearing to read 'D K Mosime', with a stylized, cursive script.

D K Mosime

Date: October 2025

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ABSTRACT

Potable water and sanitation infrastructure in South African schools are fundamental to the health and dignity of communities in the country's education sector. Adequate potable water and sanitation infrastructure systems are key to providing important educational services to communities throughout South Africa. The principles of human rights, as outlined in the Constitution of the Republic of South Africa, 1996, lay the foundation for the survival, dignity and a healthy environment for learning. However, the maladministration of potable water and sanitation infrastructure assets by municipalities, in many parts of the country, have jeopardised appropriate service delivery to schools. These conditions have had a significant influence on school programmes intended for the teaching, learning and assessment of learners at many schools in the country.

There are perpetual challenges, like pipe-line leakages, lapses in water supply, caused by old infrastructure, as well as a lack of knowledge and an absence of relevant skills. Meanwhile, the rapid growth of urban population countrywide, leads to the development of more informal settlements. In the field of education, inadequate water and sanitary facilities exacerbate hygienic circumstances in local schools. These lapses have a profound impact on the overall structure and quality of education. Moreover, poor sanitation can lead to the spread of infectious diseases such as cholera, particularly in overcrowded schools.

Learners' behavioural attitudes, especially in matters of school attendance, are affected when there is an absence of constructive learning opportunities in the classroom. It becomes worse when there are inappropriate water and sanitation services on the school premises. In rural communities, public schools with limited toilet facilities and potable water, have a profound impact on teaching. For example, water and sanitation hygiene (WASH) interventions, are in under-supply, because what is learnt in the classroom cannot always be applied on the school's premises. Conditions caused by excessive toilet usage become unsanitary and uncomfortable, posing a major health risk to the entire school community. In general, inadequate potable water and sanitation services at schools intensify problematic conditions in all educational programmes.

In view of the above, the purpose of this study is to consider the basic human right to proper potable water and sanitation at selected schools in the area of Rustenburg Local Municipality (RLM). By exploring the dynamics between human rights, governance, and infrastructure challenges, the study explores opportunities for setting things right.

The research study identifies legislative and socio-political influences on the equitable distribution and access to potable water and sanitation resources, setting a foundation for an in-depth analysis of existing barriers and potential lapses within the governance framework. By discussing the framework, the report explores the legislative and policy frameworks used to manage the potable water and sanitation infrastructure. Following that, the research study employed participatory action research (PAR) to address the conditions at selected schools in the Rustenburg Local Municipality (RLM).

The research study originally began with informal and formal discussions with school principals, governing bodies, water and sanitation managers at the Rustenburg Local Municipality (RLM), educators, and local community representatives, to identify and define the problem, aligning with the planning stage of PAR. Subsequent phases of data generation, analysis, and interpretation, made it possible to act, develop, and reflect on several stages of PAR.

The main idea in the proposed plan is to develop a framework management plan and appropriate ideas for officials at Rustenburg Local Municipality (RLM), the local area's schools, and local communities. By developing good practices in some areas that need attention, it may be possible to use threats and opportunities to develop appropriate potable water and sanitation infrastructure systems at local schools. Stakeholders may cooperate in the effective management of potable water and sanitation infrastructure assets for future generational use.

Key words: potable water, sanitation infrastructure, environment, water resource management, human rights.

OPSOMMING

Drinkbare water en sanitasie-infrastruktuur in Suid-Afrikaanse skole is fundamenteel tot die gesondheid en waardigheid van gemeenskappe in die land se onderwyssektor. Toepaslike drinkwater- en sanitasie-infrastruktuurstelsels is die sleutel tot die verskaffing van belangrike opvoedkundige dienste aan gemeenskappe regoor Suid-Afrika. Die beginsels van menseregte, soos uiteengesit in die Grondwet van die Republiek van Suid-Afrika, 1996, lê die grondslag vir die oorlewing, waardigheid en 'n gesonde omgewing vir leer. Die wanadministrasie van drinkbare water en sanitasie-infrastruktuur bates deur munisipaliteite, in baie dele van die land, het egter toepaslike dienslewering aan skole in gevaar gestel. Hierdie toestande het 'n beduidende invloed op skoolprogramme wat bedoel is vir die onderrig, leer en assessering van leerders by baie skole.

Daar is voortdurend uitdagings soos pyplynlekkasies, onderbreking in watertoevoer, veroorsaak deur ou infrastruktuur, sowel as 'n gebrek aan kennis en die afwesigheid van die nodige vaardighede. Intussen lei die vinnige groei van stedelike bevolking tot die ontwikkeling van meer informele nedersettings in Suid-Afrika. Op die gebied van onderwys vererger plaaslike skole se water- en sanitêre fasiliteite onhigiëniese toestande. Hierdie verval in water- en sanitasiefasiliteite het 'n groot impak op die algehele struktuur en kwaliteit van onderwys. Boonop kan dit lei tot aansteeklike siektes, soos cholera, veral in oorvol skole.

Leerders se gedrag en houdings, veral in terme van skoolbywoning, word beïnvloed wanneer daar 'n afwesigheid is van konstruktiewe leergeleenthede in die klaskamer. Dit word erger wanneer daar nie die noodsaaklike water- en sanitasiedienste op die skoolterrein is nie. Beperkte toiletgeriewe en drinkbare water by openbare skole in landelike gebiede het 'n groot impak op onderrig. Sodoende is byvoorbeeld die water- en sanitasiehygiëne [water and sanitation hygiene (WASH)] intervensies ontoereikend, want wat in die klaskamer geleer word, kan nie altyd op die skoolperseel toegepas word nie. Toestande wat deur oormatige toiletgebruik veroorsaak word, word ongemaklik en onhigiënies, wat 'n groot gesondheidsrisiko vir die skoolgemeenskap inhou. Oor die algemeen vererger onvoldoende drinkbare water -en sanitasiedienste by skole problematiese toestande in alle opvoedkundige programme.

Na aanleiding van bogenoemde, is die doel van hierdie navorsingstudie om die basiese mensereg op behoorlike drinkbare water en sanitasie, by geselekteerde skole te beoordeel in die gebied van Rustenburg Plaaslike Munisipaliteit. Deur die dinamika tussen menseregte-, bestuurs- en infrastruktuuruitdagings te verken, ondersoek die studie geleenthede om dinge reg te stel.

Hierdie navorsingstudie identifiseer wetgewende en sosio-politieke invloede op die billike verspreiding en toegang tot drinkbare water en sanitasiehulpbronne, wat die grondslag lê vir 'n in-diepte ontleding van bestaande hindernisse en potensiële verval binne die bestuursraamwerk. Deur bespreking van die raamwerk, ondersoek die verslag die wetgewende en beleidsraamwerke wat gebruik word om die drinkwater- en sanitasie-infrastruktuur te bestuur. Die navorsingstudie het deelnemende aksienavorsing [participatory action research, (PAR)] toegepas om die toestand by geselekteerde skole in die Rustenburg Plaaslike Munisipaliteit aan te spreek.

Die navorsingstudie het oorspronklik begin met informele en formele gesprekke met skoolhoofde, beheerliggame, water- en sanitasiebestuurders van die Rustenburg Plaaslike Munisipaliteit (RLM), opvoeders en plaaslike gemeenskapsverteenwoordigers, om die probleem te identifiseer en te definieer, in ooreenstemming met die beplanningstadium van deelnemende aksienavorsing (PAR). Die daaropvolgende fases van data-insameling, analise en interpretasie het toegelaat om die verskillende fases van PAR toe te pas, te ontwikkel en daarvoor te besin.

Die hoofgedagte in die voorgestelde plan, is om 'n raamwerk bestuursplan en toepaslike idees vir amptenare by Rustenburg Plaaslike Munisipaliteit (RLM), die plaaslike skole, en plaaslike gemeenskappe te ontwikkel. Deur goeie praktyke te ontwikkel in sommige gebiede wat aandag nodig het, kan dit moontlik wees om bedreigings en geleenthede te gebruik om toepaslike drinkwater- en sanitasie-infrastruktuurstelsels by plaaslike skole te ontwikkel. Belanghebbendes kan saamwerk in die doeltreffende bestuur van drinkbare water en sanitasie-infrastruktuur vir die gebruik van toekomstige geslagte.

Sleutelwoorde: drinkbare water, sanitasie-infrastruktuur, omgewing, waterhulpbronbestuur, menseregte

TSHOBOKANYO

Mafaratlhatlha a metsi a a nowang le a kgeleloleswe mo dikolong a botlhokwa mo boitekanelong le mo seriting sa baagi mo lephateng la thuto ya naga. Dithulaganyo tse di maleba tsa mafaratlhatlha a metsi a a siametseng go nowa le ditsamaiso tsa mafaratlhatlha a kgeleloleswe di botlhokwa mo go tlameleng ka ditirelo tsa botlhokwa tsa thuto go baagi go ralala Aforikaborwa. Melawana ya ditshwanelo tsa botho, jaaka e tlhalositswe mo Molaotheong wa Aforika Borwa (1996), e thaya motheo wa go falola, seriti le tikologo e e itekanetseng ya go ithuta. Le fa go ntse jalo, go sa tsamaisiweng sentle ga metsi a a nowang le mafaratlhatlha a kgeleloleswe ke bommassepala, mo dikarolong di le dintsi tsa naga eno, go dirile gore go se ka ga nna le ditirelo tse di tshwanetseng kwa dikolong. Maemo ano a nnile le tlhotlheletso e kgolo mo mananeong a dikolo a a diretsweng go ruta, go ithuta le go tllathloba barutwana mo dikolong di le dintsi mo nageng.

Go na le dikgwetlho tse di sa feleng tse di jaaka go dutla ga dipeipe tsa metsi, go tlhabela ga metsi go go bakiwang ke mafaratlhatlha a bogologolo, mmogo le go tlhoka kitso le go se nne le dikgono tse di maleba. Go ntse go le jalo, koketsego e e bofefo ya baagi kwa ditoropong mo nageng yotlhe e dira gore go nne le kgolo e ntsi ya mafelobonno a a sa tlhomamang. Mo lephateng la thuto, dikolo tsa mo lefelong leo di na le didirisiwa tsa metsi le tsa go tlosa leswe le go thibela malwetse, mme seno se dira gore maemo a boitekanelo a nne maswe le go feta. Go tlhabela ga metsi le thulaganyo ya go tlosa leswe go ama thata sebopego sa thuto. Mo godimo ga moo, go ka baka malwetse a a tshelanwang, a a jaaka kholera, segolobogolo mo dikolong tse di tletseng phetelela.

Mekgwa ya boitshwaro ya barutwana, segolo thata mo dikgannye tsa go tsena sekolo, e amega fa go se na ditšhono tse di agang tsa go ithuta mo phaposiborutelong. Go nna maswe le go feta fa go na le metsi a a sa siamang le ditirelo tsa go tlosa leswe mo dikolong. Kwa metseselegaeng, dikolo tsa setšhaba tse di nang le matlwanaboithusetso a a lekanyeditsweng le metsi a a nowang, di na le tlhotlheletso e kgolo mo go ruteng. Go neela sekai, go tlhabela ga metsi le thulaganyo ya go tlosa leswe le go thibela malwetse (WASH) go ntse go etegela ka gonne se se ithutiwang kwa phaposiborutelong se ka se dirisiwe mo mapatlelong a dikolo. Maemo a a bakiwang ke go dirisa ntlwanaboithusetso thata a nna a a sa itumediseng e bile a le maswe, a baka kotsi e kgolo ya boitekanelo mo

sekolong. Ka kakaretso, go tlhabela ga metsi a a nowang le ditirelo tsa kgeleloleswe mo dikolong go oketsa maemo a a nang le mathata mo dithulaganyong tsotlhe tsa thuto Go totilwe se se fa godimo, maikaelelo a patlisiso e ke go sekaseka tshwanelo ya motheo ya motho ya go nna le metsi a a phepa a go nwa le kgeleloleswe mo dikolong tse di tlhophilweng mo dikgaolong tsa Mmasepala wa Selegae wa Rustenburg. Ka go thatlhoba tsela e ditshwanelo tsa batho, puso le dikgwetlho tsa go aga di amanang ka teng, patlisiso eno e sekaseka ditšhono tsa go lolamisa maemo.

Thutopatlisiso e e supa tlhotlheletso ya molao le ya loago le ya sepolotiki mo kgaoganyong e e lekalekanang le phitlhelelo ya metsi a a nowang le metswedi ya kgeleloleswe, go thaya motheo wa tshekatsheko e e tseneletseng ya dikgoreletsi tse di leng teng le makoa a a ka nnang teng mo tsamaisong ya puso. Ka go bua ka thulaganyo eno, pegu eno e sekaseka thulaganyo ya molao le ya dipholisi e e dirisiwang go laola metsi a a nowang le mafaratlhatlha a go tlosa leswe. Morago ga moo, patlisiso e ne ya dirisa patlisiso ya tiragatso e e tsayang karolo (PAR) go sekaseka maemo kwa dikolong tse di tlhophilweng mo Mmasepaleng wa Selegae wa Rustenburg.

Tshekatsheko ya patlisiso e simolotse ka dipuisano tse di sa tlhomamang le tse di tlhomameng le bagokgo, makgotlataolo, botsamaisi ba metsi le kgeleloleswe ba Mmasepala wa Selegae wa Rustenburg, barutabana le kemedi ya baagi ya selegae, go supa le go tlhalosa bothata, go tsamaelana le kgato ya go rulaganya PAR. Dikgato tse di latelang tsa go kokoanya tshedimosetso, go e tshetshereganya le go e tlhalosa, di kgontshitse go tsewa ga kgato, go tlabolola le go akanya ka dikgato di le mmalwa tsa PAR.

Kakanyokgolo mo lenaneong le le tshitshinngwang ke go tlhama lenaneo la tsamaiso ya letlhomiso le dikakanyo tse di maleba go batlhankedi ba kwa Mmasepaleng wa Selegae wa Rustenburg, dikolo tsa selegae le baagi ba selegae. Ka go tlhama mekgwa e e siameng mo dikarolong dingwe tse di tlhokang tlhokomelo, go ka nna ga kgonega go dirisa matshosetsi le ditšhono, go tlabolola metsi a a nowang a a maleba le ditsamaiso tsa mafaratlhatlha a kgeleloleswe kwa dikolong tsa selegae. Batho ba ba nang le kgatlhego ba ka dirisana mmogo mo tsamaisong e e nonofileng ya metsi a a nowang le ditirelo tsa go tlosa leswe mo mafaratlhatlheng a dithoto go dirisiwa ke dikokomana tse di tlang.

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LIST OF ABBREVIATIONS

CAPS	Curriculum Assessment Policy Statement
CEDAW	Convention on the Elimination of all forms of Discrimination
CESCR	Committee on the Economic, Social and Cultural Rights
COGTA	Cooperative Governance and Traditional Affairs
CRPD	Convention on the Rights of Persons with Disabilities
DEAT	Department of Environmental Affairs and Tourism
DWAF	Department of Water Affairs and Forestry
EIWRM	Environmental and Integrated Water Resource Management
GIS	Geographical Information System
HRBA	Human Rights–Based Approach
IDP	Integrated Development Plan
IWRM	Integrated Water Resource Management System
MDG	Millennium Development Goals
NEMA	National Environmental Management Act
NGO's	Non-Governmental Organisations
NWU	North-West University
PAR	Participatory Action Research
PGM	Platinum Group Metal Mining
RHW	Rainwater Harvesting
RLM	Rustenburg Local Municipality
RW	Rand Water
SANS	South African National Standards
SDS	Sustainable Development Plan
TDR	Transdisciplinary Research
UN	United Nations

WASH	Water Sanitation and Hygiene
WDM	Water Demand Organisations
WMA	Water Management Area
WSP	Water Safety Plan
WSUD	Water Sensitive Urban Design
IWQMP	Integrated Water Quality Management Plan
SCR	Corporate Social Responsibility

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CHAPTER 1 ORIENTATION OF THE STUDY

1.1 Background

The Constitution of the Republic of South Africa, 1996 (hereafter referred to as the Constitution) places an obligation on various spheres of government and departments, in terms of Chapter 2 of the Constitution under the Bill of Rights, section 24, to make communities safe and healthy places in which to live (RSA, 1996: section 26(2)). Local municipalities are providers of basic services such as a potable water supply, sanitation, electricity, waste removal, housing, and roads (RSA, 1998). After 1994, South Africa's asset management also adopted and learned from international infrastructure asset management (National Treasury, 2012). The Integrated Infrastructure Management Manual (IIMM), one of the top infrastructure asset manuals for practices in South Africa, was introduced by the Institute of Municipal Engineers of South Africa at the onset of the new millennium (IMESA) (Von Holdt, 2006). The asset management framework was created by the South African Government to introduce the idea of infrastructure asset management (RSA Department of Public Works, 2007).

Section 73 (2) (c) (d) of the Local Government: Municipal Systems Act 32 of 2000 declares that "municipal services are provided to the local community in a financially and environmentally sustainable manner," while section 63 (1) (a) of the Local Government: Municipal Finance Management places the accounting officer in charge of the local authority's asset management (RSA, 2003; 2000). Provision for capital costs, operating costs, asset replacement, maintenance, and repair is all part of the financial sustainability criteria (RSA, 2003; 2000). According to section 152 (1) (b) of the Constitution of South Africa, one of the goals of local government is to guarantee the community's sustainable access to services (RSA, 1996). This implies that local governments should not only focus on short-term provision and management of potable water and sanitation infrastructure, but also adopt a long-term, sustainable vision for preserving these assets to meet future needs (RSA, 1996). According to Agol and Harvey (2018:284), South African laws and policies were promulgated from 1994 to transform all sectors, which included the political, social, economic, and environmental sectors, in the governance of the country. In addition to the Constitution, the National Environmental Management Act (NEMA, 1998) provided the Water Services Act 108 of 1997 and the National Water Act 36 of 1998, to manage

the use of water resources, as well as governing the quality of potable water in South Africa in a comprehensive, and environmentally sustainable framework of governance (Department of Water Affairs & Forestry, 1998).

The National Water Act stipulates that water must meet certain basic requirements to be suitable for human consumption. However, many communities, especially in schools, in both rural and urban areas of South Africa, are still without basic services such as potable water and sanitation (Matseke, 2020:93). South Africa's freshwater resources are rapidly diminishing because of high temporal and spatially variable rainfall (Mugambiwa & Chitonge, 2020:27; Tirivangasi, 2021; 97). The increasing demand for potable water worsens this situation. At the same time, there are persistent problems with pollution, unsustainable use, and the imminent effects of climate change that need attention (Sharma, 2022:40; Nyahunda, 2021:218). Water has become a highly publicised issue because its supply and distribution fulfil a basic human need. Montamasson-Claire (2023:134) and Schor (2017:25) confirm that there is an abundance of scholarly work on access to water in South Africa.

At the heart of the prevalent discourse has been government's National Water Resources Strategies (I, II & III) that is periodically adapted to be compliant under changing conditions of drought, floods, climate change, and population growth (Adom & Simatele, 2021:515). Yet, the challenges facing the water sector persist (Meissner, 2013:07; Pollard, Biggs & Du Toit, 2014:2). Due to a severe potable water and sanitation crisis that has led to water insecurity and inequitable access to water, there has been a collaboration focus by government to structure the water sector and bring to the forefront the principle of equity in access to all appropriate water and sanitation services (Adom & Simatele, 2021:516). Section 27 (1) (b) of the Constitution states that all citizens have the right to have access to adequate food and water (RSA, 1996: 1255). Section 27 (2) extends this obligation by stating that "the state must take practical legislative and other measures to make resources accessible to achieve the realisation of these rights" (Salo, 2014: 27).

Basic service delivery of potable water and sanitation in Rustenburg Local Municipality (RLM) in the North West Province is currently a major challenge. On several occasions, there have been local service delivery protest actions by residents in the municipal area. In 2015, statistics suggested that North West was one of the most protest-ridden

provinces in South Africa (Municipal IQ, 2016:33). Protests started because people were unhappy with basic municipal services, such as running water, electricity, and toilets, especially in informal settlements and in the towns near them.

The growth of informal settlements has led to high enrolment at local schools. By 2012, international projections suggested that about 863 million people, globally, would soon be living in informal settlements in developing countries of the world (United Nations, 2014:47). These settlements face several challenges. Potable water and sanitation services are singled out in this research. At the end of the United Nations' (UN) comprehensive deliberations over the Millennium Development Goals (MDG) period in 2015, globally, many people still did not have these services, which is why this research is important. Although South Africa is committed to the UN's Sustainable Development Goals SDG2030 (UN, 2018), there remains the challenge of securing the objectives, particularly of Goal 6, dealing with water matters.

1.2 Introduction

It is a fundamental human right to have access to potable water and sanitation services. (United Nations Meeting, 2018). In 1948, when the Universal Declaration of Human Rights was approved by the United Nations General Assembly, representing all its member states, the human right to water and sanitation were not explicitly listed. At the time, colonialism was still prevalent in many parts of the world. For obvious reasons, the absence of stipulating the need for basic services to communities in these territories would only become a priority once effective governance systems were in place. In due course, more former colonial countries qualified for UN membership. By the 1960s, matters related to the development of the so-called 'Third World' countries became more prominent. In the UN's assembly, issues of under-development, poverty, neglect, and famine came up for frequent discussion. In due course, under-development and issues of water and sanitation also came under scrutiny. Human consumption, improvements to hygiene and sanitation, and food preparation were just a few of the numerous uses for water (Gleick, 2018:571-579). There were disparities in the South African infrastructure systems when the first democratic government came to power in 1994. Certain regions and local areas lacked sufficient infrastructure (Makhathini *et al.*, 2020). Water infrastructure, including pipes, pump stations, and reservoirs, were either non-existent, in

poor condition, or scarce in the country's townships and rural areas. This is explained by the fact that throughout the apartheid era, urban areas populated by the minority group of white people, typically had good water and infrastructural services (RSA, 2014). To address this issue, the new democratic government created regulations and policies for infrastructure with the goal of achieving efficient infrastructure delivery. The early plans provided for the improvement of infrastructure, as well as facilitating investment in the nation's infrastructure service delivery (Kumo, 2012).

Due to a lack of asset management, many South African towns have since the 1990s been unable to provide appropriate services (Patience & Nel, 2021). The primary cause of potable water and sanitation infrastructure mismanagement, urbanisation, has been seen as a major threat to government's ability to deliver high-quality services. The population of South Africa is estimated to grow to 60.6 million in the year according to the national census of 2022 (StatsSA, 2022). Despite the devastating impact of COVID-19 (2020-21), the population has been increasing. If there are no accessible sources of clean water, particularly in poor countries, members of urban and rural households spend lengthy periods of searching for alternative water sources. At the level of households, this phenomenon affects, for example, the number of hours children spend at school (Chard *et al.*, 2019:144).

The critical journey towards the 21st century's Millennium Development Goals culminated in the establishment of the Sustainable Development Goals (SDGs) for 2030. By 2023 all UN member states committed compliance to the SDGs 2030 framework. Of particular importance for this study, as is the case in the sector, is Goal 6, which focuses on water and sanitation (Biswas, Dandapat, Alam & Satpati, 2022). The interconnectedness of all the goals underscores their collective importance. By 2030, South Africa should be able to provide evidence of its adherence to these comprehensive goals.

As potable water and sanitation crises in developing countries continued to grow, the UN underscored the critical nature of these issues. The 1977 UN Conference on Water in Mar del Plata, Argentina, saw representatives from UN member states outline fundamental objectives to evaluate water and sanitation services. Central to this initiative was recognizing the role of women in households, and the need for governments to be responsive to the necessity of water and sanitation as essential requirements in all

households. This campaign laid the groundwork for numerous subsequent initiatives under the UN's strategic global planning.

Several international human rights treaties emerged, including the Convention on the Elimination of All Forms of Discrimination Against Women (CEDAW) with General Recommendation No. 24 (1999), the Convention on the Rights of the Child (CRC) in Articles 6 and 24, the International Covenant on Civil and Political Rights (ICCPR) with General Comments No. 36 (2018) and No. 25 (2020), and the 2008 Convention on the Rights of Persons with Disabilities (CRPD) in Articles 28, 9, and 20. These treaties explicitly highlighted the significance of water and sanitation in realising human rights, either individually or collectively.

In 2002-2003, the Committee on Economic, Social, and Cultural Rights (CESCR) adopted General Comment No. 15 on the Human Right to Water, further emphasising the importance of these resources. The CESCR, responsible for monitoring state compliance with the International Covenant on Economic, Social, and Cultural Rights (ICESCR), requires of nations to take deliberate steps to progressively fulfil these rights. Article 2 (1) of the ICESCR mandates that these steps be purposeful and precise, ensuring the effective realisation of the covenant's commitments.

Rustenburg is home to the two largest platinum mines in the world and the world's largest platinum refinery. It attracts many job seekers arriving with their families. This puts a strain on the local government's basic service delivery capacity. Moreover, local educational facilities at public schools, both primary and secondary, become overcrowded. It is challenging to accommodate and cater for 600 to 2 000 learners per school (Ramolobe, Malatji & Mavuso, 2024:329).

Limited toilet facilities are common areas at schools. Conditions resulting from the overuse of toilets become so unbearable and appallingly unhygienic that they pose serious health hazards to both learners and their educators. The dysfunctional nature of schools' toilet facilities worsens hygiene problems in the educational framework. For example, behavioural attitudes of learners are not conducive to constructive learning opportunities. In short, inferior sanitary conditions and clean potable water at schools compound problematic circumstances at local schools.

The schools' potable water, sanitation, and hygiene facilities, i.e. boreholes, tap water, and toilets, have received little attention from many school managements in terms of maintenance and operations, facility safety, and suitability for use by learners. These facilities cost millions of rands to provide in the first place. Most existing systems have deteriorated since construction because of a lack of proper maintenance, leading to frequent breakdowns, vandalism, and severe damage (Dube, 2024:12). There is evidence of weak governance by the responsible authorities. This paves the way for poor ownership and buy-in practices on the part of local communities. In view of the details discussed above, this research study aims to investigate the challenges with regard to access and management of potable water and sanitation infrastructure in the selected schools of Rustenburg Local Municipality (RLM) of North West Province. The objective of this research is to create awareness and develop strategies, making it easier for learners, teachers, and school managements, school governing bodies (SGBs), and communities to adopt and use safe potable water and sanitation practices, and find ways to resolve problems in the school environment and communities.

1.3 Problem statement

Municipalities in South Africa's Constitution must provide the people with adequate essential basic services such as potable water and sanitation, which ensure a safe, healthy, and conducive environment for communities (RSA, 1996: Section 26(2)). Even though this constitutional requirement is quite clear, what is more problematic within municipalities is the effectiveness with which they manage and maintain water and sanitation infrastructure, also at Rustenburg Local Municipality (RLM). These deficiencies in management and operations create an environment in which the municipality cannot supply blue, safe, reliable, adequate drinking water and sanitation services. These also negatively affect the daily well-being and functioning of local schools (Municipal IQ, 2016:33).

In Rustenburg Local Municipality (RLM), the usual system structural inadequacies, aging pipelines, leakages, and irregularity of water supply are commonplace today. Most of these problems arise due to a lack of sufficient investments in the maintenance of infrastructure, technical expertise, and qualified staff to manage water and sanitation systems effectively. These infrastructural deficits are compounded by rapid urbanization;

the unprecedented influx around Rustenburg has resulted in such an increased rate of informal settlements that stretched the limited resources of the municipality and increased service delivery pressures (Mugambiwa & Chitongo, 2020:27; Tirivangasi, 2021:97). Schools located within these municipal areas always experience significant shortages of water, unreliable sanitation services, and infrastructures that do not satisfy basic health and safety standards.

The inadequacy and mismanagement of water and sanitation services in schools severely affect the health, attendance, academic achievement, and overall behaviour of learners. Poor reference to reliable potable water and proper sanitation facilities greatly decrease educational quality since they undermine teaching and learning activities and assessment processes, which are critical for learner success and institutional accountability. Particularly overcrowded schools will worsen this infrastructural lack, leading to a far greater communicable disease threat, namely cholera, which rapidly spreads among a large learner cohort (Nyahunda, 2021:218).

These adverse conditions will not merely produce a learning-unfriendly atmosphere but will even be harmful to the morale and psychological wellbeing of learners. Water supply disruptions and lack of sanitation will compel learners to adopt coping mechanisms such as absenteeism, thus negatively impacting their educational outcomes. This includes mainly rural and peri-urban schools, which have limited toilet facilities and intermittent water supply making the practical application of health and hygiene education offered in classrooms more difficult (Montamasson-Claire, 2023:134; Schor, 2017:25). What happens in class cannot take place in practice in the school setting, worsening learners' ability to internalise and practice good hygiene. This will make cleanliness a matter of continued health and attendance problems.

Poor infrastructure management leads to widespread negative consequences and extend beyond individual learners. It applies, in fact, to the effectiveness of the whole education system, and hence the consequence of poor reliability will actually bear out against the quality and credibility of educational outcomes across Rustenburg Local Municipality (RLM). Schools suffering perpetual infrastructure deficiencies are usually left without the capability to carry out the complete implementation of an educational curriculum based on the educational targets set by both the provincial and national authorities. Such failures

put the entire ideal of balanced and good quality education, plus sustainable development, to such an end - it is no longer a matter toward which South Africa's ideal constitution and socioeconomic development tend.

These are the critical human rights considerations directly addressed by this study concerning provisioning and infrastructural management of potable water and sanitation in selected schools within Rustenburg Local Municipality (RLM). The study examines critical aspects of municipal governance effectiveness, infrastructure management capacity, and compliance with human rights norms concerning water and sanitation. The outcome be a comprehensive and actionable framework that redirects municipal officials, educators, and community stakeholders to far better practices in service delivery. Finally, the study aims at ensuring the realisation of learners' constitutional rights to a safe, healthy, and supportive educational environment that is meaningfully preserved and sustainably guaranteed, thus contributing positively to broader educational and social equity objectives within the Rustenburg Local Municipality (RLM).

1.4 Purpose of the study

This study aims to examine how schools in the Rustenburg Local Municipality (RLM) manage potable water and sanitation infrastructure facilities.

1.5 Research questions

This research focuses on the following research questions:

- What is the fundamental link between a Human Rights-Based Approach (HRBA) and effective service delivery in the management of potable water and sanitation at schools in Rustenburg Local Municipality (RLM)?
- How do school communities perceive the current management practices regarding potable water supply and sanitation infrastructure provided by Rustenburg Local Municipality (RLM)?
- What is the technical capacity of Rustenburg Local Municipality (RLM) in providing consistent and adequate potable water and sanitation infrastructure services to schools?

- What specific challenges do schools within Rustenburg Local Municipality (RLM) encounter regarding the provision and management of potable water and sanitation services?
- Which service delivery mechanisms can be identified and recommended to effectively improve the potable water supply and sanitation infrastructure at schools in Rustenburg Local Municipality (RLM)?
- What guidelines should be proposed for developing a school environmental policy that effectively integrates and supports water and sanitation education into the existing curriculum?

1.6 Research objectives

1.6.1 Main research objective

The main research objective of this study is to develop an Integrated Water Resource Management (IWRM) framework that addresses the challenges of potable water and sanitation infrastructure in schools within Rustenburg Local Municipality (RLM) from a human rights-based perspective.

1.6.2 The following secondary research objectives are to:

- Critically examine the fundamental link between a Human Rights-Based Approach (HRBA) and service delivery in managing school water and sanitation.
- Assess the perceptions of school communities regarding water and sanitation management.
- Evaluate the technical capacity of Rustenburg Local Municipality (RLM) to provide potable water and sanitation infrastructure management to schools.
- Analyse the challenges schools face in the provision of effective potable water and sanitation management under Rustenburg Local Municipality's (RLMs) jurisdiction.
- Explore, assess and recommend service delivery mechanisms to improve water and sanitation infrastructure in local schools.

- Propose guidelines for a school environmental policy that supports potable water and sanitation infrastructure management in the education curriculum.

1.7 Theoretical approach

The study employs the Human Rights-Based Approach (HRBA) and the systems theory of service delivery to the provision of potable water and sanitation infrastructure for schools in the Rustenburg Local Municipality (RLM) of North West Province. Using the tenets harvested from these theories, the researcher provides the reader with a better understanding of the research problem beyond a single theory and also highlights the importance of the objectives selected for this research study. According to O'Callaghan, Adapa and Buisman (2020:2), most theories of access to potable water and sanitation supply are under-studied. Concerns about the consequences of a lack of potable water and sanitation supply have grown in poor countries, with extensive debates on, for example, better techniques to ground the supply of potable water in a theory that can be implemented in the post-2015 SDG2030 era (Salehi, 2022:4). This study demonstrates how the HRBA and systems theory of service delivery recognise the negative impacts of a lack of potable water and sanitation supply, such as death, due to water shortages. In many cases, rising mortality rates are also directly linked to endemic waterborne diseases.

In principle, the South African Constitution places an obligation on various government spheres and departments, in terms of Chapter 2 of the Constitution under the Bill of Rights Section 24, to make communities safe and healthy places in which to live (RSA, 1996: Section 26(2)). Local municipalities act as providers of basic services such as potable water, sanitation, housing, and roads (RSA, 1998). However, a lack of administrative and management capacity has been responsible for lapses in providing potable water and sanitation services. The goal of this component of the research study is to advance a collective understanding of the fundamental human rights related to potable water and sanitation-service delivery. It represents one of the prime challenges in achieving efficient and effective service delivery in poor countries and speaks to the basic human right to potable water (Bayu *et al.*, 2020:254; Chitonge *et al.*, 2020:210; World Health Organisation & United Nations Children's Fund, 2021).

The HRBA's access to potable water and sanitation has been frequently debated in recent times. Besides the air we breathe, water is the second most essential ingredient humans require to survive (Bayu *et al.*, 2020:254; Chitonge *et al.*, 2020:210). Because of the intimate link between water and life, the mainstreaming of the right to potable water has been related to acceptance of the HRBA (Oluborode, 2020:55). However, it is unfortunate that the recognition of the human right to potable water and sanitation has frequently been linked to anti-privatisation agendas (Prieto, 2021:278; Obani, 2020:80). On the other hand, it clarifies the right to potable water as being predicated on the notion that government must realise it through service delivery. In the proposed research, a HRBA is relevant to the study since potable water and sanitation is required in schools throughout Rustenburg.

Tshehle (2021:30) acknowledges the SA Human Rights Commission's call for North West education MEC, Wendy Matsemela, to address potable water and sanitation shortages at 32 schools in the province. The need to provide services of potable water and sanitation in schools aimed at creating a healthy environment for teaching and learning. The number of new informal settlements has increased rapidly since the 2010s because of ongoing mining activities in the Rustenburg Local Municipal region, resulting in a growing demand for water and sanitation service delivery.

Nhamo *et al.* (2021:3) concur that Rustenburg has many informal settlements. However, few have been formalised by the local governance authorities. One of them is Reutlwile, near Zinniaville. Although formalised, there is no municipal footprint in the area. Residents feel ignored and neglected by the Rustenburg Local Municipality (RLM). Communities in various wards across the municipality are unhappy with on-going sewage spillages, constant water cuts, a lack of basic services in informal settlements, and wasteful expenditure (Nhamo *et al.*, 2021:3). Ngcukana (2018:14) gives an example of a child who nearly died by falling into a pit toilet in the Eastern Cape, and a five-year-old Grade R pupil, Lumka Mkhethwa, drowned in a dilapidated pit latrine at Luna Junior Secondary School in Mbizana. In both cases, the incidents were due to dilapidated toilets at many schools, especially in the rural and informal urban areas of South Africa.

There is a direct link between human rights and policy execution in the provision of potable water and sanitation services. Human rights are a pipe dream for countries with

political imbalances. There is consensus amongst experts that human rights can only be realised in a political environment that strives to meet its citizens' public service goals (MacNaughton, Frey & Porter, 2021:15).

Systems theory was used to supplement the HRBA in order to analyse and formulate research questions from the perspective of the Rustenburg Local Municipality (RLM). I used elements of the systems theory applicable to the service delivery of potable water and sanitation. General systems theory was proposed in the early 20th century by the biologist Bertalanffy (Carr-Chellman & Carr-Chellman, 2020:705). According to the general theory, a system is the culmination of several interconnected parts within a much larger environment. Systems theory's foundational principles assert that "there exist models, rules, and laws that apply to generalised systems or their subclasses, regardless of their sort, the nature of their component elements, and the relationships or 'forces' between them" (Carr-Chellman & Carr-Chellman, 2020:705).

Rustenburg Municipality serves as a model for a systems approach that could be used in this research. Since I recognised the Rustenburg Local Municipality (RLM) as a system that has a variety of inputs that are processed to produce outputs (Reynolds & Holwell, 2020:4), it is crucial to understand the municipality as a system in this research study. The system's ability to achieve its objectives depends heavily on the constant feedback between its various parts. To sustain this ongoing input within the system, policies must be implemented, and the proposed policies and procedures must be continuously monitored and evaluated (Ramos, Aguiar & Pequito, 2022:3). Rustenburg Local Municipality (RLM) should ensure that the anticipated service outcome is appropriately appreciated by the schools and community at large, as part of an ongoing feedback process. As such, this study will adopt HRBA as a theoretical lens to guide research on unpacking this project's objectives. It is a fundamental human right for learners and the school community to have access to potable water and sanitation infrastructure to attain sound health conditions and quality education.

1.8 Preliminary literature review

1.8.1 South Africa's water and sanitation situation

Although there has been an improvement in the provision of potable water and sanitation in the country, significant challenges are still persistent at the local government level. Mdlongwa (2014: 2) argues that local governments have a slow rollout of services. When local municipalities become organised and render services to the people, it is a slow and tedious process which hampers the quality and efficiency of service delivery. The potable water situation in South Africa is similar to that of sanitation. The provision has increased since 1994, but significant challenges persist. In a global context, the South African situation on potable water and sanitation is affected by climate change, poor institutional capacity, poor infrastructure, and water pollution.

1.8.2 Water and sanitation challenges in North West Province

Local government is responsible for providing potable water services in South Africa, including sanitation. The statistics for potable water and sanitation in the North West Province indicate that the provision of the services has increased (Statistics South Africa, 2012). Yet, challenges still exist. Providing proper potable water and sanitation is beset by countless challenges at local government level, according to Gumbi (2020:8). Many municipalities fail to implement policies and ensure access to basic services for poor households. There is inadequate national financing to resolve potable water and sanitation backlogs, particularly in small towns and rural areas. Municipal tariff structures are generally not well-developed outside metropolitan municipalities. There is a shortage of critical skills and competencies in most municipalities, especially rural and poor municipalities. Strong leadership and management at the local municipality level are lacking. Political representatives are too involved in the management of services and there is a need to limit these inappropriate political interventions in service delivery.

The cited problems have resulted in serious challenges in potable water supply and sanitation of schools in North West Province. Lottering, Mafongoya and Lottering (2023:3) report water cuts in the province, which even resulted in a cabinet minister apologising to locals for the lack of delivery. Sedibeng Water, a water utility company supplying water in the province, at the time, explained that municipalities in North West, Free State and the

Northern Cape had failed to pay for their water services. Several bulk water supply institutions in South Africa have encountered similar problems with non-paying local and regional municipal authorities.

1.8.3 Access to water

As a water-scarce country, water is South Africa's most valuable natural resource (Mutamba, 2019: 51). There is a substantial amount of published literature on the importance of water, the rights that citizens have regarding water access, and the policy on access to water (Mishra, Kumar, Saraswat, Chakraborty & Gautam, 2021:490; Jiménez, Saikia, Giné, Avello, Leten, Lis, Lymer & Ward, 2020:827). The sixth Goal of the UN's Sustainable Development Goals (SDGs) for 2030 has been to ensure accessibility and supportable supervision of potable water and sanitation for all (ICSU & ISSU, 2015: 35). It is estimated that by 2030, the previously less-privileged people without access to potable water and sanitation all over the world, will have secured water supplies. By then, there should be equal access to water and sanitation, as well as the eradication of poverty (ICSU & ISSU 2015:35).

According to its National Development Plan (NDP) 2030, the South African Government also initiated a plan to ensure all citizens have access to clean running water in their homes by 2030 (Marumo, 2022:4). The National Water Act of South Africa also prioritised the principle of access to water. Moreover, already in 2013, the Department of Water Affairs (DWA) stipulated that water was a basic human necessity and it was necessary to recognise its role and value to ensure unbiased and viable socio-economic development in the country (Pilusa & Kanyane, 2020). The relevant policy documents on water and water provision were explored in this study.

1.8.4 Water scarcity and security

Water scarcity is the shortage of access to water as a basic resource for human survival. According to Sharafatmandrad and Khosravi Mashizi (2021:64), water scarcity is seen as an increase in the total water demand and a decrease in the available water supply. Water scarcity is caused by: (1) disputes over scarce water resources; (2) poor service delivery in terms of water distribution; (3) wastage of existing resources; and (4) environmental changes. Despite the estimated world per capita consumption of 173 l/d, the average

water consumption per capita in South Africa stands at 235 l/d (Sharafatmandrad & Khosravi Mashizi, 2021:64).

Water security is the abundance of good and valuable water for health, livelihoods, ecosystems and production, without endangering the lives of the people, and reducing risks (Mahmoud, Umachandran, Sawicka & Mtewa, 2021:511). This definition emphasises two key points: (1) enough water is available for the sustainability and wellbeing of society; and (2) society is protected from the negative impacts of the water cycle, such as droughts, floods and anthropogenic disasters. Water management is important and has a major impact on the socio-economic development of a country. Adequate measures and proper policies must be laid down to manage and develop water resources. It will enable the government to achieve water security (DWS, 2014: 8). It will also serve as a basic factor for economic development. Water is a source of life, livelihoods, and prosperity, but simultaneously also a cause of death, devastation and poverty, as seen in droughts, floods, landslides, epidemics, and erosion (Mahmoud, Umachandran, Sawicka & Mtewa, 2021:511). Hence, there is a need to promote a prolific supply of potable water and sanitation to reduce its detrimental impact on society.

1.8.5 Water policy

Rustenburg Local Municipality's (RLMs) five-year Integrated Development Plan (IDP) for 2021-22 is based on its Rustenburg Vision 2030. To achieve this vision, the priority is to provide new infrastructure and good maintenance of existing infrastructure (water, sanitation, roads, electricity, and storm water). The second priority is to build houses and improve the conditions in informal settlements (RLM, 2021: 8-9). This study discussed the current official documents from the Rustenburg Local Municipality (RLM) related to water, sanitation and educational facilities. Documents, including Vision 2030, the IDP five-year draft 2021/22, and more, were analysed and discussed, especially on matters of access to potable water and sanitation in schools and local communities.

Analysing policy documents at the local level is crucial. Municipalities are responsible for overseeing communities under their jurisdiction (Sethunyane, 2021). This research study specifically focuses on the effective management of potable water and sanitation infrastructure in schools within the Rustenburg Local Municipality's (RLMs) area of jurisdiction. Additionally, the study referred to the national policy on potable water and

sanitation to determine whether it provides guidelines for local governments regarding water supply in informal settlements. One such document is the National Water Resource Strategy Third Edition (NWRS-3), which outlines South Africa's comprehensive plan for managing its water resources (Department of Water and Sanitation (DWS), 2023). This strategy emphasises equitable and sustainable access to water for all citizens, recognising the increasing pressure on water resources due to population growth and economic development. The NWRS-3 sets forth several key goals, including reducing water demand, increasing water supply, and protecting water resources. It underscores the importance of water and sanitation and aims to reduce inequality in water access. Aligned with the principles of the National Development Plan and the Sustainable Development Goals, the NWRS-3 seeks to ensure that all South Africans have reliable access to safe water. It provides a clear and ambitious roadmap for managing the nation's water resources, and its success hinges on the collaborative efforts of all stakeholders.

1.8.6 Water quality

According to Sena and Ebi (2021:138), the increase in water pollution poses a risk to public health, food security, and livelihoods. Also, new factors are threatening water quality, such as the increasing discharge of endocrine disruptors and other dangerous chemicals into freshwater systems. Meanwhile, water quality has become a global issue because of growing linkages with global driving forces and global processes such as climate change. In the South African context, challenges are experienced that lead to a degradation of water quality. The most important driving forces in South Africa that cause degradation of water quality are river catchment systems in high-density rural population clusters and extensive urban informal housing developments that dominate land use patterns in these catchments. The situation is typically compounded by the absence of effective sanitation infrastructure systems (Nyam, Kotir, Jordaan, Ogundeji & Turton, 2020:63). The degradation of water quality is a global challenge and has health implications for users and the environment. The South African challenge regarding the quality of water is similar to other global challenges, poor water quality and its detrimental impact on the environment and water users.

1.9 Research methodology

According to Brynard and Hanekom (2021), research methodology necessitates reflection on study preparation, organisation, and implementation to meet the demands of truth and objectivity. Okubena (2012) defines research methodology as the guidebook for the generation, measurement, and analysis of data to achieve the goals of a research endeavour. In this research, the methodology gives an in-depth insight into the research design, data generation tools, data analysis and the ethics considered in the study.

1.9.1 Research design

According to Dawadi, Shrestha and Giri (2021:27), a research design is a thorough approach for addressing the primary research challenge. Research design permits the comprehensive development of research methodologies for data collection and analysis. This study adopts a Participatory Action Research design, which is introduced here and discussed in detail in Chapter 4. This is corroborated by Huntington-Klein (2021:2), who argues that research design is the specification of methodologies and procedures for gathering essential information. It is the project's overall operational pattern or framework that specifies what information is to be collected, from which source, and by what methods. For this study, the PAR methodology was used. Participatory Action Research (PAR) has the unique capability to highlight the perspectives of local human communities, capturing their challenges, problem understanding, and potential innovative ideas. These insights often differ significantly from those of the policymakers who create regulations impacting the lives of these communities. PAR emphasises collective inquiry and experimentation, grounded in experience and social history. Moreover, it serves as a transformational process, challenging conventional social science research methodologies and offering a more inclusive and dynamic approach (De Oliveira, 2023:287-288).

In Figure 1.1, a graphical representation of the PAR cycle about the research is indicated.

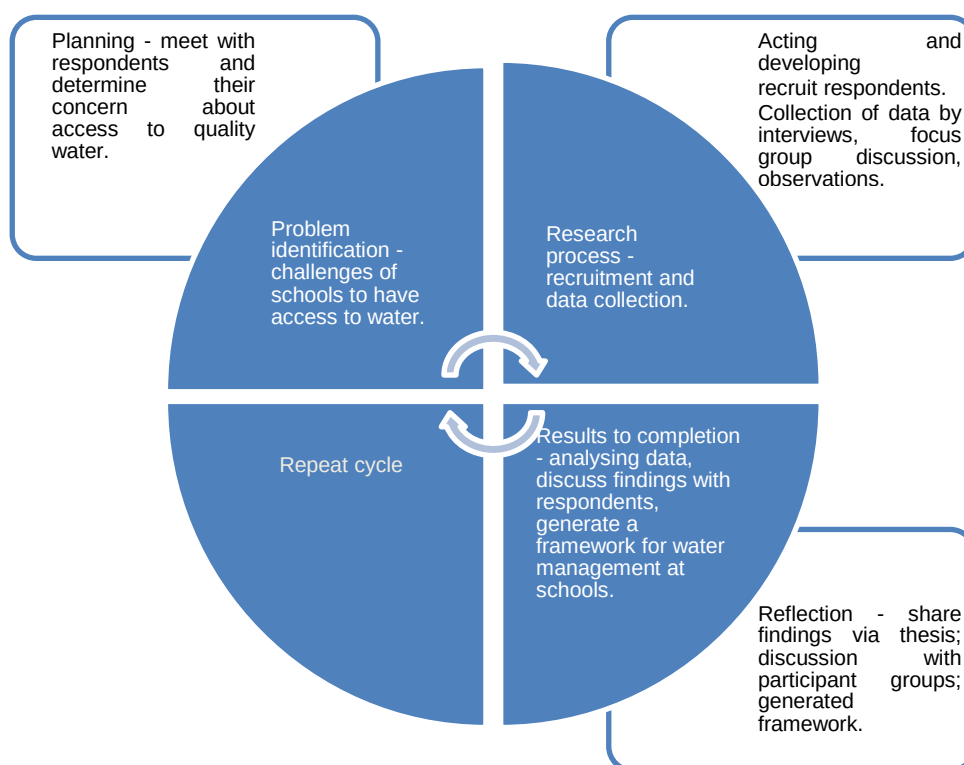


Figure 1.1: Graphical presentation of PAR in this study

Source: author's own drawing/display

1.9.1.1 Mapping out Participatory Action Research (PAR)

Mapping out a Participatory Action Research (PAR) on potable water and sanitation management in schools, involves outlining a collaborative, cyclical process that engages all stakeholders in identifying problems, co-developing solutions, and taking informed action. The first step is problem identification, where schools, teachers, maintenance staff, and community members share their lived experiences and concerns related to potable water access, toilet facilities, hygiene resources, and maintenance practices. This is followed by data collection, using tools such as surveys, observations, focus group discussions, and photo documentation, ensuring participants are both data sources and co-researchers. The analysis and reflection phase involves collaboratively interpreting the data to understand root causes and prioritise areas for intervention. Action planning and implementation then allow stakeholders to test locally driven solutions such as awareness campaigns, infrastructure improvements, or water-saving initiatives. Finally, the evaluation and reflection stage assesses the effectiveness of the interventions and

informs the next cycle of action. Throughout, the PAR process remains flexible, inclusive, and empowering, aiming not only to improve sanitation conditions but also to build capacity and ownership within the school community. Communities under siege, survivors of state negligence, or interpersonal violence, immigrants, struggling farmers, people in prison, workers, mothers, and educators are re-positioned as co-researchers, sitting alongside traditionally trained researchers, crafting the questions, methods, analyses, and research products (Cornish, Breton, Moreno-Tabarez, Delgado, Rua, de-Graft Aikins & Hodgetts, 2023:36). In the next section, the study areas and the context in which the research takes place were discussed.

1.9.2 Study Area

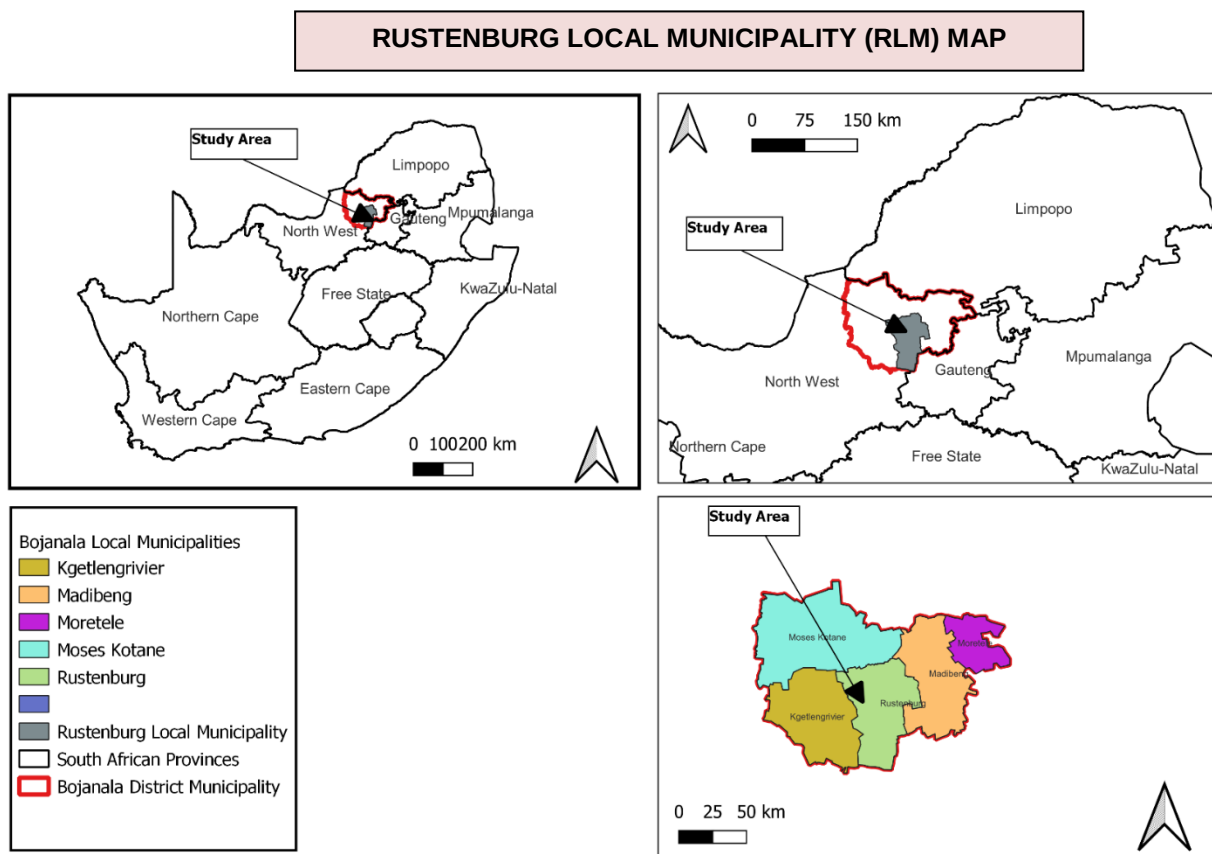


Figure 1.2: Map of Rustenburg Local Municipality (RLM) (2024)

Source: Mudau, 2023.

As seen in Figure 12, the Rustenburg Local Municipality (RLM) is located in North West Province's Bojanala District Municipality. It is one of five local municipalities, along with Madibeng, Moses Kotane, Moretele, and Kgetleng River (see Figure 2). Following section

12 of the Local Government: Municipal Structures Act 117 of 1998, the municipality was founded in September 2000 (RSA, 1998). With a total land size of 3 423 km square kilometres, it was created as a Category B municipality. According to Stats SA (2022), the Rustenburg Local Municipality's (RLMs) total population was estimated at 734 243 in 2022, out of a total of 3 804 548 in the entire North West Province. Additionally, the estimated number of households in 2022 was 368 501, out of the 1 141 291 households in the North West Province (Stats SA, 2022). Due to the economic impact of the three largest platinum mines in the world, which are located nearby, Rustenburg, a sizable town at the base of the Magaliesberg mountain range approximately 112 km, northwest of Johannesburg and Pretoria, was the municipality with the fastest growing rate in South Africa in 2010 (Mudau *et al.*, 2014; Ndebele, 2013).

Rustenburg's land area is mostly made up of rural residential, agricultural, mining industries and sub-urban areas. The Sun City resort, the Madikwe Game Reserve near the Kopfontein Border in Botswana, and the Pilanesberg Game Reserve are just a few of the tourist attractions in Rustenburg (Seokwang, 2007). Since there are more mining operations east of Rustenburg, which attract people from other parts of South Africa, Africa and especially Southern Africa, seeking work and investment opportunities. It is also the most populated part of the city (Mudau *et al.*, 2014). One of the prime reasons for Rustenburg's attraction to people from far and wide is the fact that over 70% of the world's platinum is produced locally (Ololade, 2012).

1.9.3 Justification of this research study.

This study explored potable water and sanitation infrastructure strategies to effectively manage water services delivery in selected schools within the Rustenburg Local Municipality (RLM). Throughout this process of research study, I focused on the theoretical underpinnings of potable water and sanitation infrastructure programmes regarding service delivery in schools, to better understand them. Along with technological facilities initiatives to understand them and how they can be used to manage potable water and sanitation infrastructure effectively, the study also looked at governance initiatives in terms of the implementation of policies that control and maintain potable water and sanitation infrastructure from an international, national, regional, and local

perspective, as part of the legislative framework regarding potable water and sanitation infrastructure management.

Potable water supply and sanitation are regarded as constitutional rights and is one of the UN's Sustainable Development Goals (SDG2030). However, these formal guidelines are undermined by the poor management of water infrastructure assets, which has major implications for municipalities in terms of SDG2030, number 6, featuring water. The management of potable water and sanitation infrastructure requires cooperation and coordination from a variety of stakeholders, including schools and communities. It is not only the province's job. A bottom-up strategy is needed in which industry, water sector departments, and the municipality's top management collaborate on strategies for effective potable water and sanitation infrastructure management. Schools and communities, who are regarded as the end users and beneficiaries of these services, should be involved and understand the significance of potable water and sanitation infrastructure management to prevent vandalism of infrastructure facilities.

1.9.4 Recruitment

According to Townsend (2024:12), the research population refers to all the people, activities or cases, subjects, objects and events that the researcher wishes to investigate to establish new knowledge. The target population of this research study consisted of principals, governing bodies and teachers at the schools selected for the study project, and people involved in the provision of water and sanitation in the Rustenburg Local Municipality (RLM) and representatives from the Department of Education and local community members. Govender, Mabuza, Ogunbanjo and Mash (2014:1-2) suggest it is, as a rule, not possible to collect data from the entire study population. Thus, a representative sample must be selected from the population.

1.9.4.1 Sampling procedure

I, as the researcher, employed purposeful sampling. Purposive sampling is a technique used to choose information-rich cases for the most effective use of limited resources, according to Campbell, Greenwood, Prior, Shearer, Walkem, Young and Walker (2020:655). This entails locating and selecting individuals or groups of individuals who are educated or experienced on water provision and governance in schools and

communities. In the proposed study, I conducted informal discussions with 30 purposively-selected respondents, namely six (6) principals of the schools selected for the study project; six (6) governing body chairpersons of schools selected for the study project; six (6) teachers representing each school; one Water and Sanitation Services manager of the Rustenburg Local Municipality (RLM); one (1) GIS specialist of water and sanitation of Rustenburg Local Municipality (RLM); two (2) general workers at the Infrastructure Unit at the Rustenburg Local Municipality (RLM); one (1) unit manager at the Public Works Department in Bojanala District, two (2) general workers at Public Works, one (1) director at the Department of Education, responsible for school infrastructure, and four (4) community members from the selected schools areas. In addition, observations and documentary analysis were added as data generation tools. The respondents were selected based on having experience of five years and more in their respective departments.

Table 1.1 Designation of respondents

Designation of Respondents	Recruitment technique	Reason for inclusion as respondents	Number of respondents
Water and Sanitation manager of the Rustenburg Local Municipality (RLM)	Purposive recruitment. The purposive recruitment technique, according to Sarantakos (2013:177), allows researchers to select people who, in their opinion, are relevant to the research topic.	The basis for using purposive recruitment was to allow me to select the respondents from the municipality, to solicit knowledge from respondents who have better knowledge of the water provision and its impact on the human right to water for potable water provision. The objective is to explore their knowledge of the Rustenburg Municipality's water provision and implementation policy.	One

Designation of Respondents	Recruitment technique	Reason for inclusion as respondents	Number of respondents
Teachers of the selected schools	Purposive recruitment	The three teachers selected from each school, i.e. in the fields of Life Orientation, Geography, and Physical Science teaching. They were identified because of their deeper understanding of water issues and the knowledge dissemination in the curriculum of those subjects.	Six
School managers or principals	Purposive recruitment	These role players act as the catalyst between the municipality and community members. They are in a position to demand water and sanitation infrastructure service provision. Furthermore, they oversee implementation of the necessary management at ground level. They are also witness and receive reports from teachers on the lived experiences learners undergo in respect of matters of water and sanitation.	Six
School Governing Body (Chairpersons)	Purposive recruitment	They are community leaders and members in the selected schools. As a collective they can hold the municipality accountable for challenges with regard to local water and sanitation service delivery lapses.	Six
Geographical Information System (GIS) specialist of water and sanitation	Purposive recruitment	These are the implementing authorities with sufficient skills to advice on water projects in the province.	One

Designation of Respondents	Recruitment technique	Reason for inclusion as respondents	Number of respondents
at Rustenburg Local Municipality (RLM)			
General workers	Purposive recruitment	These are workers responsible for installing potable water and sanitation infrastructure around the selected schools in Rustenburg Local Municipality (RLM).	Two
Director of Public Works in the Bojanala District	Purposive recruitment	The manager is responsible for maintenance of the schools as an active stakeholder to engage with the Department of Education.	One
General workers at Public Works	Purposive Recruitment	They are responsible for the maintenance of schools in the Bojanala District.	Two
Chief Education Specialist of Infrastructure in schools at the Department of Education	Purposive Recruitment	Responsible for school safety and maintenance in the Rustenburg Education Office.	One
Community members	Purposive Recruitment	Community members where schools are located.	Four
Total Respondents	30		

Source: author

I used a purposive sampling method to select six schools from which respondents were drawn. Units are selected for inclusion in the sample because they are generally more accessible. The schools were selected due to water related challenges observed by an education inspection during the schools visits There have regularly been running water

from fractured pipelines, broken toilet facilities and frequent notifications from schools that they would be closing early because of water outages.

The purposive sampling of respondents was based on geographical proximity, availability at a given time, or willingness to participate in the research. In this case, I selected schools where there is an established contact with designated gatekeepers. Typically, schools not included experience similar problems to those selected for this research project.

1.9.5 Data generation

The selection of a data generation method precisely depends on the choice of the research method, the research topic, and the availability of data (Zhang, 2021:10). This study used informal discussions (SSIs), observations, and documentary analysis. The data generation tools are discussed below.

1.9.5.1 Informal discussions

Informal discussions were conducted with managers at the municipal water and sanitation department; managers at Rustenburg Local Municipality (RLM); members of the selected school governing bodies, teachers, and school principals in the area under investigation; workers from Bojanala Public Works; the relevant manager of potable water and wastewater infrastructure in schools, and community members of the selected schools. The discussion and informal discussion schedule were developed and contain open-ended questions. Informal discussions were conducted to collect qualitative data from respondents. According to Mack *et al.* (2012:30) and Adeoye-Olatunde and Olenik (2021:135), researchers engage with respondents by neutrally posing questions, listening attentively to respondents' responses, and asking follow-up questions. The main reason for selecting the respondents in this research study was to acquire relevant information and information on the issues of providing water and sanitation services to schools in the Rustenburg Local Municipality (RLM).

1.9.5.2 Observation

According to Bardon, Garreau, Abdallah, Journé and Korica (2020:2), school buildings and facilities regarding potable water and sanitation distribution make a difference to the

school's quality, and one method to improve a school's quality lies in the influence of the physical school environment. I requested teachers and principals to indicate areas of concern and then observe specific aspects regarding potable water and sanitation, only to support and enhance data interpretation for the research study. For example, infrastructure such as school buildings, facilities of water resources such as water pipes, and storage, have an impact on the culture of learning, and support teachers, principals and learners.

Also, observations of consensual rituals such as assemblies, water facilities areas, ceremonies, uniforms, and badges are valuable. The information supported and supplemented the data obtained through questionnaires and informal discussions. According to Yin (2009:109), observations tend to focus on specific practices, and a researcher needs to be conscious of his own biases, and design ways to deal with them. Observations regarding potable water and sanitation infrastructure, water metering, leakages and hand washing, were recorded, guided by the reporting template. To document the observation, I recorded field notes of my observation of the various stakeholders, such as educators and municipal officials.

1.9.5.3 Documentary analysis

I used documentary analysis to establish the national and international perspective of the topic under study. The literature review helps me to avoid duplication by establishing what is already known about the topic in which I am interested (Grazziotin, Klaus & Pereira, 2022:3).

The following databases were consulted to ascertain the availability of study material for the purpose of this research study: (i) catalogues of theses and dissertations in South African Universities, (ii) the catalogue of books in the NWU Vaal Campus Library, (iii) NRF: Nexus, (iv) EBSCO Academic Search Elite, (v) SA e-Publications, (vi) the website of the National Government, <http://www.gov.za>, (vii) SA media, and (viii) Libraries and databases of DWA, DWEA, DEAT, COGTA and CSIR. In addition, the CAPS documents, the South African Schools Act, legislation, and international reports were consulted. In research papers, 20 adequate sources regarding this topic were found and consulted to ensure that a study of this nature could be executed successfully. The Nexus database indicated that no doctoral thesis with the topic of effective management of potable water

and sanitation infrastructure in selected schools of Rustenburg Local Municipality (RLM) has been under investigation.

1.9.5.4 Data analysis

The data analysis was done by means of thematic analysis, according to Boyatzis (1998:3), who states: Thematic content analysis is a process of encoding qualitative information. Thus, I then developed 'codes', words or phrases that served as labels for sections of data. Depending on the methodology and research question, codes can come in many shapes and sizes.

The same views are shared by Teker and Güler (2019:281), to the effect that during the data analysis phase of the research, after data generation, transcripts are coded according to respondent responses to each question, and to the most salient themes emerging across the set of informal discussions.

Therefore, codes were developed to serve as labels for sections of data. The codes were used to highlight the main themes of the responses to ensure that similar qualitative responses are well-classified and grouped. This is essential to determine the underlying issues emanating from the responses provided by the respondents. It will also assist in effectively analysing and reporting the qualitative responses.

1.10 Role of the researcher

Kemmis (2012) is critical of approaches to action research that maintain a sense of the external researcher who initiates, enables, or in some way, regulates the research process, and who maintains a type of academic 'disinterest' in what transpires in the research. This 'outsider' position may buffer the academic facilitator of action research from the real-world effects of participation in the research for other respondents in industrial, social, or educational contexts. While outside consultants and collaborators can and often do provide real and significant support to respondent researchers, we believe they can also become active respondents in an action research effort for the sake of the research. They need not be members of a community conducting action research or employees of an organisation conducting action research to be complete research respondents. In this research study, as an educator, I participated as a researcher and provided an emic view from both my experiences and those of the respondents.

1.11 Quality criteria

To ensure the validity of the study, seven different types of validity were employed. These include (a) democratic process, (b) Communicative space for dialogue, (c) Participatory validity, and (d) Process validity conclusion validity, (e) Dialogic validity, outcome validity and catalytic validity.

(i) Democratic process

I ensured that there was equal participation by the respondents and myself with the professional researchers. PAR means that the course of the project from conception to implementation of action steps, involved collaboration of both me and the respondents. I involved the respondents in defining project goals and determining how information was collected and interpreted.

(ii) Creating a communicative space for dialogue

I created a communicative space for dialogue as a way of ensuring quality criteria. "This formation of communicative space is in itself a form of action. It may well be that the most important thing we can do in certain situations is to open, develop, maintain, and encourage new and better forms of communication and dialogue" (Reason, 2006: 6). I created a dialogic space, for instance, by creating the 'people's circle', which gives everyone equal space to respond to a question or issue, without interruption – one at a time. This was useful because it helps to break the normal dynamics of a group where some people may talk too much and others never talk.

According to Rubin and Babbie (2016) and Haq, Rasheed, Rashid and Akhter (2023:2), research was based on four data verification methods: credibility, transferability, dependability, and conformability. The following is an explanation of how the research study meets the standards of the data verification methods listed above.

In Participatory Action Research (PAR), validity is understood differently than in traditional research paradigms. Since PAR is collaborative, context-specific, and aimed at transformation, its validity focuses more on credibility, relevance, and impact than on standard metrics like statistical validity. Below are the main types of validity relevant to PAR:

1.11.1 Participatory validity

This refers to the extent to which the research process genuinely includes and empowers participants. Validity is strengthened when all stakeholders, especially community members, are actively involved in defining problems, collecting data, analysing results, and implementing actions (Reason & Bradbury, 2008; Herr & Anderson, 2015). I have incorporated participatory validity into the research methodology following the frameworks outlined by Reason and Bradbury (2008) and Herr and Anderson (2015). In my study on water and sanitation management in schools, I have ensured that stakeholders, learners, teachers, support staff, and parents are actively engaged as co-researchers, rather than merely subjects. By involving them from the initial problem identification stage through data collection, analysis, and action planning, I have aimed to generate findings that are both contextually relevant and rooted in the lived experiences of those directly affected by the issues at hand.

I have also established mechanisms for ongoing dialogue and feedback, such as regular discussions to facilitate collective reflection and ensured that diverse voices were heard and integrated into the research process. This approach not only enhances the credibility and ethical integrity of the research study but also empowers participants to take ownership of the outcomes, fostering sustainable change in water and sanitation practices. Through this participatory method, I have strived to create a research environment where the process itself becomes a transformative tool for community empowerment and social action.

1.11.2 Process validity

This type focuses on the integrity and quality of the research process itself. It examines whether the research cycles (planning, acting, observing, and reflecting) were followed rigorously and ethically. (Herr & Anderson, 2015; Reason & Bradbury, 2008). I used process validity, as described by Reason and Bradbury (2008) and Herr and Anderson (2015), to guide the rigour and structure of my research methodology on potable water and sanitation management in schools. This involved carefully following the cyclical stages of participatory action research: planning, acting, observing, and reflecting. At each stage, I ensured that the research study activities were ethically sound, systematically documented, and responsive to the evolving needs and insights of the

participants. By doing so, I was able to maintain methodological integrity and adapt the research process based on real-time feedback and observations from the school community.

To strengthen process validity, I also used multiple data collection methods such as interviews, observations, and participatory mapping to ensure a comprehensive understanding of the issues. Each method was selected and implemented in consultation with participants to ensure appropriateness and inclusivity. I maintained detailed records of decisions, reflections, and actions taken during the research study, which allowed for continuous evaluation and improvement of the research process. This approach ensured that the research remained grounded, transparent, and capable of producing credible and meaningful outcomes that reflect the realities of those affected by water and sanitation challenges in schools.

1.11.3 Dialogic validity

Dialogic validity is achieved through open dialogue among respondents and researchers. It involves collective reflection and critique to ensure multiple perspectives are heard and respected. (Herr & Anderson, 2015; Reason & Bradbury, 2008). This validity has helped shape my research methodology by ensuring that open and continuous dialogue occurred throughout the study. Dialogic validity, as described by Reason and Bradbury (2008) and Herr and Anderson (2015), emphasises the importance of collective reflection and discussion among all stakeholders involved in the research process. In my research study on potable water and sanitation infrastructure management in schools, I created spaces for meaningful conversations with school management teams, teachers, support staff and surrounding communities where ideas, interpretations, and experiences could be shared and challenged. These dialogues ensured that the findings were not based on one-sided perspectives but rather co-constructed through ongoing interaction and reflection.

Through discussion sessions and collaborative meetings, this validity helped to expose assumptions, refine interpretations, and build mutual understanding among participants. By listening to diverse voices and allowing participants to critique and influence the direction of the research, I strengthened both the ethical foundation and the credibility of the study. Dialogic validity ensured that participants were not passive contributors but active co-thinkers, whose insights were essential in shaping both the process and the

outcomes of the research. This collaborative approach enhanced the trustworthiness and depth of the data and led to more contextually grounded and accepted recommendations for improving water and sanitation in schools.

1.11.4 Outcome validity

The outcome validity refers to whether the research led to meaningful action or transformation. PAR is not just about understanding a problem, but about solving it in context. (Herr & Anderson, 2015; Reason & Bradbury, 2008). This validity helped guide this research methodology by focusing on the tangible changes and improvements resulting from the study, rather than just understanding the water and sanitation issues in schools. Outcome validity, as described by Reason and Bradbury (2008) and Herr and Anderson (2015), emphasises that participatory action research should lead to meaningful action and transformation within the community involved. In my research, I prioritised not only collecting and analysing data but also ensuring that the findings translated into practical solutions that address sanitation challenges in the schools. This meant actively involving participants in developing and implementing action plans, which helped bridge the gap between knowledge and real-world impact.

Additionally, this validity helped me establish clear criteria for evaluating the success of the interventions introduced during the research process. By continuously assessing whether the actions taken resulted in improvements, such as better water access, enhanced hygiene practices, or increased awareness among learners and staff, I was able to measure the effectiveness and relevance of the research study outcomes. Outcome validity ensured that the research remained focused on producing positive social change and empowered participants to sustain improvements beyond the study period. This approach reinforced the ethical responsibility of the research to contribute to community wellbeing and foster lasting transformation.

1.11.5 Catalytic validity

Catalytic validity gauges whether the research deepened participants' understanding and motivated further action or change. It values the extent to which the process was transformative. (Herr & Anderson, 2015; Reason & Bradbury, 2008). By highlighting the research process's capacity to transform all participants, this validity influenced the

direction of my study. Catalytic validity, as defined by Reason and Bradbury (2008) and Herr and Anderson (2015), is concerned with how the study helps participants better understand their circumstances and inspires them to act. This meant that in addition to collecting data, my study on water and sanitation management in schools also aimed to empower learners, staff, and instructors through reflection. Inspiring community-driven change and increasing awareness, the study process itself became a catalyst by encouraging discussion and cooperative problem-solving.

Using catalytic validity helped ensure that the study went beyond generating knowledge to fostering ongoing engagement and action. I incorporated participatory activities that allowed stakeholders to question existing practices, explore new possibilities, and develop a shared vision for improving water and sanitation conditions. This approach supported the participants in becoming active agents of change rather than passive recipients of information. Ultimately, catalytic validity reinforced the ethical and practical goals of this research by promoting sustained motivation and capacity for transformation within the school communities.

1.12 Ethical considerations

Ethical consideration is one of the prime requirements in the fulfilment of a PhD degree at North-West University. According to Pietilä, Nurmi, Halkoaho and Kyngäs (2020:51), researchers who do not execute research ethically are negligent towards society. Ethics should be taken into consideration throughout the research process (Chervenak & McCullough, 2021:42). An ethical code of conduct should apply to the research problem, objectives and questions, data generation, data analysis and interpretation, and in the writing and distribution of research (Chervenak & McCullough, 2021:42). I was mindful of these ethical considerations throughout the research process. I outlined to respondents the risks of participating in the study and informed them that this research was conducted based on the generally accepted norms, standards and values of North-West University's ethics management guidelines.

Informed consent from respondents was requested and obtained before permission to conduct this research project, as part of the ethical clearance processes at North-West University, Vaal Campus.

Prior to data generation, respondents were given an explanation and a written outline information sheet of the research project's aims, nature and data generation methods. The letter to request permission to conduct research was written to the Department of Education, Rustenburg Local Municipality (RLM), and the Department of Public Works at the Bojanala District. Respondents were informed that ethical requirements were adhered to. Both the oral explanation and the written information sheet will stress that participation in the research project is voluntary, and all reporting will keep respondents' details anonymous (Creswell, 2014:135).

Ethical clearance was subject to the approval of the relevant ethics review committee interacting with the research committee. All respondents in the proposed research project, was taken into an information session where they were addressed by the researcher. They were given the opportunity to ask questions regarding their participation in the research.

In addition, all precautions in effect for the COVID-19 pandemic were applied, if need be. This could include wearing face masks, sanitising hands and equipment, social distancing, and a limit on the number of people in any one venue.

According to Millum and Bromwich (2021:47), the following principled ethical guidelines guided the research:

- Informed consent of all respondents to participate in the research was obtained.
- For respondents under the age of 18 years (i.e. minors), consent would also be required from the parent or guardian.
- Participation is voluntary, and respondents may withdraw at any time without adverse consequences.
- Respondents received no remuneration for participating.
- The right to privacy of the respondents was respected by not disclosing their identities and by protecting them from harmful activities.
- Respondents were assured of indemnification.

- Respondents were not manipulated or influenced; they were treated as individuals, and not merely as objects or numbers.
- Data was stored in a password-protected computer. Hard copies were kept in a locked cupboard. Only the supervisors and I will have access to the data.
- Data was used only for this academic research.

I outlined to respondents the risk of participating in the study and informed the respondents that research was conducted based on generally accepted norms, standards and values of the North-West University. They were also informed that they can withdraw their participation at any point as the research unfolds. The above ethical considerations were carried out following the guidelines provided by Chervenak and McCullough (2021:42). I did not manipulate respondents or employ any unacceptable or unethical techniques in the informal discussion process. I used an appropriate letter of consent and adhered to the code of ethics according to the NWU on how to conduct research in an ethically appropriate manner to maintain a high standard of responsibility.

1.13 Significance of the study

Section 27 (1) (b) of the South African Constitution of 1996 requires municipalities to supply water, which is a basic human necessity (RSA, 1996). However, several issues made it difficult to supply water to communities, including poor data management, outdated infrastructure, inadequate maintenance, and mismanaged equipment that causes leaks and pipe bursts (Boshoff, 2009; Kang, 2019; Singh & Ogra, 2016; Gandy, 2004; Rooijen, 2011). It is crucial to collect data about assets and relevant information about potable water and sanitation infrastructure to determine their condition and when they may be replaced, because municipalities have seen an increase in pipe bursts and leaks as a result of the aforementioned issues, which has affected their assurance of supply, because of higher water losses (Love, 2014; Vanier, 2000). The research study aimed to better understand basic service delivery difficulties related to potable water and sanitation services in Rustenburg Local Municipality's (RLMs) schools. It also identified weaknesses in the policy process and implementation, such as a lack of management, monitoring, and evaluation, as well as community involvement at provincial level. Furthermore, the study may assist public officials and political office holders in better

understanding the dynamics and obstacles they confront when carrying out their mission in the local municipality and its area. According to the Constitution, as well as the National Water Act, water is a human right and a basic requirement. Hence, various water policies accentuate that people must have access to water. People in Rustenburg Local Municipality (RLM), on the other hand, have restricted access to potable water and sanitation. It is therefore important to conduct studies on this topic to learn how they survive, despite the challenges of potable water and sanitation service delivery, with a focus on schools (DWAF, 1996; RSA, 1998).

The research study revealed that the provision of safe potable water and sanitation services can be compliant with the rights of learners, educators, and the school community. It has a direct bearing on education, health, and wellbeing, all of which have significant contributions to the realisation of the SDG2030. This research study highlighted the benefits of providing adequate potable water, sanitation, and hygienic facilities within the context of South Africa.

The research study added to academic and government-related research publications for future references, as well as widening research on potable water and sanitation infrastructure concerns. It specifically contributed to the limited current literature on basic service delivery in schools in North West Province. The study highlighted the issues and findings to come up with recommendations that can show where the local government needs to make changes, with a focus on the schools in the Rustenburg Sub-District.

The research study's findings will help to improve existing potable water and sanitation infrastructure management methods and recommend new ones. The results of the research study will also help the municipality's planners and engineers, as well as those of other nearby municipalities and sector units, to implement policies and make use of technical advancements in the management of potable water and sanitation infrastructure assets. This research contributes to the corpus of knowledge and theoretical understanding of potable water and sanitation infrastructure within the municipalities for the schools. I think this contribution will help to increase the pool of information regarding water quality management in poor nations in general, and in South Africa, particularly in rural and urban communities. The study's findings may inspire other academics to do other research projects from different perspectives to improve the proper management of

potable water and sanitation infrastructure in schools. The study results were disseminated through publications, conference presentations, and seminar presentations.

1.14 Chapter layout

Chapter 1 presents the introduction. The orientation and problem statement are all included in this chapter. It goes on to look at the research issues and objectives, as well as leading theoretical arguments and research techniques. The chapter covers the unit of analysis and the research gaps it attempts to fill, which address the water and sanitation management issues faced by schools because of the Rustenburg Local Municipality's (RLMs) inability to provide services due to a dearth of competent staff members. The research scope, impact of the research, and project summary on potable water and sanitation facilities in secondary schools in the Rustenburg sub-District will also be discussed.

Chapter 2 focus on the provision of the theoretical and methodological framework on effective management of potable water and sanitation infrastructure in schools, specifically with interest in the planning at the local government sphere in South Africa. It elaborates on the crucial link that exists between the HRBA and the provision of drinkable water and sanitation in the Rustenburg Community.

Chapter 3 presents a literature review on the effective management of potable water and sanitation infrastructure in schools. This chapter analysed the relevant literature that applies to potable water and sanitation supply management by a municipality in South Africa to schools. The existing literature was discussed, and research gaps were identified and discussed in detail.

Chapter 4 describes the research methods and procedures used in this study, as well as the study's design, population, population demographics, instrumentation, data generation, and data analysis methods.

Chapter 5 presents the first empirical research findings which address the perceptions of the Rustenburg sub-district residents and learners regarding the management of potable water and sanitation infrastructure of schools. The empirical findings present data on the technical capacity to provide potable water and sanitation infrastructure to schools.

The chapter also addresses the challenges that schools face in the supply of potable water and sanitation by Rustenburg Local Municipality (RLM). The second section of the chapter provides recommendations which can be implemented to improve the state of potable water and sanitation infrastructure at local schools.

Chapter 6 presents the proposed Environmental and IWRM plan for Rustenburg Local Municipality (RLM). This chapter focuses on designing a model framework of environmental and integrated water resource management for potable water and sanitation infrastructure for Rustenburg Local Municipality (RLM). This is done by looking at other water resource management models in the world.

Chapter 7 presents the conclusions and recommendations of the study. The chapter also suggests areas for future study.

1.15 Chapter conclusion

This orientation chapter defines the goals for the study and explains the issue that prompted the investigation. The role that municipalities play in managing the supply of potable water and sanitation, along with guidelines on how to raise awareness and devise strategies that facilitate the adoption and use of safe potable water and sanitation practices by schools and communities in the Rustenburg Local Municipality (RLM), gives a background of the study's location and focus. The major theoretical claims, the research questions, and the study objectives all influence the problem statement. A thorough description of the methodology employed came next. Additionally, an outline of the thesis's various chapters' contents is provided. The theoretical framework is covered in the following chapter, which establishes the conceptual foundation for the inquiry. This is required to collect data for the study's final objective, which is to create a strategy for the management of potable water and sanitation for communities and schools in the Rustenburg Local Municipality (RLM).

CHAPTER 2 POTABLE WATER AND SANITATION MANAGEMENT: THEORETICAL FRAMEWORK UNDERPINNING AND THE USE IN WATER AUTHORITY

2.1 Introduction

This chapter presents the theoretical milieu of the study, emphasising the governance and management of potable water and sanitation infrastructure in public schools around the Rustenburg Local Municipality (RLM). It reveals and explores the challenges of service delivery associated with the mentioned context in terms of Human Rights Based Approach (HRBA) and Systems Theories, which are linked together. The analysis is grounded by the Human Rights Based Approach in constitutional and international human rights obligations, with special emphasis on access to water and sanitation as basic rights. This holds particular resonance in a South African context, where legal instruments, like the Constitution, establish a right to basic services. On the other hand, systems theory allows us to understand the structure of how service delivery mechanisms do or do not function throughout several levels of municipal governance, with respect to under-resourced communities.

The main goal of this chapter is to develop a coherent conceptual and theoretical framework for the larger inquiry of this study. To this end, the chapter is organised into various sections, systematically introducing and interrogating the HRBA and systems theory concerning their origins, main concepts, and relevance to public service delivery. This is approached through a two-track analysis: the first unfolding how these theories relate to educational infrastructure, and the second revealing their application within the context of the Rustenburg Local Municipality (RLM). These tandem explorations are used as framing mechanisms for analysing the empirical findings presented in the later chapters of this study, as well as guiding the emergence of an integrated and useful platform, namely, the Environmental Integrated Water Resource Management (EIWRM) framework. By doing so, the chapter thus provides a theoretical map to comprehending the intersection of human rights imperatives and systemic governance challenges pertaining to the provision of water and sanitation in schools.

2.2 Human Rights-Based Approach (HRBA)

2.2.1 Overview

The Human Rights-Based Approach (HRBA) to development has gathered considerable global attention since the late 20th century. Originating from international human rights law, this approach seeks to embed human rights principles and standards into the design, execution, and assessment of development initiatives and policies (Vitkova, 2018). In 2003, the United Nations institutionalised HRBA as a guiding framework, underscoring that development should extend beyond economic advancement to facilitate a life of dignity for all individuals (Vandenhoe, 2024:322). The widespread adoption of HRBA has been shaped by multiple international legal instruments, such as the Universal Declaration of Human Rights (1948), the International Covenant on Economic, Social and Cultural Rights (1967), and the Convention on the Rights of the Child (1989) (United Nations, 1967; United Nations Meeting, 1989). These foundational documents have facilitated the application of HRBA across diverse sectors, including potable water and sanitation, education, and healthcare (United Nations, 2014:2).

The assimilation of HRBA is linked to the nation's democratic transition of South Africa in 1994. The Constitution of the Republic of South Africa (1996) explicitly endorsed human rights principles, encompassing the right to adequate potable water and access to sanitation (RSA, 1996). The National Water Act of 1998 further clarifies this constitutional directive, offering a legal framework for water governance predicated on human rights principles (Department of Water Affairs & Forestry, 1998:2). The incorporation of HRBA within South Africa is influenced by the nation's apartheid history, characterized by inequalities in access to fundamental services such as potable water and sanitation. Consequently, post-apartheid policy frameworks have been oriented towards rectifying these historical inequities, with the HRBA serving as an instrumental framework for such attempts (Gumbi 2020:8; Mattei, 2022:678). Contemporary research indicates that the use of HRBA in South Africa has contributed to the formulation of more inclusive and equitable potable water and sanitation policies, although obstacles remain in the sphere of implementation and governance (Nyahunda, 2021:122). Below is a visual representation of the HRBA.

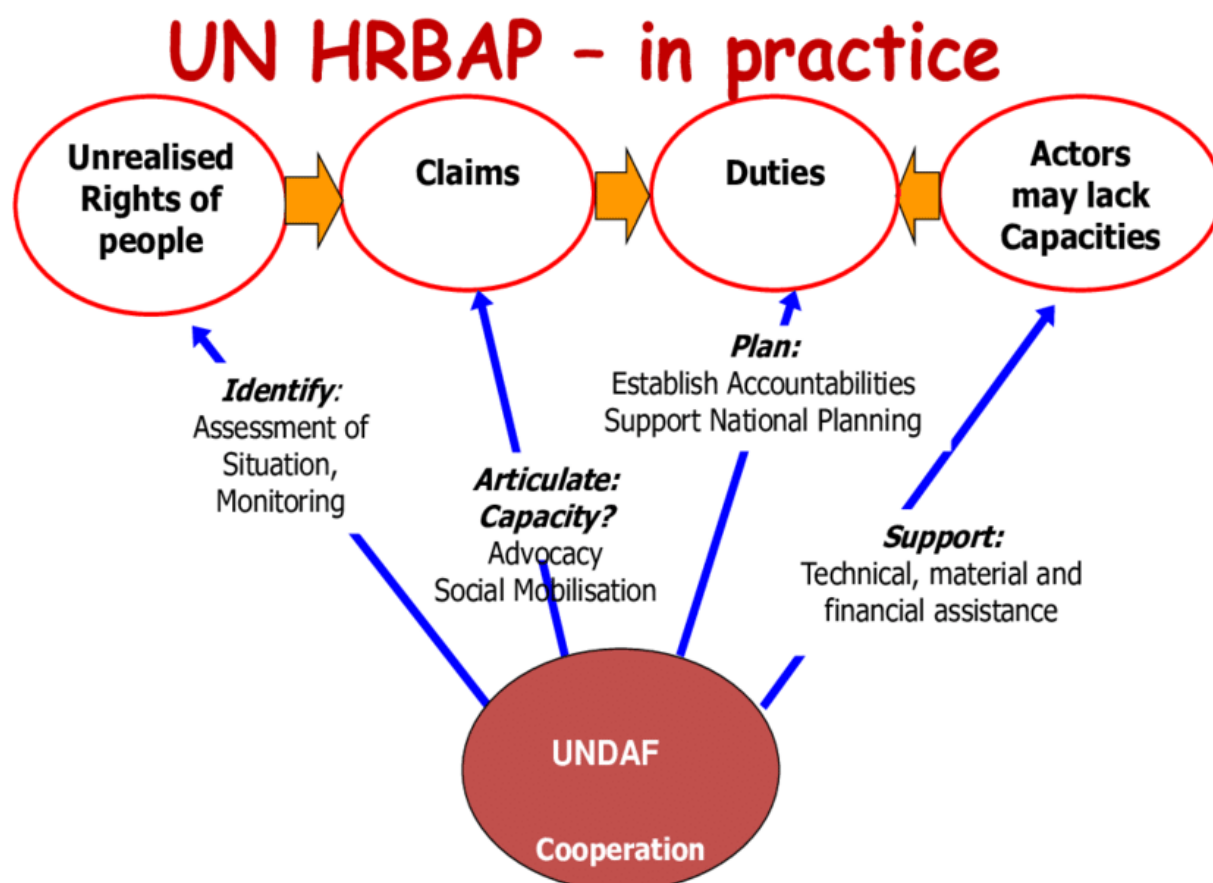


Figure 2.1: HRBA conceptual framework

Source: Khan (2015)

2.2.2 Core principles of HRBA

Below is a representation of the various principles that encompass the Human Rights-Based Approach.

Table 2.1 Representation of the various principles

Participation	Ensures all stakeholders, particularly the marginalised and vulnerable, are actively involved in decision-making processes.	Participation extends beyond mere symbolic representation, encompassing substantive engagement that allows stakeholders to exert real influence on outcomes. This principle ensures that policies and programmes are sustainable and genuinely reflective of the needs of their intended beneficiaries. In the context of Rustenburg, active involvement of

		school management, parents, and learners in water and sanitation initiatives is essential.
Accountability	Holds entities and individuals responsible for safeguarding human rights answerable for their actions.	Accountability involves mechanisms for monitoring, evaluation, and redress where rights are infringed upon. This principle is crucial for ensuring that duty-bearers meet their obligations, and that rights-holders can seek justice. In Rustenburg, accountability frameworks would require local governmental bodies and mining corporations to be transparent and responsive regarding the provision of water and sanitation services.
Non-discrimination	Ensures equal treatment for all individuals, irrespective of race, gender, socio-economic status, or other characteristics.	Non-discrimination aims to neutralize systemic biases and prejudices that obstruct access to fundamental human rights. In Rustenburg, where disparities in access to water and sanitation are stark, adopting this principle can help address these inequalities and ensure that all schools receive adequate services regardless of their location or demographic composition.
Transparency	Involves openness in governance processes, including decision-making and budget allocation.	Transparency is crucial for the effective implementation of a Human Rights-Based Approach (HRBA). It enables stakeholders to hold institutions accountable and ensures that decisions and resource allocations are made openly and fairly. For Rustenburg, transparent processes would involve clear communication and reporting about water and sanitation policies and practices, enabling communities to understand and engage with these processes.
Human Dignity	Focuses on fulfilling basic human needs and recognising the intrinsic value of all individuals.	Human dignity is the goal of HRBA, ensuring that development initiatives aim for more than just economic benefits. They strive for a life of dignity for all. In Rustenburg, this would mean prioritising water and sanitation projects that

		respect and enhance the dignity of learners and communities, recognising that access to these services is fundamental to living a dignified life.
Empowerment	Equips individuals and communities with the tools to assert their rights and engage fully in development processes.	Empowerment is about enabling people to take control of their lives and participate actively in the development of their communities. In the Rustenburg context, empowerment could involve educational campaigns and capacity-building activities that inform communities about their rights to water and sanitation and how to advocate for these rights effectively.
Rule of Law	Ensures that human rights are protected by a consistently enforced legal framework.	The rule of law provides the structural underpinning for the application of all other HRBA principles. It ensures that human rights are not just theoretical constructs but are ingrained in legal and governance systems. For Rustenburg, this means that water and sanitation services must be supported by strong legal protections that guarantee their provision and quality, and that these laws are effectively enforced.

Source: United Nation Development Programme (2015)

2.2.3 Specific focus on the application of HRBA in schools

The implementation of the HRBA in educational settings, specifically in the selected schools and education department of the Rustenburg Local Municipality (RLM), has gathered increasing attention and examination. A remarkable illustration of HRBA's practical application is the engagement of school administrative teams, parents, and local communities in decision-making processes concerning water and sanitation infrastructure. For example, some educational institutions have adopted a participatory budgeting model to determine the allocation of financial resources for water and sanitation. This approach not only aligns with the HRBA principle of participation but also yields solutions that are both sustainable and contextually relevant (Vandenhoe & Gready, 2018:22).

An additional example is the use of social audits, a community-driven methodology that enables residents and school administrators to comprehend, interpret, and evaluate the planning and execution of public services within a human rights framework. In the Rustenburg Local Municipality (RLM) context, social audits have been instrumental in holding local municipal authorities accountable for deficiencies in the delivery of water and sanitation services to schools. These audits, often facilitated by civil society organisations, serve as an effective mechanism for ensuring accountability, another fundamental tenet of HRBA (Wolhuter *et al.*, 2022:3).

Nevertheless, the deployment of HRBA in educational institutions is not devoid of challenges and critiques. A prominent obstacle is limited awareness and comprehension of the HRBA among diverse stakeholders, including school administrators, local governmental officials, and community members. This lack of understanding frequently results in superficial participation, where community involvement occurs but exercises minimal influence over resultant decisions (Lubinga, Maramura & Masiya, 2023:1).

Furthermore, the HRBA has faced criticism for its apparent idealistic nature, which may overlook the difficulties and limitations inherent in real-world contexts. For instance, the principle of non-discrimination, although commendable, presents implementation challenges in settings constrained by limited resources and needs. Educational institutions, such as schools in economically disadvantaged areas of Rustenburg municipality, often struggle with the basic needs of existing potable water and sanitation facilities, thereby complicating the realisation of the principle of equality in service provision.

2.2.4 Potential limitations, criticisms, and challenges in implementing HRBA and equity in access

The Human Rights-Based Approach (HRBA) has received commendation for its transformative potential in the delivery of essential services, such as water and sanitation. Nonetheless, the approach is not without its challenges, criticisms, and limitations. A significant obstacle arises from the difference between the HRBA's idealistic principles and the pragmatic constraints encountered at the time of real-world implementation. For example, the principle of equality, a cornerstone of HRBA, often conflicts with the resource limitations experienced by many municipalities, including Rustenburg. While

HRBA promotes equitable access to services for all individuals, the practical reality often involves limited resources that must be allocated based on competing priorities, thereby complicating the realisation of this ideal (Lubinga, Maramura & Masiya, 2023:5).

Additionally, HRBA has been subject to scrutiny for its perceived Western-centric orientation, raising questions about its applicability and relevance across diverse cultural and socio-economic landscapes. Critics claim that HRBA imposes an intrinsic framework that fails to consider the unique challenges and difficulties associated with the implementation of potable water and sanitation projects in varied settings (Leslie, Katell, Aitken, Singh, Briggs, Powell & Mazumder, 2022:3). This criticism is relevant in the case of Rustenburg Local Municipality (RLM), where water and sanitation needs and priorities can differ substantially across urban, peri-urban, and rural educational institutions. The emphasis of the HRBA on legal frameworks and policy instruments supplies a strong structural foundation for tackling social justice issues. By aligning the delivery of potable water and sanitation services with international human rights legislation, national policies, and local byelaws, the HRBA ensures that the matter is recognised, not merely as a charitable or developmental concern, but as a fundamental human right. This legal underpinning supplies schools and communities in Rustenburg Local Municipality (RLM) with the necessary tools to demand improved services and holds governmental bodies and other stakeholders legally accountable to provide these services of potable water and sanitation services (McGregor & Chatiza, 2019:1556).

In Rustenburg, employing a case study methodology can offer insights into how the HRBA addresses inequalities and social justice concerns in the areas of potable water and sanitation access. For example, an educational institution like a school situated in one of Rustenburg's informal settlements recently became the beneficiary of an initiative driven by HRBA principles. Funded through a partnership between local governmental bodies and non-governmental organisations, the initiative aimed to enhance the potable water and sanitation infrastructure of the school. Notably, the project was not merely a top-down intervention, but actively engaged the school community, comprising learners, teachers, and parents in both the planning and implementation phases. This participatory methodology ensured that solutions were found, meeting the unique needs and cultural needs of the local community. The initiative has subsequently been praised as a

paradigmatic example of how HRBA can efficiently be used to correct established inequalities (Botha, 2019:35).

Furthermore, the emphasis of HRBA on utilising legal frameworks as instruments for social justice gains particular relevance in the South African context. The Constitution of South Africa cherishes access to potable water and sanitation as a human right, thereby supplying an additional layer of accountability. This constitutional provision enables legal choice in scenarios where governmental bodies or other stakeholders fail to fulfil their obligations. In the context of Rustenburg, this legal framework has empowered local communities to initiate legal proceedings against mining corporations that have contaminated local water supplies, consequently affecting the water quality in nearby educational institutions (Owor, 2022:2).

It is imperative to acknowledge that while HRBA provides a structural framework for tackling issues of inequality and social justice, its efficacy is often linked with the political will of the implementing entities. In the Rustenburg scenario, for instance, the presence of influential mining corporations has occasionally served as an impediment to the full realisation of HRBA principles. Owing to their economic influence, these companies have, at times, swayed local policies in ways that compromise the equitable distribution of potable water and sanitation services (Khumalo, 2020:54).

2.2.5 HRBA applied in the context of Rustenburg Local Municipality (RLM)

In the context of Rustenburg Local Municipality (RLM), the HRBA holds the potential to function as a transformative paradigm for addressing urgent concerns related to potable water and sanitation, especially within educational institutions. Characterised by its abundant mineral resources, Rustenburg presents a contradiction wherein considerable natural wealth coexists with striking inequalities in the provision of basic services. The deployment of HRBA in this setting could serve as a crucial intervention, particularly considering the emphasis on human rights, including the right to potable water and sanitation, enshrined in the Constitution of the Republic of South Africa (1996).

Accountability, a cornerstone principle of HRBA, gains relevance in the Rustenburg environment. Here, multiple stakeholders, including local governmental bodies, mining corporations, and civil society, bear responsibilities in ensuring equitable access to

potable water and sanitation services. Previous instances have been documented where mining operations have resulted in water contamination, thereby impacting the quality of water accessible to educational institutions and local communities (Ower, 2022:2). Implementing HRBA would necessitate the establishment of transparent mechanisms for the monitoring and reporting of potable water quality, thereby holding accountable the involved entities. Furthermore, it would supply community members with an approach for seeking a remedy, underpinned by the existing legal frameworks that advocate human rights (Botha, 2019:35).

Participation, another important principle of HRBA, could be realised through the active engagement of communities in decision-making processes. For example, entities such as school management committees, parent-teacher associations, and learner councils could be integrally involved in the planning and execution phases of potable water and sanitation initiatives. This participatory approach would not only ensure that interventions are culturally linked and contextually relevant but would also expose a sense of ownership among the beneficiaries. This, in turn, would enhance the likelihood of the sustainability of these projects (Khumalo, 2020:54).

The prospective results of adopting an HRBA in the Rustenburg Local Municipality (RLM) are diverse. Initially, it would establish a precedent for other South African urban centres grappling with similar challenges, thereby illustrating the practicality of harmonising economic growth with social justice imperatives. Subsequently, it would contribute to the achievement of the United Nations' SDG2030, specifically Goal 6, which aspires to ensure the availability and sustainable management of potable water and sanitation for all. Lastly, it would empower communities, particularly those within educational environments, to assert their rights and actively participate in shaping their futures, thus cultivating a more equitable and socially just society (UNDP, 2021:1).

The prospective implications of the HRBA in Rustenburg could extend into the domains of policy formulation and institutional restructuring. The incorporation of HRBA may necessitate a comprehensive reassessment of extant policies and regulations that govern water and sanitation, particularly within educational settings. Such a reassessment could culminate in the development of more inclusive and equitable policy frameworks that correspond with human rights tenets (Ngang, 2021:351). For example, financial

allocations designated for potable water and sanitation could undergo revisions to prioritise educational institutions in socioeconomically disadvantaged communities, thereby correcting established systemic inequalities (Adom *et al.*, 2020:506).

About educational outcomes, the implementation of HRBA within Rustenburg's educational institutions, such as schools, could give way to extensive developments. Existing research suggests that a lack of potable water and sanitation facilities in schools can have a detrimental impact on both attendance rates and learning performance, particularly among female learners. By facilitating equitable access to potable water and adequate sanitation, HRBA could engender a conducive learning environment, thereby enhancing educational outcomes, and disrupting the continuance of poverty and inequality (Sibanda, 2021:1-4).

Finally, the effective execution of HRBA within the Rustenburg Local Municipality (RLM) context could function as an exemplar for other geographical regions, both nationally and internationally. Such a model could provide invaluable insights into the complications and challenges associated with the practical application of human rights principles in the delivery of essential services, such as the provision of potable water and sanitation services. This, in turn, would contribute to the expanding body of scholarly literature on the subject (Muller, 2023:71). As global society contends with the dual challenges of climate change and social inequality, HRBA emerges as a comprehensive and sustainable development strategy, one that focuses on human dignity and social justice as its foundational pillars (UNICEF, 2022:1).

From a security perspective, the HRBA can potentially contribute to staving off community anger. The Rustenburg area is synonymous with Marikana (2012) – an event that had a profound impact on South African society's awareness of the circumstances of miners, and their communities of residence in the area.

The HRBA should also provide civil society with the opportunity to engage in a constructive way that does not do harm to or damage the well-being of local people who are living under very difficult circumstances in Rustenburg's mining areas.

2.2.6 Future path and potential impact of adopting HRBA in Rustenburg schools

The prospective route of implementing HRBA at educational institutions such as schools in the Rustenburg Local Municipality (RLM) holds considerable potential for bringing about transformative shifts, particularly in the sectors of potable water and sanitation service delivery. One immediate outcome of HRBA adoption would be the elevation of equitable access to potable water and sanitation facilities as a priority within educational environments such as schools. Given the established correlation between inadequate potable water and sanitation facilities and compromised educational outcomes, such as attendance and academic performance (Vandenhoe, 2024:322), the HRBA framework would mandate an inclusive examination of extant infrastructure, policies, and practices. The objective would typically be to secure their consent and agreement with human rights principles, such as those of equality, dignity, and non-discrimination. Such an alignment could unexpectedly target interventions, particularly in schools situated in socioeconomically disadvantaged communities, thereby amending persistent systemic inequities of the past (Ngang, 2021:359).

Another noticeable impact would be the increase of community participation and empowerment. The HRBA paradigm underscores the importance of participatory decision-making processes, fostering the active engagement of a diverse group of stakeholders, ranging from learners and parents to educators and community members, in the conceptualisation and execution of potable water and sanitation initiatives. This participatory model not only ensures that various needs and challenges unique to each educational institution are adequately addressed. It also cultivates a sense of ownership and accountability amongst respondent groups. Such an approach is of relevance in the Rustenburg environment, because community engagement in broad-spectrum service delivery has frequently been found wanting (Adom *et al.*, 2020:507).

Regarding policy developments, the incorporation of the HRBA at Rustenburg's educational institutions could act as an inspiration for more expansive institutional and legislative transformation. For example, this could lead to the formulation of novel policy instruments and guidelines that integrate human rights principles into the governance frameworks overseeing potable water and sanitation services. Such an evolution could encompass the installation of monitoring and evaluation mechanisms designed to gauge

progress and enforce accountability, thereby engendering a system characterised by enhanced transparency and responsiveness (Sibanda, 2021:1-4). Furthermore, the effective realisation of HRBA at Rustenburg Local Municipality (RLM) could set an example for other South African local municipal authorities. It may inspire them to invaluable and locally relevant insights and best practices to apply in their respective areas of jurisdiction.

Lastly, the long-term reflection of HRBA adoption at Rustenburg's educational institutions could even transcend the boundary sectors of potable water and sanitation. By instilling a culture established on human rights and social justice, HRBA possesses the capacity to use influence over additional aspects of educational policy and practice, including curriculum design, educator professional development, and learner wellbeing. A comprehensive impact could contribute to the holistic development of learners, equipping them with the required knowledge, competencies, and ethical frameworks to evolve into well-behaved and proactive citizens dedicated to the advancement of human rights and social justice (UNICEF, 2022). Creating a sustainable environment that enhances potable water and sanitation service delivery, may even generate employment opportunities for individuals, once the human framework of collaboration and consensus is established (Oke *et al.*, 2022). Also, the HRBA could supply the social infrastructure (business, culture, education, training, and health) to develop a skilled labour force and boost competitiveness in the local and global knowledge economy (Oke *et al.*, 2022). The main goal of creating this framework is to enhance people's quality of life, encourage public participation, ensure social inclusion, and promote sustainable economic growth (Bashynska & Dyskina, 2018). The following section discusses systems theory, a component of the research process focused on explaining the potable water and sanitation situation at South African schools.

2.3 Systems theory

The systems theory emphasises the adaptive nature of organisations in response to their environments. The theory attempts to describe and account for the characteristics of systems and the relationships among the components parts found within the system. The nature and origin of the theory is described below:

2.3.1 Brief overview and origins of systems theory

Systems theory, a multidisciplinary paradigm originating in the early 20th century, has been applied across diverse disciplines such as biology, engineering, psychology and notably, public administration. Initially conceived to clarify complex biological systems, the theory swiftly gained traction in the social sciences, as scholars noticed its potential to explain the complexities of human organisations and governance structures (Patton & McMahon, 2021:74). In the domain of public administration, systems theory firmly rose to importance during the mid-20th century as a solution to the deficiencies inherent in conventional administrative models. These traditional frameworks frequently neglected the interconnectedness and interdependence of various elements within administrative systems (Eriksson & Hallberg, 2022:12). Subsequently, the theory has undergone change to accommodate existing complexities, including technological influences on potable water and sanitation, and the imperative for adaptive governance in an increasingly interconnected global landscape. Technology's contribution to sustainability leads to sustainable development that prioritises social justice (access to opportunities, infrastructures, and services), claim Bramley and Power (2009). Technology advancements facilitate the creation of opportunities for individuals and their leaders to participate in the development of systems (Monfaredzadeh & Krueger, 2015). Initiatives for water-sensitive urban design (WSUD) can be implemented with more knowledge about potable water and sanitation flows and their consumption (RSA, 2021). This is possible when information is shared. Data generated by the system is then used to engage citizens (RSA, 2021).

A critical construct in systems theory, particularly in its application to public administration, is the notion of "open systems." Contrary to closed systems, which operate in isolation, open systems engage in dynamic interactions with their external environment, undergoing adaptation and evolution in response to external stimuli (Scott & Davis, 2015:2). This construct holds significant effects for public administration, positing that governmental organisations cannot operate effectively in emptiness but must instead interact with a broader ecosystem comprising political institutions, civil society, and the private sector (Shoemaker & Gros, 2024:1325). Such interconnectedness mandates a holistic governance approach that contemplates, not merely individual components, but

also the interrelationships among them (Tichenor *et al.*, 2021; Kumar & Shamar, 2020; Jalonen, 2024:11).

Another foundational construct in systems theory is "feedback loops". They refer to the mechanisms through which a system integrates information from its environment and modulates its behaviour in a corresponding manner (Sulkowski, Blanch-Hartigan, Goldberg, Verbos, Bu & Nunez, 2022:122). In many respects, it is like an echo chamber that resonates with sounds that are picked up by attentive listeners and practitioners of systems theory. In public administration, feedback loops serve as indispensable instruments for policy evaluation, public accountability, and adaptive governance. These mechanisms empower administrative entities to scrutinise the efficacy of their current initiatives and potentially implement requisite adjustments, thereby augmenting both operational efficiency and responsiveness (Rodina, 2024:12). For instance, feedback engagements with residents may function as a valuable datum in the formulation of policy and the provision of services, ensuring that governmental actions are congruent with public needs and expectations.

In the process, systemic resilience increasingly becomes relative and relevant. It then leads on to 'systemic resilience,' particularly in the face of global challenges such as climate change, pandemics, and social inequality. Systemic resilience, in effect, refers to a system's capacity to endure shocks and nevertheless preserve its essential functions (Zhang & Ahmed, 2020:426). Within the context of public administration, systemic resilience entails the cultivation of adaptive capacities, encompassing institutional frameworks, quick governance mechanisms, and inclusive decision-making processes, to navigate confusingly interrelated and unpredictable environments (Salvador & Sancho, 2023:462).

2.3.2 Key Concepts of systems theory

In systems theory, the construct of a 'system' is defined as a group of interconnected components collaboratively engaged in achieving a unified objective. Contrary to a mere assemblage of discrete elements, a system is conceptualised as an integrated entity wherein the collective sum rises above the attributes of its constituents (Post, Sarala, Gatrell & Prescott, 2020:352). It can be of substantial value to the understanding of social ecological systems. Within the purview of public administration and service delivery, the

term 'system' may be applied to an expansive governmental organisation or to a specialised programme designed to furnish a specific service, such as potable water and sanitation. A comprehensive understanding of a system in its totality is imperative for effective governance and service delivery, as it facilitates an all-encompassing perspective on the interaction and mutual influence among diverse elements (Zhang & Ahmed, 2020:426).

A 'subsystem' is conceptualised as a little system fixed within a more extensive system, furnished with its own generation of components and objectives, yet contributory to the overarching goals of the larger system (Msaka, 2019:5). For instance, within a municipal potable water and sanitation department, a water treatment facility might be categorized as a subsystem subordinate to the department's broader system. The comprehension of subsystems is analytic, as they frequently exhibit distinct attributes and prerequisites that necessitate great knowledge management to assure the success of the larger system (Ramage *et al.*, 2020:57).

If and when systems theory is applied under circumstances where the prevalent social-ecological conditions are conducive to absorption amongst all stakeholders, substantive spontaneous changes may ensue in communities of service delivery operatives, as well as the beneficiaries of these services.

Central to systems theory is the notion of 'feedback,' denoting the mechanisms by which systems integrate information from their external environment and adjust their behaviour in accordance (Forrester, 1961; Sterman, 2000). Within the domain of public administration, feedback mechanisms are indispensable for the evaluation of service delivery efficacy and the implementation of requisite adjustments. Such mechanisms may encompass a generation of instruments, from public opinion surveys to performance metrics, equipping decision-makers with insights into the system's current status and potential areas for modification (Radin, 2019:13).

Another salient remarkable term within systems theory is 'homeostasis,' referring to a system's capacity to sustain stability, or equilibrium, through the modulation of its internal processes in response to external concerns (Pitre, 2022:31). In the realm of service delivery, homeostasis would entail the deployment of mechanisms designed to guarantee consistent and reliable services, notwithstanding external stressors such as demographic

expansion, budgetary limitations, or natural calamities, or disasters. Achieving homeostasis often mandates a mutual combination of proactive planning, adaptive management strategies, and robust feedback mechanisms to continually monitor and correct system performance (Ansell & Boin, 2019:1089).

2.3.3 Systems theory and public service delivery

Within the domain of public service delivery, systems theory furnishes a comprehensive framework for illustrating and enhancing the confusingly interrelated interconnections among diverse components engaged in rendering services to people. Using systems theory in this setting exceeds theoretical discourse, exerting tangible implications on the design, execution, and assessment of public services (Post, Sarala, Gatrell & Prescott, 2020:352). For example, systems theory facilitates the identification of service delivery bottlenecks, advises on efficacious resource allocation, and yields insights into optimising coordination among disparate departments or agencies (Sulkowski, Blanch-Hartigan, Goldberg, Verbos, Bu & Nunez, 2022:122). By conceptualising a public service, be it potable water and sanitation, or educational infrastructure, as a system, policymakers and administrators acquire a refined understanding of how alterations in one segment of the system can communicate reflection throughout the entire structure (Post, Sarala, Gatrell & Prescott, 2020:352).

Specifically, in the context of educational infrastructure, systems theory offers considerable analytical utility. Educational institutions do not function in isolation, but are constituents of expansive educational, social, and political systems. These institutions engage in multiple subsystems, encompassing local communities, governmental entities, and private sector collaborators, all of which collectively influence the educational environment (Rapp & Corral-Granados, 2024:425). For instance, the measure of educational infrastructure, ranging from classrooms and sanitation facilities to instructional materials, is not the exclusive purview of educational institutions. It is modulated by broader systemic variables, such as national educational policies, regional and local governance structures, as well as community participation (Patton & McMahon, 2021:18). Comprehending these systemic interrelations can inform the development of effective policies and interventions aimed at developing advanced educational infrastructure (Rapp & Corral-Granados, 2024:425).

Furthermore, systems theory introduces the construct of a feedback belt, key for adaptive management, in the educational realm (Sulkowski, Blanch-Hartigan, Goldberg, Verbos, Bu & Nunez, 2022:122). Feedback mechanisms may span a spectrum from learner performance metrics to parent-teacher consultations, each proffering invaluable data that can be exploited to refine and enhance the system. For example, if a newly established sanitation facility at a school remains underutilized, due to perceptions of inconvenience or safety concerns among learners, such feedback can inform requisite modifications (Radin, 2019:17). Without feedback, the system risks maintaining inefficiencies, wasting resources and failing to meet its objectives.

Lastly, systems theory underscores the importance of homeostasis, defined as a system's capability to sustain equilibrium in the face of external perturbations (Pitre, 2022:31). Within the realm of educational infrastructure, this may entail the incorporation of adaptable designs capable of accommodating fluctuating learner demographics or the integration of sustainable technologies that remain operational despite resource constraints (Ansell & Boin, 2019:1081). By applying systems theory, educational administrators and policymakers are better positioned to construct more resilient and adaptive educational infrastructure systems, thereby equipping themselves to confront new and multifaceted challenges in the 21st century. Different components, or subsystems, make up the conceptualisation of cities (Matamanda & Chirisa, 2014:1). Interlinkages among the three frameworks of human rights based, systems, technology, and systems theory, in a municipal context, can improve the efficiency of improved service delivery, embedded numerous system sectors, such as technology, as well as institutional, and their anthropogenic components. Since one framework cannot function without the other, all must be connected to accomplish the SDG2030 and achieve sustainable development in a municipal setting.

In a municipal setting, ICT technologies are used to collect and store data in an asset register for planning purposes. Because potable water and sanitation infrastructure data identify areas that require maintenance and repairs, this aids in planning. Reports produced by the potable water and sanitation infrastructure management system enhance the quality of services. Although technology has replaced human labour, it still needs human operators. Thus, human contact is the prime focus of the infrastructure technologies framework. Despite the existence of technologies, no organisation or

municipality can operate without people. Information provided by local communities or residents is captured by the technologies used by municipalities. Therefore, the success of technology depends on human contact and active engagement through public participation. Without human interaction, technology cannot work.

The Fourth Industrial Revolution (FIR4), the digital revolution we are currently experiencing, has enhanced and made municipal governance easier. According to the literature review, a variety of technologies have been used to manage potable water and sanitation infrastructure, including the Infrastructure Management Query System (IMQS), particularly for data management and the generation of report frameworks for planning. With new technologies built on systems, technology has brought about a tangible and immediate benefit to organisational profit distribution. To reap the benefits of this technology, organisations have to learn how to integrate it into their infrastructure systems (Lai & Lin, 2017).

In this research study, the institutional framework that encompasses the state and civil society is inclusive of municipalities, schools, businesses, community forums, and other departmental entities of governance and even private sector operations. The municipality as an institution is governed by laws, such as the Municipal Systems Act 32 of 2000 and the Municipal Finance Management Act 53 of 2003. Their policy guidelines serve as a guide for municipal service delivery. However, as technologies are implemented in a local environment setting, rules that encourage innovation are required as the world advances through the Fourth Industrial Revolution (FIR). Therefore, the management of potable water and sanitation infrastructure should not be a municipal matter, but rather a management system that attracts intergovernmental cooperation and the involvement of other sectoral departments at higher levels of governance. As Torfing *et al.* (2012:2) state, the framework system illustrates interactive government, involving collaboration with several players promoting sustainable development.

Through the exchange of concepts, resources, and strategies, civil society collaboration can enhance service delivery. A municipality's potable water and sanitation infrastructure can be improved by stakeholders working together. These frameworks' interconnections can result in smart urban governance in smart cities that complement urban sustainability by leveraging ICT as the foundation to enhance living standards and provide effective

service delivery (Huovila *et al.*, 2019). Ensuring that demands are addressed will safeguard the current and future generations against poor living conditions. Consideration to social, economic, and environmental facets of life is but one way to do this (Hara *et al.*, 2016). The incorporation of interconnections could be very effective when incorporated properly.

2.3.4 Application of systems theory and the management of school facilities

The use of systems theory in the governance of educational facilities, specifically on matters of potable water and sanitation, supplies an integrative framework for comprehending and following the difficulties inherent in components of a social ecological educational water and sanitation infrastructure system. The theory suggests that the administration of such comfort is not a classification attempt, but essentially totally linked to multiple other subsystems, including local governance structures, community engagement, and overarching educational policies (Ballantine, Stuber & Everitt, 2021:14). For example, the accessibility and measure of potable water and sanitation facilities within educational institutions such as schools, are not solely dependent upon the managerial efforts of the school. They are also balanced by local governmental policies, resource availability, and community involvement (Ballantine, Stuber & Everitt, 2021:14).

Furthermore, systems theory enhances the importance of the feedback circle as an instrumental mechanism for adaptive management (Sulkowski, Blanch-Hartigan, Goldberg, Verbos, Bu & Nunez, 2022:122). Within the social ecological environment of educational facilities, this may encompass routine inspections, feedback from learners and staff, and community assessments. Such feedback channels offer invaluable data on the efficacy of facilities and can inform timely modifications. For instance, should a potable water purification system at a school be defective, immediate feedback can encourage remedial actions, thereby safeguarding the health and wellbeing of the learner body and larger community served by the school (Ballantine, Stuber & Everett, 2021:14).

Nevertheless, the deployment of systems theory is not empty of operational complexities. A primary challenge resides in the complex management of multiple subsystems and stakeholders (Xu & Ouyang, 2022:59). The participation of diverse governmental and non-governmental entities, each supplied with its unique set of priorities and operational

protocols, can occasionally create conflicts and inefficiencies (Sulkowski, Blanch-Hartigan, Goldberg, Verbos, Bu & Nunez, 2022:122). Moreover, the theory's emphasis on feedback loops and adaptive management may necessitate an organisational cultural transformation, particularly for individuals used to a more hierarchical and linear problem-solving paradigm (Ansell & Boin, 2019:108).

An additional operational obstacle is the phenomenon of 'systemic drift,' wherein the system progressively diverges from its prescribed objectives due to external pressures or internal incompetence (Ansell & Boin, 2019:1082). This is especially applicable in the context of educational facilities, where setbacks in regular upkeep and upgrades can suddenly lead to a gradual deterioration in the quality of potable water and sanitation services. Consequently, constantly monitoring and adaptive governance, as indicated by systems theory, emerge as condemning for the accomplished administration of all facilities (Xu & Ouyang, 2022:59).

2.3.5 Systems theory and local government

The incorporation of systems theory into the governance of local municipalities, specifically in the variety of public utilities such as potable water and sanitation, brings a generation of complex challenges necessitating distinct comprehension and strategic interventions. To enhance service delivery and sustainable development generally, the three frameworks theory has been examined above. However, a municipality must have sound governance in place before implementing any of these theories. Since local government is linked to communities, it is the most accountable type of government (Slack, 2015). Since local government is in charge of making sure that social, economic, and environmental services are delivered fairly, it is a starting point for implementing the SDGs (Rogerson, 2014; Chikulo, 2016). A remarkable challenge relates to the allocation of resources. Systems theory advocates that for the optimal functioning of a system, resources must be reasonably distributed to facilitate the absolute operation of all constituent subsystems (Xu & Ouyang, 2022:59). Nonetheless, local governmental bodies frequently battle with budgetary limitations and an abundance of competing imperatives, thereby complicating the equitable distribution of resources across all subsystems (Bovaird & Löffler, 2016; Pollitt & Bouckaert, 2017). For example, although local government may acknowledge the imperative of furnishing high-quality potable

water and sanitation conveniences in educational institutions like schools, it may concurrently be confronted with other pressing demands, such as healthcare, housing and employment, thus engendering a resource allocation challenge (Osborne, 2010; Rainey, 2014).

An additional challenge resides in the governance of feedback loops, a cornerstone of systems theory that underscores the necessity for constant monitoring and adaptability (Forrester, 1961; Sterman, 2000). While feedback loops are all-important for systemic value, they can ironically serve as a channel for systemic inefficiency if poorly managed (Sulkowski, Blanch-Hartigan, Goldberg, Verbos, Bu & Nunez, 2022:122). For instance, should a local government institute a feedback mechanism to assess the efficacy of potable water and sanitation services in schools, but neglect to act upon the gathered feedback, it could culminate in public dissatisfaction and wavering trust in the system (Radin, 2019:19). Furthermore, feedback loops may occasionally give conflicting or undefined data, complicating the decision-making process for local governmental (Ansell & Boin, 2019:1086).

Systemic ineffectiveness forms another point of concern in the application of systems theory to local governance. The theory posits that ineffectiveness can arise from countless sources, including minimal communication amongst subsystems, an absence of coordination, and even systemic drift, wherein the system turns away from its predetermined objectives (Ansell & Boin, 2019:1087). Such inefficiencies can apply a flow blockage on the quality of public utilities, encompassing potable water and sanitation in educational institutions such as schools. For example, if the local governmental subsystem tasked with potable water purification is not aligned with the educational department, this could lead to delays in the execution of critical potable water and sanitation treatment protocols, thereby jeopardising the health and wellbeing of the learner populace (Ballantine, Stuber & Everitt, 2021:14).

Although systems theory offers a framework for the comprehension and administration of complex systems such as local governance, its deployment is full of challenges. They include problems in resource allocation, the management of feedback loops and systemic inefficiencies. To overcome these challenges, a multifaceted strategy is required, including strategic resource allocation, effective feedback mechanisms, and continuous

monitoring to detect and rectify systemic inefficiencies (Sulkowski, Blanch-Hartigan, Goldberg, Verbos, Bu & Nunez, 2022:122). Act 108 of 1996, which aims to address good governance through equitable and just administration, places a strong emphasis on promoting good governance in South African municipal government (Section 33). In section 195 (1), it encourages professional ethics; in section 195 (1) (g), it maintains transparency; and in section 195 (1) it represents the public administration of citizens (RSA, 1996). As outlined in the Batho Pele principles, the 1996 approval of South Africa's constitution opens the door for the implementation of legislative and regulatory measures that serve as a cornerstone of an honest, moral, and clean government (RSA, 1997). Batho Pele's principles seek to develop the foundation and principles of good governance through consultation, service standard setting, expanding access, guaranteeing civility, information availability, openness and transparency, redress, and value for money (RSA, 1997). Lack of service delivery, hunger, poverty, inequality, and unemployment are but a few of the socioeconomic issues that have compelled the government to make constant efforts to address them and implement strategic and tactical planning in support of good governance (Mantzaris & Pillay, 2014). The government presents well-informed legislative frameworks that encourage integrity and ethical governance, such as the Municipal Finance Management Act 56 of 2003, the Municipal Systems Act 32 of 2000, the anti-corruption plan for local government and public service, and municipal policies (Pillay, 2016).

2.3.6 Interplay between systems theory and HRBA

The application of systems theory provides a comprehensive framework for illustrating the existing condition of potable water and sanitation facilities in the selected schools of Rustenburg Local Municipality (RLM). According to systems theory, a combination of interconnected realities, including local governmental bodies, educational establishments, and community stakeholders, constitutes a system, complete with various subsystems that mutually operate for the provision of essential services (Post, Sarala, Gatrell & Prescott, 2020:352). Within the Rustenburg Local Municipality (RLM) environment, this system is surrounded by a web of difficulties, which can be traced to a linkage of historical, socio-economic, and political factors (Xu & Ouyang, 2022:59). For example, the enduring legacy of apartheid has forever been infused into the allocation of

resources, creating noticeable difference in accessibility to potable water and sanitation facilities across educational institutions (Atkinson, 2007; Cameron, 2010).

Therefore, feedback loops, an integral component of systems theory, are essential for the compliance and responsiveness of the system (Msaka, 2019:12). Nevertheless, feedback mechanisms currently operational within Rustenburg Local Municipality (RLM), are incompetent, as confirmed by the ongoing inequalities and incompetence affecting the water and sanitation infrastructure in schools (Mkhize, 2018:5). This inefficacy can be attributed to a shortage of accountability and transparency within the local governmental apparatus and its affiliated subsystems (Zhang & Ahmed, 2020:421). Furthermore, systemic inefficiencies, including administrative interference and corruption, worsen the situation. It complicates the implementation of effective remedial measures (Msaka, 2019:13).

The HRBA can function as a complementary framework to systems theory for the improvement of these challenges. The HRBA emphasises the principles of equality, accountability, and participation consistent with the objectives of an efficient functioning system, as illustrated in systems theory (UN General Assembly, 2010; Republic of South Africa, 1996). For instance, the principle of accountability is essential in the HRBA, and can strengthen feedback within the system, thereby ensuring that the local governmental bodies are familiar with local emergencies and complaints of the community, particularly in relation to potable water and sanitation in schools (Sulkowski, Blanch-Hartigan, Goldberg, Verbos, Bu & Nunez, 2022:122).

The prospective track record of systems theory in Rustenburg Local Municipality (RLM), particularly in relation to potable water and sanitation within educational settings, appears to be favourable when considered in concert with HRBA. The combination of these frameworks could serve as an ideal model for other municipalities and regions battling with similar challenges, offering a comprehensive methodology that is both systemic and orientated towards human rights. This could potentially instigate a paradigmatic shift in public service delivery, rendering it more efficient, equitable, and conforming with all-inclusive objectives of sustainable development and social justice (Visage *et al.*, 2020: 126). Since the said legislative frameworks are regarded as the cornerstone of accountability, transparency, and sound management of the essentials of financial

management, they play a crucial role in serving as the foundation of good governance practices (Woods and Mantzaris, 2012). Fighting failing organisations and eliminating corruption, which worsens inadequate resource management, are the goals of good governance (Pillay, 2016). Therefore, it is impossible to provide communities with developmental services without a combination of procedures based on creative leadership, deeply integrated financial management systems, and open, responsible, and informed human resource management (RSA, 1996; RSA, 2003; Mantzaris & Pillay, 2014; Woods & Mantzaris, 2012).

2.4 Future Research Directions

The intersection of systems theory and the HRBA in the service delivery of potable water and sanitation at selected schools of Rustenburg Local Municipality (RLM), provide a favourable position for academic inquiry. An impressive area for further exploration is the formulation of integrated models capable of implementing the principle of both systems theory and HRBA within more complex connected frameworks. Such models would not merely serve as comprehensive instruments for policy formulation but would also signify a methodological progression in interdisciplinary scholarship (Ramage *et al.*, 2020: 57). The difficulties remain in harmonising frequently quantitative, systems-oriented measures with qualitative, value-laden indicators applicable to human rights. This aim would necessitate the creation of methodologies for data attainment and review (Zhang & Ahmed 2020:426).

An additional prospective way forward for academic investigation includes an examination of the adaptability of systems theory and HRBA to divergent cultural and socio-economic backgrounds. Although the principles essential to both frameworks possess universal applicability, their success may be determined by various local conditions and other requirements (Zhang & Ahmed 2020:426). This requires studies capable of explaining the obstacles and prospects associated with the application of these theories in various environments. For example, questions could be posed regarding the functionality of systems theory and HRBA in rural as opposed to urban school settings in Rustenburg Local Municipality (RLM), or the adaptability or flexibility of these frameworks to communities with different levels of resources and potable water and sanitation infrastructure (Salvador & Sancho, 2023:462).

Moreover, the influence of technological advancements in increasing the effectiveness of systems theory and HRBA are of value. Progress in data analysis, machine learning, and the Internet of Things (IoT) has the potential to supply effective instruments for surveillance, evaluation, and adaptive governance, enhancing system responsiveness and accountability (Ballantine, Stuber & Everitt, 2021:14). Nonetheless, the ethical implications of employing such technologies, particularly within the human rights context, necessitate careful review. Research attempts in this area could build the formulation of ethical protocols and best practices for using technology in public service provision (Visage *et al.*, 2020:125).

Lastly, policy developments of the combination of systems theory and HRBA are extensive and deserve comprehensive further research and applied explorations. Future academic efforts could be directed towards the creation of policy instruments that classify the integration of these frameworks, encompassing guidelines, norms, and potentially even legislative amendments. Furthermore, the effectiveness of such policy instruments in realising envisaged outcomes, whether improved service provision or enhanced accountability, comprises a subject for empirical investigation. This could entail longitudinal studies, designed to monitor the effect of these integrated frameworks over an extended period, thereby presenting precious and costly data for ongoing improvement and policy amendments.

2.5 What challenges good environmental governance in a municipality?

A city's future development depends on partnerships with stakeholders, such as corporations, civil society, and communities (Rameli, 2021). According to Mamokhere and Meyer (2022), there is a lack of community involvement in the municipal strategic planning process, or the annual integrated development plans (IDPs), of local authorities. It has a profound impact on the delivery of priority services, such as a steady supply of sustainable potable water and sanitation services. Tracking information between the community and government is subject to lapses when there is a lack of public engagement, simply because the needs and desires of people using the systems are not taken into consideration and recorded.

It has been discovered that politicians and public servants are not held accountable for issues pertaining to service delivery (Makanyeza *et al.*, 2013). According to Mamokhere

(2022), the Auditor General's Report for the 2017–2018 financial year underscores the crucial role leadership plays in municipalities, leading to problems due to a lack of accountability, non-compliance with laws, and non-compliance with supply chain management procedures. Consequently, service delivery deteriorated. In terms of accountability, the absence of leadership has jeopardised performance management and service delivery. This is because non-compliant individuals do not face repercussions.

According to Zindi *et al.* (2022), attaining the SDG2030 objectives is hampered by the absence of accountability in providing essential services, such as water and sanitation services, in disadvantaged communities. Neglecting basic principles of oversight diverts attention away from the municipal responsibility to secure clean water and proper wastewater infrastructure systems (Christopher, 2015). Political meddling and the politics of manipulation by councillors frequently result in corruption and a lack of accountability and transparency are often the main causes of inferior service delivery (Makanyeza *et al.*, 2013; Rameli, 2021; Dailiati *et al.*, 2018).

2.5.1 Qualities of good governance in a municipality

The qualities of accountability, efficiency, and inclusivity can be defined as components of good governance (Keping, 2018). The following concepts are defined below:

2.5.1.1 Accountability

Officials with high moral standards, transparency, and honesty are essential to municipalities. Transparency means, amongst many other factors, owning up to one's mistakes, accepting the consequences, becoming aware, and learning from them. Public accountability is reflected in all three branches of government, as required by the 1996 South African Constitution (Munzhedzi, 2016). The implementation and promotion of good governance, as depicted in Figure 2-1, is essential for South African municipalities to realise sustainable service delivery as stipulated in the Constitution. Fairness, openness, and increased responsibility to reduce poverty and corruption by social engagement are characteristics of good governance.

Integrity, which is about moral honesty, truthfulness, and an unwavering commitment to high moral standards in the service of the public, is what makes up accountability (Barnejee, 2020). Integrity encourages the fight against corruption, the abolition of

bribery, and the strategic guidance of organisations. Transparency should be carried out following the Constitution's clause pertaining to public involvement in political decisions (Da Cruz *et al.*, 2016). Public administration values and principles are included in the South African Constitution. All areas of government must be transparent. According to Chapter 2 of the Bill of Rights, everyone must have access to information (RSA, 1996). Oversight organisations, such as the Auditor General and Corruption Watch, are necessary to preserve public confidence in governments. Moreover, the news media need to become part of programmes aimed at creating greater public awareness on matters vital to the proper governance of the country.

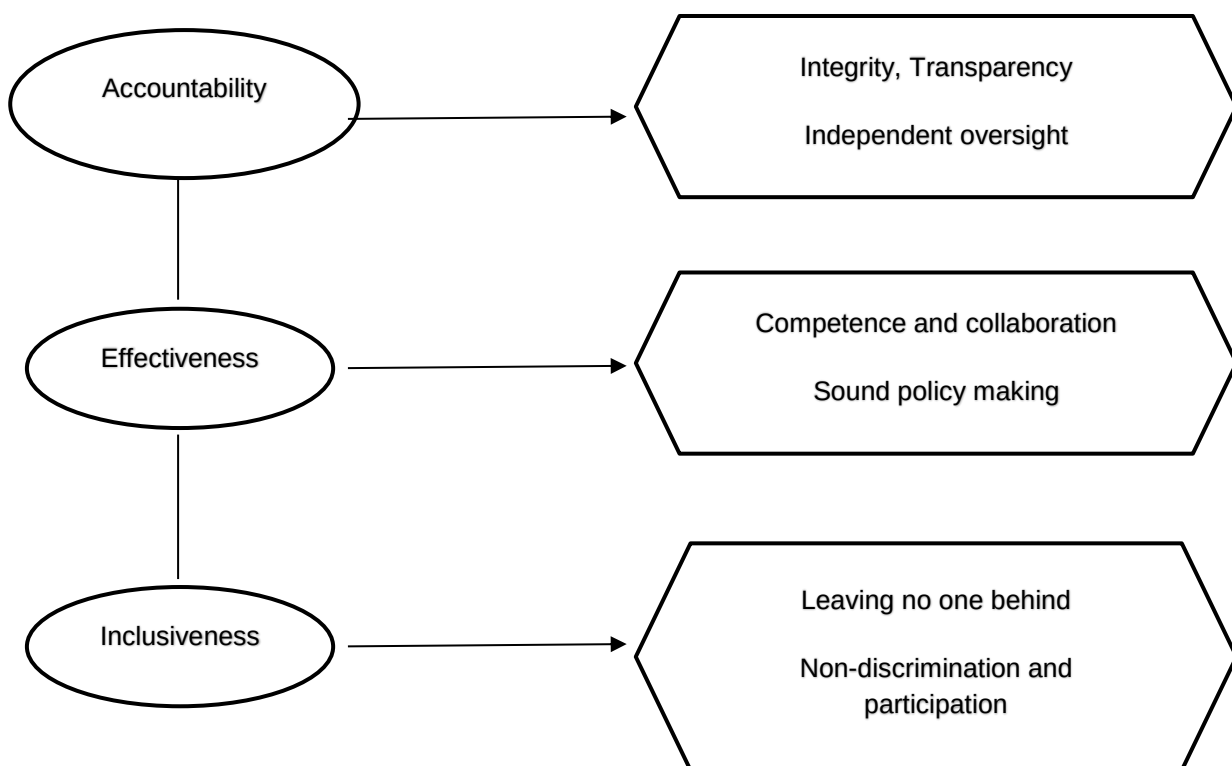


Figure 2.2: Good governance characteristics

Source: author's own (2024)

Granting people access who may otherwise be excluded or marginalised – such as those with physical or mental disabilities, or members of other minority groups – equal access to opportunities and resources, is known as inclusiveness (Keping, 2018). When it comes to service delivery, it is important to include people in consultation about their needs, to prevent discrimination based on their skin colour or handicap (as illustrated in Figure 2-1). The SDG2030 agenda for inclusive development mentions exclusion, stating that

marginalised and vulnerable individuals do not always have access to various possibilities (Mamokhere, 2022). To engage with these communities, municipalities need to improve accountability and inclusivity on matters of access to scarce resource facilities, such as potable water and sanitation. When it comes to providing services, public governance must involve marginalised and disadvantaged groups. They deserve the opportunity to participate in making decisions (Brown, 2022).

The tactics of voluntary, free, and fair elections, public involvement regulation, multi-stakeholder forums, community-driven development, and participatory budgeting are all components of inclusiveness. Public engagement is necessary to meet people's desired requirements (Mamokhere & Meyer, 2022). If it is not prioritised, the fulfilment of the SDGs may be delayed, and there may be a lack of trust in the government (Hansson *et al.*, 2015). The Rustenburg Local Municipality (RLM) should include community forums, people, especially the impoverished and marginalised communities, businesses, and other stakeholders, to manage the water and sanitation infrastructure. All parties involved must participate to secure these services.

2.6 Chapter conclusion

This limited exploration of the Human Rights-Based Approach (HRBA) and systems theory in terms of the environment of potable water and sanitation in educational institutions, such as schools in Rustenburg Local Municipality (RLM), demonstrates varied interrelationships between conceptual frameworks. The HRBA supplies a regulating range for the examination of issues related to equity, social justice, and human dignity, thereby establishing a moral imperative for intervention. Systems theory, in turn, offers methodological instruments for explaining the complex connection of relationships, feedback, and systemic design supporting strategies to provide potable water and sanitation services in the Rustenburg Local Municipality (RLM) schools. In summary, these frameworks constitute a comprehensive paradigm that facilitates the identification of gaps and inefficiencies in extant systems, while concurrently describing ethical parameters for reformative action (Sulkowski, Blanch-Hartigan, Goldberg, Verbos, Bu & Nunez, 2022:122).

This thematic methodology further emphasises the importance of context-specific applications, policy implications, and the contributory role of technological advancements

for improving service delivery. Although the principles inherent to HRBA and systems theory possess universal applicability, effective implementation mandates a fine comprehension of the indigenous socio-economic, cultural, and political arena. This is particularly applicable to the Rustenburg Local Municipality (RLM) context, where the complexities of ensuring equitable access to potable water and sanitation in educational settings, such as schools, are worsened by diverse issues, such as resource limitations, governance challenges, and societal inequalities. Consequently, any attempt aimed at improving these conditions must be based on an in-depth understanding of these local technicalities, as well as an insight that a thematic methodology is properly positioned to supply.

In summary, the thematic methodology functions as a system, facilitating a multi-dimensional review of relevant issues. This approach enables the amalgamation of ethical deliberations with systemic analyses. Ultimately, it yields a holistic perspective on the challenges and prospects inherent in the delivery of potable water and sanitation services in the selected schools of Rustenburg Local Municipality (RLM). This approach not only increases the academic discussion on public service provision but also proffers sensible insights for policymakers, practitioners, and stakeholders dedicated to enhancing the quality of life for learners at schools in the Rustenburg Local Municipality (RLM)'s area of jurisdiction. (Gcelu & Marongwe, 2023:115).

The three basic frameworks (technological, institutional, and human) that came up within the discussion of potable water and sanitation infrastructure technologies are of substantive relevance to plans for improving services of potable water and sanitation in schools and communities in the Rustenburg Local Municipality's (RLMs) area of jurisdiction. The institutional framework goes into detail about the significance of government and civil society cooperation for enhancing potable water infrastructure asset management through knowledge and idea sharing. In turn, the human framework highlights how crucial it is for citizens to participate in municipal budgeting and governance. The final framework, known as the technological framework, emphasises how potable water and sanitation infrastructure asset management may be enhanced by technology, which is regarded as the digital era of the fourth industrial revolution. In view of the fact that it explains how human behaviour and technology may help manage potable water and sanitation infrastructure assets in the Rustenburg Local Municipality

(RLM), the theory was selected for this research study. This is similar to what local governments, elsewhere in the country, may also hope to accomplish. Improving living circumstances is one of the goals of sustainable development, which is also one of the goals in the theory of improving potable water and sanitation infrastructure in schools and communities. Inclusion is another requirement of good administration. Marginalised, disabled, and minority groups should not be left out. Their opinions are essential for sensible growth and development in urban communities. The citizens of society, the government, and the private sector must work together to support one another and improve the development of potable water and sanitation infrastructure for human dignity and human rights, as outlined in the Constitution. The framework of laws and policies about potable water and sanitation infrastructure asset management from a global, regional, national, and local standpoint was the subject of the following chapter, the literature review.

CHAPTER 3 THE LITERATURE ASSESSMENT ON POTABLE WATER AND SANITATION INFRASTRUCTURE IN SOUTH AFRICAN SCHOOLS

3.1 Introduction

Chapter 3 does an analysis of the literature currently available on the management of potable water and sanitation infrastructure in South African schools. It assesses the relevant acts and policy documents, including the Constitution of South Africa, National Development Plan Vision 2030, Water Services Act, and other relevant legislations that govern the provision and sanitation of potable water. The chapter will also highlight relevant Sustainable Development Goals (especially 6, 9, and 17) and how these align with the national context, thereby underscoring the importance of promoting sustainable infrastructure and collaborative management practices.

The literature study further identifies some critical issues around water access, scarcity, and security that occur within the broad focus of the North West Province and the impacts these factors have upon educational institutions. Particular attention will be paid to infrastructural challenges of schools in the province and how poor governance and funding constrain maintenance capacity for those infrastructures to continue the service delivery failure. This discussion thus highlights where cases of systemic failure intersect with poor educational and health outcomes for learners and communities.

The chapter identifies research gaps around governance, policy integrative issues, and the presence or absence of community and indigenous knowledge in the management of water. The chapter calls for a broad and integrated framework in the management of water, considering social, economic, and environmental aspects. The literature review shall provide a pathway for guiding the empirical study, which aims to recommend viable strategies to proliferate the potable water and sanitation management in the schools of Rustenburg Local Municipality (RLM).

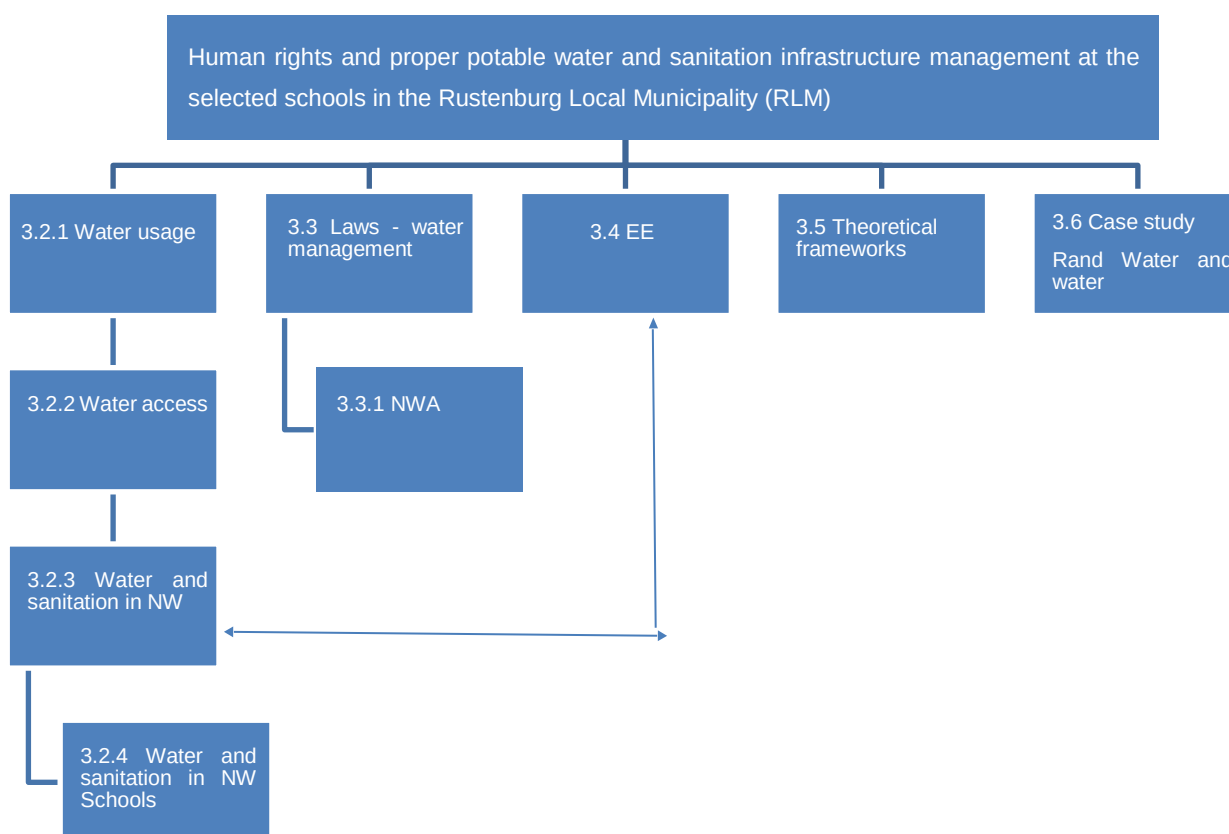


Figure 3.1: The proposal for the literature review

Source: author (2024)

3.2 Water usage in South Africa

The climatic conditions of South Africa, mainly characterised as semi-arid with significant periods of hot and dry weather conditions, leading to high rates of evaporation, exert a significant influence on water consumption in the country. The South African Department of Water and Sanitation (DWS) (2019:1) consistently create awareness that climatic factors substantially contribute to the country's water scarcity, aggravating the already high demand for water for rural and urban domestic, agricultural, and industrial purposes. Nhamo, Mabhaudhi, Mpandeli, Dickens, Nhemachena, Senzanje and Modi (2020:16) concur with these observations, citing frequent droughts, a direct consequence of the country's climate, as a substantial obstacle to maintaining a consistent water supply, with a profound effect on consumption patterns.

Furthermore, projections of global climate change anticipate complications of South Africa's water scarcity problems, with direct implications for water availability and usage.

Predictions of researchers at the Water Research Commission (2021:1) suggest the country will experience higher temperatures and more variable precipitation patterns, increasing evaporation rates, reducing surface water reserves, and intensifying the risk of droughts. This outlook is supported by a study conducted by Olabanji, Ndarana, Davis and Archer (2020:2). The authors suggest climate change will lead to an increase in the frequency and intensity of droughts in South Africa, thereby further straining the country's water resources.

South Africa exhibits significant differences in water accessibility, with distribution unevenly divided across different regions and provinces. According to De Juan and Wegner (2019), rural areas in particular face significant obstacles in accessing clean, safe water, compared to urban regions. Abrams, Carden, Teta and Wågsæther (2021:1) argue that these differences exist as a legacy of the apartheid era, when resource allocations, including potable water, were skewed and unbalanced, with a bias favouring certain cultures. Fantoso and Yessoufou (2022:2) further indicate that among the nine provinces, the Eastern Cape, KwaZulu-Natal, and Limpopo experience the highest water insecurity due to infrastructure challenges and geographic constraints.

The unequal access to water across provinces is evident when considering the diversity in water supply sources. Metropolitan regions predominantly rely on centrally managed and well-maintained dams and reservoirs, whereas rural communities frequently depend on less reliable sources, such as boreholes, springs, or rainwater harvesting (DWS, 2023:1). Ndeketeya and Dundu (2019:164) reach a similar conclusion. The authors highlight dependence on unreliable water sources in rural regions that often culminates in a conservative approach to water use.

Political factors significantly affect South Africa's water availability situation. Several scholars point out there is a distinct political side to the water scarcity issue, linking it to the legacy of apartheid and subsequent resource allocation struggles (Mancosu *et al.*, 2021:2). Abrams, Carden, Teta and Wågsæther (2021:2) argue that political will to address water issues, varies across provinces and municipalities, affecting local water policies and accessibility. Politics also plays a role in potable water and sanitation infrastructure development and maintenance, affecting water supply. Findings from a study by De Kadt and Lieberman (2020:186) suggest that political interference and

corruption often impede the efficient operation and maintenance of potable water and sanitation infrastructure.

International politics also play a role in South Africa's water accessibility. Dutta (2021:2) notes that interstate water politics significantly affect water accessibility, particularly concerning shared watercourses. South Africa shares several significant river systems with neighbouring countries. These transboundary water resources often become contentious points, affecting their efficient and equitable use. These political dimensions add to the complexity of ensuring water accessibility in South Africa, underscoring the need for more integrated and cooperative governance strategies (Adom & Simatele, 2021:504).

The economic implications of water accessibility and usage in South Africa are significant. The World Bank (2021:1) asserts that the economic cost of water scarcity, considering lost agricultural output, health impacts, and time spent collecting water, is high, particularly in disadvantaged rural areas. Moreover, research by Libey, Adank and Thomas (2020:2) reveals that the cost of providing potable water and sanitation infrastructure in remote rural areas often exceeds the available budget, causing water shortages and reduced usage. Mullin (2020:2) also demonstrates that economic inequality contributes to differences in water usage, as households with higher incomes can afford more water than their less wealthy counterparts.

Water plays a significant role in the South African economy, particularly in water-intensive sectors such as agriculture, mining, manufacturing industries, and tourism, which are vital for the country's economic development (DWS, 2023:2). However, these sectors compete for water resources. De Kadt and Lieberman (2020:187) warn that this competition could constrain South Africa's economic growth if not managed effectively. They also suggest the current pricing of water does not reflect its true value, promoting wasteful use and discouraging investment in water-saving technologies.

In South Africa, water usage varies from domestic to industrial applications. Domestic use includes drinking, cooking, cleaning, and sanitation, whereas agricultural uses are predominantly irrigation for crop production. Industrial uses encompass cooling in thermal power plants, processing in factories, and mining operations (Statistics South Africa, 2022:1). DWS (2021:1) reports that agriculture consumes the largest portion of the

country's water supply, while domestic and industrial uses account for a smaller portion. This usage pattern imposes significant pressure on the country's water resources, especially because of anticipated climate change, population growth, and economic development.

Various forms of water use contribute differently to water stress. Botha (2019:2) finds that while domestic water use remains consistent throughout the year, agricultural water use fluctuates seasonally, peaking during the dry season when irrigation needs are highest. In turn, Ndeketeya and Dundu (2019:164) observe that industrial water use significantly pollutes water, contributing to quality issues that further strain South Africa's water supply.

3.2.1 The importance of potable water and sanitation infrastructure management within the municipality

Potable water and sanitation infrastructure are vital for water accessibility across South Africa. However, the South African Human Rights Commission (SAHRC) (2022:1) reports that the country's water infrastructure is in a state of disrepair, with poor maintenance and lack of investment leading to significant water losses. Moreover, a study by Nyam, Kotir, Jordaan, Ogundeji and Turton (2020:2) suggests that potable water and sanitation infrastructure mismanagement has led to water supply interruptions and reduced water accessibility in several regions.

Rustenburg Local Municipality (RLM) has Blue Drop Certification for excellence in water quality management, but is beset by serious infrastructural backlogs, with approximately 27 191 households without sufficient water service and 36 047 lacking decent sanitation service. To resolve these backlogs, sanitation eradication backlogs have been designed by the municipality in conjunction with the Department of Water Affairs, alongside the DBSA and COGTA backlog eradication plans that will be used in a systematic manner to close the infrastructural gaps mentioned.

Potable water and sanitation infrastructure assets improve service delivery, according to the Auditor-General's report (2021); nonetheless, communities suffer from poor maintenance and a lack of infrastructure, which limits service delivery. The National Treasury defines infrastructure asset management (2008:3) as follows:

"A broad function that includes a structured process of decision-making, planning, and control over the acquisition, use, safeguarding, and disposal of assets to maximize their service delivery potential and benefits and to minimize their related risks and costs over their entire life,"

Studies show that South Africa's infrastructure assets support the nation's economy and strengthen linkages between businesses, communities, and civil society (Singh & Ogra, 2016; Smith *et al.*, 2008; Tortajada, 2014). This is significant for managers, since asset management is crucial in local government. Information about infrastructure asset management is used to plan the municipality's asset life cycle by carrying out a comprehensive asset investigation using the plan, acquire, use, and disposal phases of the asset life cycle. This is because an asset's performance determines the kind and calibre of services it should offer (Ugarelli & Saegrov, 2022). Municipalities must manage their assets because urbanisation and population growth put a strain on their infrastructure needs. To improve service delivery, infrastructure must be effectively managed and monitored (McDonald *et al.*, 2014; Mikovits *et al.*, 2014; Hall, 2004; Teisman *et al.*, 2013). Jodan-Tank and Tvedt (2018), therefore believe that by monitoring the asset's performance and condition, an asset register, along with other municipal planning elements, makes it easier to maintain control over infrastructure assets. To investigate strategies for managing potable water and sanitation infrastructure assets in the Rustenburg Local Municipality (RLM), infrastructure asset management is a key component of this research study.

Infrastructure development and management significantly influence potable water and sanitation accessibility and usage patterns. Nonetheless, the World Bank (2023) notes that infrastructure development has not kept pace with the country's growing population and urbanisation, resulting in a widening gap between water supply and water management practices. Research by Fantoso and Yessoufou (2022:2) suggests that the traditional focus on large-scale, centralised projects often fails to address the specific water needs of rural and marginalised communities. They advocate a more inclusive and diversified approach to infrastructure development to improve water accessibility for all demographic groups and regions.

3.3 Laws governing water access in South Africa

An interpretation of the policies and legislated acts, focusing on the legislation that shapes the management of water services in South Africa, will follow. The legal and policy frameworks outline the position and then examine the current government's attempts to facilitate public potable water and sanitation operations. This includes:

3.3.1 The Constitution of the Republic of South Africa.

On December 18, 1996, the 1996 South African Constitution was ratified, and on February 4, 1997, it became operative. The goal of the South African Constitution is to build a society founded on social fairness, democracy, and fundamental human rights while mending divisions of the past (RSA, 1996). Section 151 (1) of the South African Constitution, Act 108 of 1996, states that in order to ensure that the people receive services, developing local government must be democratic and answerable to the people. Everyone has a constitutional right to use water services, as stated in section 27 (1) (b) of the South African Constitution (RSA, 1996).

The South African Constitution was chosen for this study to support its goal, since it states that communities have a constitutional right to potable water, and if sanitation infrastructure management is in place, water services were provided. To fulfil local government's constitutional goals as outlined in section 152 of the South African Constitution (RSA, 1996), this study intends to assess Rustenburg Local Municipality (RLM)'s potable water and sanitation infrastructure management at the schools identified for the purposes of this research. Ensuring that potable water and sanitation services are sustainably provided to communities and schools is one of the goals of the local government. To provide services necessitates keeping up the quality of potable water and sanitation infrastructure systems. Rustenburg Local Municipality (RLM) oversees the potable water and sanitation infrastructure at the schools identified for this research.

Even though South Africa's Constitution spearheaded the country's journey from apartheid to democracy, numerous obstacles remain. These have to be overcome to fortify democracy and uphold the country's Bill of Rights (Harden, 2014). It was not a right that owning potable water and sanitation infrastructure assets entailed having access to water security and provision when the government implemented the roll-out of water

infrastructure assets for reticulation systems (Smith & Green, 2005). Furthermore, it soon dawned upon society that issues like poverty, inequality, and corruption have not been addressed by the South African Constitution, severely jeopardising the country's status as a liberal democracy (Becks, 2012; Lancaster, 2013).

3.3.2 Potable water and sanitation regulatory framework

The South African government started creating an operational environment for water management after 1994, addressing sustainable quality water as well as access to water services (Jonker, 2014: 42). The water policy before 1997, addressed the growing scarcity of water by expanding supplies, allocating water resources, and managing water as a central bureaucracy through a ministry of water affairs. High rehabilitation requirements for water supply infrastructure, fierce competition among water users, and rising water demand were the defining characteristics of the South African water sector at the time. A greater supply from the nation's already-stressed water resources was required due to externalities brought on by water contamination and the high social cost of providing water subsidies for everyone (Bakker, 2012:914). Capacity for effective water demand management and conservation was becoming increasingly limited (WDM).

Shortly after the new government took office, Professor Kadar Asmal, the first minister of the Department of Water Affairs and Forestry (DWAF) in the new South Africa, began reviewing all of the laws pertaining to water (DWAF, 2004a:181). Because the planning process had to align with the goals of the government and South African society at large, there was a noticeable scholarly push for human rights. The goal of the water sector was to adapt the (ancient) South African water system to the current socioeconomic needs and ecologically conscious standards. The law has to satisfy the requirements of being inexpensive, effective, and efficient. Water was a limited, valuable resource that needed to be gathered responsibly for the environment and equally available to all South Africans (Schreiner & Van Koppen, 2015:548). The legislation, policies of potable water and sanitation management are discussed below:

3.3.3 The Water Act (No. 54 of 1956)

The Water Act (No. 54 of 1956) served as a pioneering legislative measure to regulate water resources in South Africa. This act, considered a landmark legislation by Adom and

Simatele (2021:505), established the foundation for water rights, albeit influenced heavily by the socio-political context of the apartheid period. This Act inadvertently amplified already prevalent disparities in water access characteristic of apartheid South Africa, a sentiment echoed by Mullin (2020:2), who notes the persistence of these inequalities despite subsequent legislative modifications.

Responding to the urgent need for a more equitable and sustainable potable and sanitation water management approach, the National Water Act (No. 36 of 1998) was approved. The transformative potential of the Act in reallocating water rights and rectifying historical inequities is underscored by Nyam, Kotir, Jordaan, Ogundeji and Turton (2020:62). Despite its transformative potential, Botha (2019) highlights implementation difficulties arising from systemic and operational challenges. Furthermore, the DWS (2023:1) identifies a need for stronger enforcement mechanisms in their most recent master plan.

3.3.4 The Water Services Act (No. 108 of 1997)

The Water Services Act (No. 108 of 1997) plays a critical role in regulating water services in the country. According to Ndeketeya and Dundu (2019:164), this Act mandates municipal authorities, as primary potable water and sanitation service providers, with a responsibility that has been met with numerous logistical and resource-related constraints. The South African Human Rights Commission (2022:2) asserts that, while the Act has advanced water accessibility, numerous areas, particularly remote and rural ones, continue to experience inadequate water services, a situation that Mullin (2020:2) suggests necessitates significant investment for rectification.

3.3.5 The Local Government: Municipal Structures Act (No. 117 of 1998)

The Local Government: Municipal Structures Act (No. 117 of 1998) and the Local Government: Municipal Systems Act (No. 32 of 2000) have had considerable influence on water governance in South Africa. Fanteso and Yessoufou (2022:2) note that these pieces of legislation devolved responsibilities and powers to municipalities, thus presenting a combination of opportunities and challenges. De Kadt and Lieberman (2020:184) say the Acts cause capacity constraints to municipalities that foreground effective water service delivery. Simultaneously, Adom and Simatele (2021:503)

underscore the positive outcome of devolution, highlighting enhanced public participation in water governance.

3.3.6 Local Government: Finance Management Act 56 of 2003

The Local Government: Municipal Finance Management Act 56 of 2003 was implemented and ratified in 2003 (RSA, 2003). This act's mandate is to support the sustainable management of municipal finances and other areas of governance (RSA, 2003). Considering the municipality's financial situation with regard to potable water and sanitation infrastructure management for the delivery of water services to the communities within the Rustenburg Local Municipality (RLM), this Act was selected for this study. Since infrastructure asset maintenance requires funding, the Act is useful for this study on potable water and sanitation infrastructure management. Sections 63 (1) (a) (b) (c), 63 (2) (a) (b) (c), and 96 (1) (a) (b), (2) (a) (b) of the Local Government: Municipal Finance Management Act 56 of 2003 specify that the municipality's accounting officer is in charge of managing its potable water and sanitation infrastructure assets, using an information system that keeps track of all infrastructure assets (RSA, 2003). This Act is associated with the aspects of technology and the SDG2030's section 9, promoting the use of technological systems.

Infrastructure South Africa, under the direction of Dr Kgosientsho Ramokgopa of the Department of Public Works and Infrastructure, created the National Infrastructure Plan Vision 2050 (RSA, 2022). Following its adoption by the cabinet on March 11, 2022, as Phase 2, the document was subsequently signed by Minister Patricia De Lille (RSA, 2022). This plan's objective is to provide a strategic vision and strategy for the establishment of infrastructure networks by the year 2050 (RSA, 2022). The National Infrastructure Plan supports the National Development Plan by laying the groundwork for realising the plan's goals of equitable growth, infrastructure delivery, and removing institutional barriers (RSA, 2022).

To promote an equitable economy and a healthy environment, the National Development Plan on the water sector specifies the amount and quality of dependable access to water. To promote sustainable infrastructure, the National Infrastructure Plan invests in telecommunications to support digital infrastructure (Kumo, 2012). By generating employment opportunities, the standard of living is potentially raised for impoverished

people. The plan, which describes the management of infrastructure through digital innovation, is most appropriate for this study. It combats poverty, inequality, and unemployment in society. The government's National Development Plan (NDP) Vision 2030 also supports this motion.

3.3.7 The National Environmental Management Act (No. 107 of 1998)

The National Environmental Management Act (No. 107 of 1998) (NEMA) contains extensive parameters for water management, promoting sustainable usage and conservation of all natural resources, including water (Department of Water Affairs, 2021:2). The challenge of integrating water resource management within broader environmental management frameworks is underscored by Botha (2019:35). Further, the South African Human Rights Commission Report (2022:1) highlights the need for comprehensive enforcement of this Act to ensure the protection of water resources.

To address emerging challenges in potable water and sanitation management, the National Water Amendment Act (No. 27 of 2014) was introduced. This amendment, according to Nyam, Kotir, Jordaan, Ogundejí and Turton (2020:62), was essential for addressing gaps in water governance. Notwithstanding this amendment, Woodhouse and Muller (2017) posit that substantial work remains to be done, particularly in the fields of water conservation and demand management (Koop, Van Dorssen & Brouwer, 2019:86). Botha (2019) further highlights the Amendment Act's potential as a tool for enhancing resilience to climate change. Promoting research in water management is the main aim of the Water Research Act (No. 34 of 1971). The World Bank (2023:1) argues that such research is vital for informing policy and decision-making processes. However, Ndeketeya and Dundu (2019:164) remark that, despite this Act, water-related research remains underfunded and overlooked in South Africa. The necessity for more effective integration of research into policy-making processes is emphasised by Mullin (2020:2).

3.3.8 The Strategic Framework for Water Services (2003)

This was designed to provide a clear direction for the development of water services in South Africa. According to the DWS (2023:1), the framework's success has varied. Fanteso and Yessoufou (2022:2) note that progress has been hindered by numerous factors, including infrastructural deficits and capacity constraints. Concurrently, the South

African Human Rights Commission (2022) advocates for increased accountability in the implementation of this framework.

3.3.9 Rustenburg Local Municipality (RLM) Integrated Development Plan 2021/2022

The Rustenburg Local Municipality (RLM) developed an Integrated Development Plan, which was adopted by the Council in 2021. The mandate behind this plan is to give direction to the plans of the Rustenburg Local Municipality (RLM). This study focused on certain aspects of the plan in support of the aim of the study. The plan emphasises the importance of intergovernmental relations, where Rustenburg Local Municipality (RLM) forms a subsidiary part of the District IDP Forum for the alignment of plans and project implementation (Rustenburg Local Municipality (RLM), 2021/2022). This alignment between the Rustenburg Local Municipality (RLM) and other stakeholders improves potable water and sanitation service provision, as ideas are being shared. Even SDG2030's section 17 for partnership goals emphasises the collaboration and participation of societies, businesses, organisations, and governments to share knowledge and ideas to improve service delivery. Such engagement can also help during community participation to know about community development issues.

In the IDP document of 2022-2027, Rustenburg Local Municipality (RLM) emphasises its strategic commitment to improving the water and sanitation supply. The IDP points at huge infrastructure projects that are meant to improve service delivery, including heavy investment in water conservation and demand management and upgrading sanitation infrastructure. Some of the priority projects include refurbishing bulk water lines, replacing asbestos-cement pipes, and installing water geysers, aimed at effective service delivery and resolution of existing challenges.

The strategy further explains how ICT is used to assist the Fourth Industrial Revolution and technological innovation to create potable water and sanitation management systems (Rustenburg Local Municipality, 2021/2022). In this instance, Web-GIS is a tool that municipalities employ to manage potable water and sanitation infrastructure in accordance with SDG2030, section 9.

3.3.10 Sustainable Development Goals: Agenda 2030

"Transforming our world: The 2030 Agenda for Sustainable Development" (SDG2030) is the new Sustainable Development Agenda that the United Nations' member states accepted at their September 2015 summit (United Nations, 2015). Agenda 2030, which aims to accomplish goals by 2030, came into force on January 1, 2016 (United Nations, 2015). There are 169 targets and 17 Sustainable Development Goals in Agenda 2030. The primary objectives of Agenda 2030 were to eradicate poverty, safeguard the environment, and guarantee an inclusive, equitable, and peaceful society (Mahlatsi, 2021).

The goal of Agenda 2030 for Sustainable Development is to address inequality and advance social fairness and prosperity (Lauman *et al.*, 2022). The ideology of SDG2030 stems from the fact that it is related to other goals. In view of the fact that they deal with infrastructure, water, and governance, SDG2030, sections 6 (Clean water and sanitation), 9 (Industry, innovation, and infrastructure), and 17 (Partnership for objectives) are pertinent to this study.

The SDG2030 goals are in line with human rights and proper potable water and sanitation theory. It forms the foundation of this research study. The theory emphasises institutional frameworks in terms of municipal governance, technological frameworks in terms of ICT, and human frameworks in terms of individuals, civil societies, and businesses. The development of any country is to attain sustainable development goals (Andrzej & Bartosz, 2019).

3.3.10.1 Goal 6: Clean water and sanitation

Achieving universal access to sustainable water and sanitation management is the sixth Sustainable Development Goal. Since it highlights the significance of ensuring water security and the availability of water in adequate quantities, acceptable quality, and in a sustainable manner (Monni *et al.*, 2018), this goal is crucial to the study. But in South Africa, the delivery of clean water poses significant challenges for urban local authorities, districts, and metro areas (Zindi & Shava, 2022). Water services delivery has become inefficient because inadequate financial management was the consequence of putting

political interests before the basic requirements of local communities (Eales, 2011; Munzhedzi, 2020).

The lack of transparency and community confidence about water availability has resulted in vandalism of municipal water infrastructure because of discontent with the failure to provide appropriate water services (Majuru *et al.*, 2012; Sershen *et al.*, 2016).

SDG 6 provides guidance for resolving these issues. To provide clean, drinkable water, South Africa has water laws and sustainable development goals that are backed by the national Constitution. Because water facilitates both economic growth and sustainable development, achieving this goal is of importance. After all, water supports fundamental rights of health and human dignity. Water is also key to the food security of society.

3.3.10.2 Goal 9: Industry, innovation and infrastructure

Goal 9 of the SDG2030 Agenda, which focuses on encouraging innovation and inclusive, sustainable industrialisation while creating resilient infrastructure, is similarly related to this study through technology. Clean water is a key component of SDG2030 section 6, which, covered in the previous section. Infrastructure must be technologically controlled, managed and monitored. Many SDG2030, especially sections 6 and 9 depend on technological transformation (Allen *et al.*, 2018).

Rustenburg Local Municipality's (RLMs) potable water and sanitation infrastructure management is the subject of this research study. The literature study states that Geographic Information Systems (GIS) and information and communication technologies work together to create Web-GIS, an infrastructure management system that aids in the updating and monitoring of water infrastructure assets for municipal planning.

Potable water and sanitation infrastructure management and service delivery can be enhanced through the innovation and technologies offered by SDG 9. The Internet of Things (IOT) for water monitoring (Andres *et al.*, 2018), satellite data for remote water supply monitoring (Amitrano *et al.*, 2014), and machine learning for water quality monitoring are some of the technologies that have been utilized to enhance the delivery of water services (Liu *et al.*, 2019). All these technologies are related to the Fourth Industrial Revolution, which is the digital age. The ICT is necessary to attain an efficient

and successful government (Mavuri *et al.*, 2020). By updating local infrastructure and investing in information and communication technology, the SDG 9 targets can be met.

3.3.10.3 Goal 17: Partnership for goals

Strengthening implementation tools and reviving the global cooperation for sustainable development are the goals of SDG2030 section 17 (Bull *et al.*, 2019). This SDG is pertinent to the study, since it encourages collaboration and partnerships across sector departments and municipalities to fight poverty and inequality by providing water. A partnership is an arrangement in which individuals, collective actors, and the state work together (Sondermann & Ulbert, 2021). Partnerships in sustainable development are created by means of incorporating the citizens of the nation state. There should be space for local resident communities in all parts of a country to participate in the process (Filho *et al.*, 2022).

Municipalities need to incorporate local people for greater community involvement, especially in developing communities, in terms of the Local Government: Municipal Systems Act 32 of 2000. To address problems related to service delivery, matters of water, sanitation and infrastructure require local municipal officials to seek cooperation and participation from stakeholders, such as residents, non-governmental organisations, as well as national and provincial departments, municipal infrastructure support agencies, in the spirit of cooperative governance. Cooperative collaboration between the public and especially the private sector can put the government in a position to strategically provide services (Taute, 2021). This involvement and cooperation support for municipal good governance, which includes openness, accountability, combating corruption, community involvement, and inclusivity, implies that no one should be left out.

In order to illustrate the necessity of a coordinated and cooperative response from the government, this sustainable development goal also promotes connections between the aforementioned goals. Interconnections between the sections of SDG2030 are essential for dismantling organisational silos and promoting increased stakeholder interactions (Zhou *et al.*, 2017). To provide water to the inhabitants of the Rustenburg Local Municipality (RLM), the research study can link SDG2030's sections 6, 9, and 17 to contribute constructively to matters of potable water and sanitation infrastructure. It has to be managed effectively by means of active engagement with human, technological,

and institutional governance representatives. The SDG2030 is not only about what wealthy nations should do for the poor. It is all about nations working together for the global welfare of the present and future generations (Sachs, 2012).

3.3.10.4 The Integrated Urban Development Framework

In April 2016, the South African government adopted the Integrated Urban Development Framework (IUDF), released by the Department of Cooperative Governance in collaboration with a number of partners (RSA, 2016). According to the National Development Plan's goal, the IUDF is a set of policies that suggest how the South African urban system might be restructured to make its cities and towns more welcoming, resource-efficient, and enjoyable spaces for humans to live, work, and engage in leisure activities (CoGTA, 2014:9). Even though the legacy of apartheid led to inequalities between spatial areas, other factors include changing demographics, such as evolving migratory patterns and the town or city's social and economic and performance profile (DCoGTA, 2014:89).

Spatial segregation, social marginalisation, and insufficient access to essential services resulted from apartheid's planning policies' failure to address issues with spatial governance, such as inner-city township regeneration (Van Der Berg, 2017). To enhance living conditions and make cities more resilient and liveable, this framework was put into place to rewrite the history of apartheid and promote inclusivity among people of all races, genders, and disabilities who actively participate in urban life (DCoGTA, 2014).

The National Water Resource Strategy (2004, updated in 2013 and 2023) was crafted to guide the protection, usage, development, conservation, management, and control of water resources. As argued by Nyam, Kotir, Jordaan, Ogundeji and Turton (2020:62), the strategy provided an essential roadmap for integrated water resource management. However, DWS (2021) points out that implementation has been challenged by numerous factors, including capacity constraints and a lack of institutional integration. The World Bank (2021:2) subsequently explained that the attainment of the strategy's objectives necessitates sustained commitment and investment. The next section gives a review of the Water Act of 1998, which is a piece of legislation regarding water provision.

3.4 A Review of the Water Act of 1998

The National Water Act (NWA) of 1998 represents a legislative measure in South Africa which fundamentally revamped the nation's water management policy (Biswas, 2004). Replacing the rights-based system featured in the earlier Water Act of 1956, the Act introduced a framework based on equitable access and sustainability, marking a juncture in South Africa's water resource management trajectory.

In their exploration of the NWA's emphasis on decentralising water management, Ndeketeya and Dundu (2019:164) examine how the NWA transfers considerable responsibility to Catchment Management Agencies (CMAs) and Water User Associations (WUAs). This includes tasks such as water allocation, water resource protection, and conflict resolution. Although stakeholder engagement at the community level and democratic governance promotion are potential benefits, Ndeketeya and Dundu (2019:164) postulate that implementation has been beset with obstacles, including a lack of technical expertise and the management of diverse stakeholder interests.

The Act sought to redress historical socio-economic imbalances amplified by the former apartheid regime. For instance, the water allocation system within the NWA prioritised basic human needs and ecological reserves and facilitated redress through its reserve and water licensing requirements (Tivaringe, 2019). However, Rodina, Harris, Ziervogel, and Wilson (2024) argue that the implementation of the Act failed to surmount the entrenched inequalities in water access, a reflection of South Africa's broader socio-political dynamics. Frequently, academic literature about the NWA underscores the discrepancy between the Act's lofty ambitions and the reality of its implementation. Weindl (2022) proposes that the complexity and ambitious scope of the legislation often surpass the institutional capacity for its execution, resulting in delays and inconsistencies.

Despite challenges, the NWA is recognised as a significant milestone in South African water legislation and policy planning (Nyam, Kotir, Jordaan, Ogundeji & Turton, 2020:62). It embodies a transformative vision for equitable and sustainable potable water management. Insights gleaned from its implementation are of value for other water-scarce nations facing similar issues of equitable distribution and sustainable management (Koh & Askill, 2021:282).

3.4.1 Analysis of water access, security and scarcity in South Africa

Water accessibility in South Africa presents an adaptable and complex problem, shaped by a variety of factors such as geography, societal inequalities, and institutional policies. Grewatsch, Kennedy and Bansal (2023:722) scrutinised the nature of household water accessibility across South Africa in a nationwide study. Their research uncovered significant gaps in water accessibility, with urban regions generally performing better than their rural counterparts. However, even in urban areas, the study found a significant swath of social and economic factors, with low-income households facing inadequate access due to affordability challenges and infrastructural shortages.

The promise of equitable water access, as stated in the National Water Act (1998), faces obstacles created by historical land differences and associated rural-urban migration patterns. The complexity of this situation is further increased in size by the abuse of water, which, although it enhances supply competence, poses risks of the further marginalisation of impoverished communities (Abrams, Carden, Teta & Wågsæther, 2021:1). This examination aligns with the findings of Koh and Askell-Williams (2021). They observe that while water supply systems have improved significantly since the end of apartheid in 1994, vulnerable groups remain underserved due to economic and institutional challenges.

The issue of water security in South Africa is increasingly becoming an area of substantial concern. The combined impact of climate change, demographic pressure, urbanisation and economic development consistently tends to compromise sensible principles of water security. Nyam, Kotir, Jordaan, Ogundeji, and Turton (2020:62) argue that South Africa, as a water-stressed nation, often faces a scenario where water demand surpasses supply, especially in densely populated and economically productive areas. The researchers contend this situation is worsened by climate change, predicted to cause more frequent and severe periods of drought.

On the other hand, De Kadt and Lieberman (2020:186) presume that water insecurity in South Africa does not merely arise from physical scarcity. It is also a product of systemic weaknesses in water governance. These encompass issues such as inefficient water usage, limited enforcement of water legislation, a lack of investment in water infrastructure, and widespread inequality in water access. Consequently, they suggest

strengthening water institutions and governance systems because it is a key to enhancing water security.

Water scarcity in South Africa is a pressing concern with a wide-ranging impact. Leal Filho *et al.* (2022:150) characterise South Africa's water scarcity as a product of both physical insufficiencies, caused by climatic and geographical factors, and economic scarcity, driven by insufficient investment in potable water infrastructure and inefficient water usage. One of the goals of the South African Constitution is to guarantee that services are delivered to communities in a sustainable way (RSA, 1996). However, this is possible if the infrastructure is intelligently maintained to prevent neglect, which has an impact on the economy and citizens' access to services (Wall, 2021). Due to the apartheid system, the democratic government inherited infrastructure characterised by inequalities. The significance of potable water and sanitation infrastructure management must be considered. It is important to maintain a functional society and conduct appropriate business (Watermeyer, 2018:1). Water resource conservation is aided by water infrastructure services, such as dams and wastewater treatment plants (Dangui & Jia, 2022). To maintain a more sustainable municipality, potable water supply and sanitation infrastructure systems must be maintained sustainably (Koop *et al.*, 2022).

According to Mutamba (2019), the poor condition of South Africa's potable water sanitation infrastructure, particularly aging infrastructure systems that cause pipe breaks and leaks, have a profound impact on the country's water security. To address infrastructure backlogs, South Africa has, in recent years, had to raise its financing budget for infrastructure development and improvement (National Treasury, 2017:3). This is because the delivery of water to communities demonstrates the significance of proper infrastructure. Municipalities must manage their infrastructure by combining data on municipal networks and infrastructure, while also taking into consideration the city's population growth (Haupt & Wessels, 2017). Researchers underscore the threat posed by the evident scarcity to South Africa's social and economic development.

In a similar vein, Ndeketeya and Dundu (2019:165) highlight a controversial discourse on the issue of water exploitation. They argue that while usage can enhance efficiency in water use, it poses a risk of marginalising destitute communities. This reflects on broader

debates regarding the interaction between water access, scarcity, and socio-economic inequality.

Conversations around water security frequently emphasise the relationship between water scarcity, climate change, and socio-economic development. Nyam, Kotir, Jordaan, Ogundeji, and Turton (2020:62) argue that South Africa's water security challenges arise not only because of increasing scarcity, but also because of climate change and demographic pressures. They advocate comprehensive strategies for water security that ideally integrate water management with climate change adaptation and socio-economic development.

Simultaneously, De Kadt and Lieberman (2020:186) underscore the issue of water governance in relation to water security. They contend that enhancing water security involves more than simply augmenting the water supply. It necessitates strengthening water institutions and governance. The cost of running water supply has increased for South African towns due to a lack of potable water and sanitation infrastructure management – a vital tool for oversight of water and sanitation infrastructure assets (Raftells, 2011). In addition to affecting operating costs, a municipality's lack of potable water and sanitation infrastructure assets also results in a lack of pertinent data on water infrastructure. That influences municipal planning and awareness of the size of the backlog, ultimately resulting in insufficient operational and maintenance budgeting.

According to the South African Constitution, one goal is to guarantee that services are delivered to communities in a sustainable way (RSA, 1996). However, this is possible only if infrastructure is intelligently maintained to prevent neglect, which has an impact on the economy and citizens' access to services (Wall, 2021). This viewpoint aligns with broader debates concerning the relationship between water security, governance, and social equity. The next section discusses the water and sanitation challenges in North West Province.

3.4.2 Water and sanitation challenges in North West Province

South Africa's North West Province faces substantial challenges in delivering equitable and ample water and sanitation services to its residents. A paramount issue includes differences in access to water. The contrasting consumption patterns are most evident in

the province's rural regions. Research conducted by Ndeketeya and Dundu (2019:165) reveals a disturbing outline of an unreliable potable water supply. Infrastructure, particularly pipes and water treatment facilities, is often found in a state of deterioration, affecting the reliability and safety of direct water supply systems. Further instances, in the municipality of Tswaing, demonstrate residents' dependence on brackish groundwater because of the collapse of the local water supply infrastructure (Ndeketeya & Dundu, 2019:164). Such situations are commonplace. It is an ever-present narrative amongst residents, resounding throughout the province.

Moreover, Gumbi (2020) extends the reach of this concern to include not only rural areas but also urban areas. Despite urban areas' typically superior resources and infrastructure, it was also determined that similar discourses also pass through urban areas of the province. One example involves the township of Majakaneng, where residents resorted to protests in 2015 following extensive water shortages (Gumbi, 2020). Instances of this nature demonstrate that water access remains a critical issue across the province, giving rise to destructive coping strategies, such as unregulated and potentially unsafe water sources.

Governance plays a role in this context, as illustrated by Akhmouch, Clavreul, Hendry, Megdal, Nickum, Nunes-Correia and Ross (2020). They focus on the declining water situation. This apparent crisis primarily stems from the absence of political commitment and prevalent corruption in the water sector. The study specifically identifies a culture of non-transparency and mismanagement factors, which not only impede the implementation of efficient potable water and sanitation policies but also foster corruption. Scanlon *et al.* (2023) resonate with these concerns in their analyses of the implementation of the Local Government: Municipal Structures Act (1998) and the Local Government: Municipal Systems Act (2000). They are of the view that, despite the potential of legislation to significantly enhance water and sanitation service delivery, the execution of projects was hampered by mismanagement and inadequate resources.

North West Province's sanitation condition creates more confusion about the issue. Swatuk and Cash (2022:233) maintain that a significant portion of the population, especially in rural areas, continues to lack access to basic sanitation facilities. In such a position, insufficient access to sanitation infrastructure leads to widespread open

defecation, a practice carrying significant health risks and further escalating the province's public health challenges. In the village of Lekgophung, for instance, residents resorted to using fields and bushy areas, due to the absence of proper sanitation facilities (Swatuk & Cash, 2022:233). The authors underline the discriminatory nature of these sanitation challenges. Their study demonstrates that poorer households suffer most because of the municipality's failure to provide adequate sanitation. These conditions deepen socio-economic disparities in the province.

The potable water and sanitation issues of North West Province form part of a broader socio-political landscape characterised by infrastructural shortage, governance failures, and economic differences. What is needed seems to be a comprehensive approach to address these challenges. There is a need for infrastructural development, improved management, transparency, as well as inclusive and sustainable strategies prioritising the province's most vulnerable groups.

Nhamo *et al.* (2020:15) confirm the association between waterborne diseases and a lack of clean potable water and sanitation services. Their research demonstrated a surge in cholera and diarrhoea cases in areas where water quality and sanitation were below average. The communities of Koster and Swartruggens are among the sickest in the province, because of regular diarrhoea outbreaks due to water contamination (Nhamo *et al.*, 2020:15). Furthermore, these issues have a profound impact on vulnerable groups in the community, such as children and those living in poverty, and an ever-deepening health inequality gap.

Potable water quality is a critical consideration. Tiimub (2020:16) spotlights several threats to water quality in the province. Instances of agricultural runoff, mining operations, and failing wastewater treatment systems stand out. There are alarming levels of nitrates and *E.coli* in several of the province's drinking water sources, presenting significant health risks to the population. Of considerable concern is the intersection of deteriorating local water infrastructure, escalating potential water contamination and subsequent disease outbreaks.

Engaging various stakeholders is essential to address water and sanitation issues in North West Province. The literature suggests that non-governmental organisations and community-based organisations play an important role. Motshabi (2023:3) analyses

these organisations' role in water service delivery in Rustenburg Local Municipality (RLM), finding their involvement beneficial in bridging the gap between the municipality and the community, particularly regarding accountability and service delivery. However, the authors cautioned against over-reliance on this organisational structure, calling for a more substantial investment in public water and sanitation infrastructure.

A careful investigation of the North West Province reveals the stark contrast in the delivery of water and sanitation services between urban and rural regions - a phenomenon frequently observed across South Africa. Bazaanah and Mothapo (2024:142) underscore the rural-urban divide, revealing that rural communities typically experience diminished access to reliable and clean water sources more often than their urban counterparts. For instance, in the rural areas of the Ngaka Modiri Molema and Dr Ruth Segomotsi Mompati districts, water sources are often unprotected and susceptible to contamination, engendering significant health hazards. On the other hand, urban areas in these districts, although not free from water challenges, generally enjoy better access to appropriate water and sanitation services.

Further complications are introduced by recurrent drought conditions in North West Province. A study by Kos *et al.* (2023:270) portrays a description of the impact of drought influenced by climate change on water scarcity within the province. Prolonged durations of drought have resulted in many surface water sources drying up. Consequently, groundwater resources have come under substantial duress. Circumstances like these have strained the province's already fragile potable water and sanitation infrastructure and exacerbated water access issues for both urban and rural communities.

Administrative and governance issues, in addition to physical and climatic challenges, substantially contribute to the water and sanitation crises in North West Province. A report by the South African Human Rights Commission (2022:1) reprimanded the local authorities for poor governance, absence of accountability, and financial mismanagement in several municipalities of the province. Such issues have resulted in the dysfunctional implementation of water policies, poor maintenance of water infrastructure, and overall failure to provide adequate water and sanitation services to residents.

The role of community participation in addressing water and sanitation challenges is important and cannot be disregarded. Studies by Hutete and Sibanda (2022:12)

demonstrate that community involvement in water service delivery can cause more sustainable and equitable outcomes. For example, the establishment of a community water forum in the Tlokwe Municipality led to improved communication between residents and the municipality, culminating in more effective service delivery (Mumba & van der Waldt, 2023). Despite these positive instances, the study also discovered that community participation is often limited. There exists a dire need for more meaningful engagement.

The vast majority of water and sanitation difficulties in the North West Province are attributable to insufficient and decaying infrastructure. In a report by Bazaanah and Mothapo (2024:142), the inadequate maintenance of potable water and sanitation infrastructure leads to regular system failures and service disruptions. As an example, the Bojanala Platinum District experiences high levels of non-revenue water (water produced but not billed due to leakage, metering inaccuracies, or unauthorised usage), underscoring substantial losses incurred because of ageing infrastructure.

The human rights aspect of the water and sanitation crisis is evident. The South African Human Rights Commission (2023:1) maintains, the inability to provide suitable water and sanitation services infringes upon individuals' constitutional rights to access clean potable water and a healthy environment. These violations affect the most vulnerable part of society: the elderly, disabled, women, and children. In many rural areas, the responsibility of collecting water typically falls upon women and girls, detrimentally affecting their health and restricting their opportunities for education and employment.

The literature reinforces the need for enhanced social accountability and transparency in water service delivery. Ndeketeya and Dundu (2019:164) advocate for the significance of social audits. Service providers must be accountable and ensure the equitable distribution of available water resources. Despite attempts at social audits in the province, a multitude of factors have limited their effectiveness. There is a lack of access to information, community disengagement, and apprehension about reprisals.

The water and sanitation crisis in North West Province represents a complicated set of circumstances, shaped by geographical, climatic, administrative, and societal factors. Addressing these challenges requires a comprehensive approach, accounting for all elements and incorporating various stakeholders at different levels. The existing body of literature offers vital insights into these issues and potential strategies for advancement.

However, significant work remains to be done before people may enjoy conditions of safe and equitable access to water and sanitation for all in North West Province.

3.4.3 Water and sanitation of NW schools

The condition of potable water and sanitation infrastructure in educational institutions in South Africa's North West Province constitutes a significant concern, as numerous establishments grapple with inadequate facilities and service delivery. A study undertaken by Gumbi (2020:3) unveils the reality that several schools in this region lack adequate access to safe drinking water, thereby negatively affecting the educational environment and posing considerable risks to learner health. The investigation concludes that 37% of schools in the province had insufficient or non-existent access to potable water. Additionally, the available water often fails to meet the South African National Standard (SANS) for potable water (SANS 241). Petersen *et al.*'s survey (2021) reveals that 54% of the surveyed schools within the province contained water that was insufficient to meet the SANS 241 standards. Microbial contamination emerged as a significant problem, underscoring the appalling need for interventions aimed at enhancing the drinking water quality in these establishments.

Sanitation facilities at the North West's schools also pose a formidable obstacle. The Department of Basic Education's report (2022:1) found that, despite governmental initiatives to eliminate such systems, 26% of schools in the province continue to use pit latrines. This absence of satisfactory sanitation at these institutions exposes learners to substantial health hazards. It breaches their dignity and right to education. A case study by Maluleke, Moeletsi and Tsubo (2023:2) emphasises the unique obstacles confronted by female learners, who frequently miss school during their menstrual cycle because of the absence of private and hygienic sanitation facilities.

Regarding infrastructure upkeep, Mkandawire *et al.* (2023) highlight the struggle of numerous schools in North West Province with ageing and poorly maintained water and sanitation infrastructure. Problems include leaking taps and pipes, blocked or overflowing toilets, and dysfunctional hand-washing facilities. The poor maintenance of these facilities not only worsens access issues. It also leads to considerable water wastage.

Resolving drinking water and sanitation infrastructure challenges in the province's schools necessitates a comprehensive approach. Ruiters and Amadi-Echendu's (2022) research recommends heightened investment in infrastructure development and maintenance. They encourage the involvement of local communities in such projects, thereby fostering a sense of ownership and improved maintenance habits.

Furthermore, Shoji, Mbatha and Sithole (2023:2) underline the need for exhaustive water, sanitation, and hygiene (WASH) education at schools. Their research discovered a deficiency in knowledge about proper hygiene practices among many of the province's school learners. It contributes to the misuse and deterioration of facilities. WASH education can empower learners to safeguard their health and make more efficient use of available resources. Beyond the essential need for infrastructure improvement, the function of efficient management of water and sanitation services remains paramount. A deficiency in efficient management and neglect towards water and sanitation services increases existing problems in the province. Efficient management, complemented by community participation, can dramatically improve water and sanitation conditions.

Moreover, government and relevant policies play a critical role in shaping the water and sanitation landscape at schools in the province. According to Momberg, Mahlangu, Ngandu, May, Norris & Said-Mohamed (2020:129), while the South African government has made efforts to improve access to clean water and sanitation within schools in recent years, these measures have proved inadequate. Their research study suggests a larger allocation of resources and the implementation of effective policies to thoroughly address the issue.

An essential component in understanding the water and sanitation challenges in the province's schools involves considering the impact of these problems on children's education and health. As per Matseke (2020:90), the lack of potable water and appropriate sanitation facilities in schools significantly affects children's health and educational achievement. The study suggests this predicament contributes to a high rate of absenteeism and low academic performance, as children often miss school due to illnesses induced by the poor quality of water and sanitation facilities.

To summarise, the potable water and sanitation crisis within the North West province's schools is a complex issue. The literature indicates that resolving this crisis necessitates

a collective effort from various stakeholders, encompassing government bodies, school management, communities, and non-governmental organisations. Addressing these concerns ensures the basic human rights of children, contributing to a healthier and more educated society (Matseke, 2020:91). Therefore, it is imperative to prioritise the enhancement of potable water and sanitation infrastructure at these institutions, given their impact on learner health, dignity, and educational outcomes.

3.5 Education on water and environment in South African schools

The discussion surrounding water and environmental education at South African schools is comprehensive and profound. This is attributed to the critical role that education plays in fostering environmental awareness and promoting the sustainable use of water resources. Pesanayi, Mashozhera and Khitsane (2016:133) state that current curricula have unsuccessfully integrated environmental education across various subjects, thereby highlighting the importance of sustainable living and responsible environmental stewardship. Nevertheless, the practical implementation and effective curricula remain areas of concern, necessitating methodical research study and in-depth analysis.

Moreover, extensive research has been conducted regarding the role of educators in implementing water and environmental education. Molefe and Aubin (2021) indicated that educators are instrumental in environmental education, although many feel inadequately equipped due to insufficient content knowledge and pedagogical skills. This finding underscores the necessity for continual teacher training and professional development in environmental education to ensure effective delivery.

Conversely, Eze (2020:89) investigate the role of non-formal education in enhancing learners' environmental awareness. They reported that educational field trips to nature reserves, water treatment facilities, and environmental centres provide experiential learning opportunities that significantly enhance learners' understanding of water and environmental issues. They recommended incorporating such activities more regularly into the school curriculum.

It is also crucial to understand learners' perspectives when examining water and environmental education. Ferguson, Rooft and Cook (2021:134) reveal that while learners acknowledge the importance of water conservation and environmental

stewardship, many felt their learning did not translate into action. This suggests environmental education should extend beyond the cognitive domain to encompass affective and psychomotor domains, thereby encouraging learners to adopt sustainable practices in their daily lives.

The influence of contextual factors on water efficiency and environmental education has been a significant focus in the literature. Kretzer, Ali and Schweiger (2023:1) observe that social, economic, and cultural contexts significantly influence environmental education. It is perceived and implemented, which underscores the need for a contextual approach to environmental education that takes these factors into account. These studies provide valuable insights, but they also expose gaps in the current literature. For example, few studies have explored the role of school leadership in facilitating or hindering the implementation of water and environmental education. Similarly, the impact of various teaching methodologies on learners' environmental attitudes and behaviours warrants further investigation. The current body of literature tends to focus more on the cognitive outcomes of environmental education, with less attention to affective and behavioural outcomes. Consequently, future research endeavours should aim to address these gaps, thereby providing a more comprehensive understanding of water and environmental education in South African schools.

Moreover, while non-formal education is praised for its potential to enhance environmental awareness, there is limited knowledge regarding its optimal integration into the formal school curriculum (Ardoin, Bowers & Gaillard, 2020:1). Additional studies are required to identify best practices in this regard. Similarly, despite the recognised influence of contextual factors on environmental education, more empirical studies investigating these influences in specific contexts are needed.

Considering the points, the literature review unveils a field that, although extensively researched, still leaves room for further exploration. This justifies ongoing efforts to enhance coverage of potable water and sanitation within environmental education in South African schools, drawing on lessons from both research and practice (Du Plessis & Mestry, 2019:2). The goal is to cultivate an environmentally conscious generation capable of dealing with the pressing water and environmental challenges facing South Africa and the wider world.

Beyond the classroom, a growing body of literature underscores the importance of incorporating indigenous knowledge into environmental and water education. According to Kretzer, Ali and Schweiger (2023:1), indigenous knowledge plays an important role in bridging the gap between theory and practice. It enhances learners' understanding of the intricate nature of environmental issues, including water conservation. This is particularly applicable in a multicultural country like South Africa, where indigenous communities have coexisted with the environment for centuries, utilising their unique knowledge systems for sustainable resource management.

Serge Kubanza (2021) highlights the importance of community participation in environmental education. The author argues that active community involvement enhances the relevance and applicability of the environmental curriculum, thereby empowering learners to actively participate in solving local environmental problems. Similarly, Reddy (2021:161) finds that community-based environmental projects contribute to improved environmental attitudes among learners, instilling a sense of ownership and responsibility towards the environment.

However, challenges persist in plans for implementing water and environmental education in South African schools. A study by Ardoin, Bowers and Gaillard (2020:1) emphasises issues, such as the lack of trained educators, inadequate resources, and an overloaded curriculum as key obstructions. This highlights the need for more significant investment in teacher training, curriculum development, and resource provision to effectively integrate water and environmental education into the school system.

3.5.1 Role of NGOs in Environmental Education

Non-governmental organisations (NGOs) are instrumental in delivering environmental education, especially in areas where government efforts may fall short. In the Rustenburg Local Municipality (RLM), where potable water scarcity and sanitation issues are uncontrolled, NGOs can fill the gap by providing targeted educational programmes and resources. Collaborating with schools, NGOs can develop and implement environmental curricula focused on local water-related challenges such as conservation, sanitation, and hygiene practices (Angmann, Bezemer & Pick, 2021:209). By manipulating their expertise and resources, NGOs can significantly enhance the quality and relevance of

environmental education, equipping learners with the knowledge and skills needed to effectively address these issues.

Additionally, NGOs play a crucial role in facilitating community engagement and participation in environmental initiatives. They can organise workshops, training sessions, and awareness campaigns to educate community members on the importance of water conservation, sanitation, and hygiene (Swatuk & Cash, 2022:233). Through active community involvement, NGOs can foster a sense of ownership and responsibility towards environmental issues, leading to more sustainable and impactful outcomes. For instance, NGOs can partner with local communities to implement rainwater harvesting projects or establish community-led water management committees, empowering individuals to manage their water resources sustainably.

Beyond educational initiatives, NGOs are vital in advocating for policy changes and holding government agencies accountable for their environmental responsibilities. They can conduct research, monitor environmental conditions, and highlight the impacts of water scarcity and sanitation challenges on communities (Ndeketeya & Dundu, 2019:164). Through advocacy and lobbying, NGOs can influence policy decisions to ensure community needs and rights are prioritised in water and sanitation management plans. For example, NGOs can push for increased investment in potable water infrastructure, improved sanitation facilities in schools, and the implementation of equitable water distribution policies.

Moreover, NGOs contribute to capacity building and knowledge sharing in environmental education. They can train teachers, community leaders, and other stakeholders on effective environmental education methodologies, providing them with essential resources and tools (Langmann, Bezemer & Pick, 2021:309). By enhancing local capacity, NGOs ensure the sustainability and long-term impact of their interventions. For instance, NGOs can organise workshops on water quality testing, sanitation facility maintenance, and hygiene education, equipping individuals with the expertise to tackle environmental challenges in their communities.

3.5.1.1 Citizenship participation

Involving people in a city's development initiatives is a key component of good government (Ruijter *et al.*, 2017). Local governments include communities in planning-related administrative matters (Rodina & Harris, 2016). Section 16 of the Municipal Systems Act 32 of 2000 mandates that citizens be involved in municipal planning and adoption of the Integrated Development Plan (RSA, 2000). Since the community is located at grassroots level, it can advise on the conditions of the municipal potable water and sanitation infrastructure, as well as other relevant development projects required throughout the local municipality. Community participation can determine municipal services, such as the use of potable water and sanitation infrastructure technologies for precise and real-time information generation, in smart cities (Younus, 2021). According to Prahaj *et al.* (2018), citizenship participation can also enhance the management of potable water and sanitation infrastructure, such as pipes, by alerting local authorities to any vandalism that occurs on their property and by using tools to record infrastructure issues to facilitate prompt maintenance and management.

3.6 Theoretical framework of the study

A theoretical framework, as explained by Jabareen (2009), represents a structure that coordinates research by supplying a coherent interpretation of the research problem, the approach to its resolution, and its relationship with extant knowledge. Essentially, it comprises the infrastructure upon which a study is erected, offering an analytical lens for interpreting research data and findings. In the sphere of water research in South Africa, a useful theoretical framework could be the Water Demand Management (WDM) theory or socio-hydrology theory, laying the foundation for comprehending and examining complex issues such as water access, water security, and water scarcity (Swatuk & Cash, 2022:233).

The importance of a theoretical framework within academic research warrants significant emphasis. As explained by Grant and Osanloo (2014:86), the theoretical framework not only directs the research process but also assists in the research problem and question. Additionally, it shapes research design and methodology and influences how data are collected, interpreted, and reported (Grant & Osanloo, 2016). In relation to water research in South Africa, the theoretical framework plays an indispensable role by structuring the

analysis of diverse issues, spanning from government policies and water infrastructure to societal perceptions and behaviours concerning water usage. Essentially, it offers a context for understanding and addressing the multifaceted and interconnected challenges of water management in South Africa (Muller, 2014). The following Water Demand Management theoretical frameworks are being considered, together with motivation for why they are relevant to the study.

3.6.1 Water Demand Management (WDM) theory

Water demand management (WDM) theory is of paramount importance to this study, given the water scarcity challenges faced by schools in the Rustenburg Local Municipality (RLM). This theory emphasises the efficient and effective use of water resources, aligning perfectly with the study's objective of investigating the management of potable water and sanitation infrastructure in these schools. In the context of South Africa's water scarcity issues, worsened by high water use, evaporation, and rising demand, WDM strategies are vital for ensuring sustainable water access in educational institutions (DWS, 2019:1). The study's focus on the impact of water scarcity, particularly during periods such as the COVID-19 pandemic, when water tanks were provided, but remained empty due to shortages, underscores the relevance of WDM (Harper, 2020).

WDM theory provides several actionable strategies to enhance water management in Rustenburg's schools. Key components include promoting water conservation, improving water use efficiency, and adjusting water pricing and tariff structures to encourage responsible usage and alleviate pressure on water resources. The literature reviewed in this study supports the potential of WDM to address water scarcity, especially in urban areas, by minimising environmental impacts and reducing the need for additional water supply infrastructure (Punt *et al.*, 2023:1; Lede & Meleady, 2019:2).

For Rustenburg's schools, implementing water conservation measures such as fixing leaks, using water-efficient appliances, and educating learners and staff about responsible water use could significantly improve water availability. Additionally, exploring alternative water sources like rainwater harvesting could further bolster water security. By adopting these WDM strategies, Rustenburg's schools can contribute to sustainable water management practices, ensuring a reliable water supply for learners and staff.

3.6.2 Socio-hydrology theory

Socio-hydrology, conceptualised as a theory, aims to comprehend the co-evolutionary dynamics existing between human societies and water systems. An in-depth exploration of the fundamental concepts inherent in this theory is provided by Roobavannan *et al.* (2018:133), who emphasise the complex interactions and feedback mechanisms occurring between human societies and the hydrological environment. The theory postulates that human actions significantly influence the evolution of water systems, actions that are in turn shaped by social, economic, and political factors. The central focus of the theory encompasses the significance of human-water interactions, the concept of system dynamics and feedback, and the principle of co-evolution (Roobavannan *et al.*, 2018:133).

Further elaborating on these principles, Harris *et al.* (2018:89) assert that socio-hydrology, as a field of study, strives to provide insights into how societies and water systems adapt to each other over time, leading to patterns of development and water use. For example, it is believed that societal water demands, governance structures and decisions directly influence water infrastructure development, thereby affecting hydrological patterns and processes. These interactions exhibit the cyclical nature inherent in socio-hydrological dynamics (Lynch *et al.*, 2020:2). The municipality's operations will be standardised by means of agreements for performance management of all levels of management with effect from July 2022 in order to enhance governance and operational efficiency. These agreements seek to enhance accountability while ensuring that management behaviours are aligned with the overall strategic goals of the IDP in areas of critical services like water and sanitation infrastructure management.

Debates surrounding socio-hydrology as a theory have been outlined, drawing insights from a range of disciplinary perspectives. Zapana-Churata *et al.* (2022:364) critique the overemphasis on quantification within socio-hydrology, proposing it tends to overlook qualitative aspects of human-water relationships. In a counter, Roobavannan *et al.* (2018) contend that while quantification is central to socio-hydrology, it does not exclude qualitative investigations, instead promoting an integrated approach. Additionally, Di Baldassarre *et al.* (2018:56) provide an insight into the risk of oversimplification,

cautioning that the complexity of socio-hydrological systems could lead to overly simplistic models that omit critical factors.

Regarding the applicability of socio-hydrology to South Africa's water situation, various studies investigate its potential. Swatuk and Cash (2022:233) utilise the theory to analyse water management challenges in the Vaal River Basin, underscoring the influence of socio-political factors on water governance. Similarly, Ndeketeya and Dundu (2019:164) adopted socio-hydrological perspectives to probe the causes and implications of Cape Town's "Day Zero" water crisis, demonstrating how socio-economic dynamics both shaped and were influenced by hydrological realities.

The water and sanitation crisis in the North West Province is a complex issue, resulting from infrastructural deficiencies, governance failures, and socio-economic inequalities. The lack of access to clean water and proper sanitation disproportionately impacts vulnerable populations, especially women and children in rural areas, infringing upon their constitutional rights. Despite some advancements in water and sanitation services, persistent challenges remain due to inadequate infrastructure maintenance, scarce resources, and ineffective governance. Addressing these issues requires enhancing social accountability and transparency through measures like social audits. Such initiatives are essential for ensuring equitable access to water and sanitation for all residents in the province (Ndeketeya and Dundu, 2019:164; South African Human Rights Commission, 2023:1).

Socio-hydrology theory is equally pertinent to this study due to its emphasis on the relationship between human society and water systems. Given that the study examines the management of potable water and sanitation infrastructure at schools in Rustenburg Local Municipality (RLM), understanding the interplay between societal factors and water resource management is crucial. This theory's focus on the co-evolutionary dynamics between human actions and hydrological systems aligns with the study's aim to explore the challenges and potential solutions in water and sanitation provision (Roobavannan *et al.*, 2019:133). Rustenburg, as a mining hub with a growing population and urbanisation pressures, demonstrates a context where human activities significantly impact water resources. Applying socio-hydrology theory allows for an analysis of how societal factors

such as population growth, urbanisation, and mining activities influence water demand, infrastructure development, and overall water management practices in the municipality.

The major water supply infrastructure of Rustenburg Local Municipality (RLM) is supplied through surface water abstraction of the Elands, Crocodile, and Hex Rivers, conveyed through the Vaalkop Dam. However, this infrastructure is near the maximum utilization point, presenting serious challenges to future water security. The IDP explicitly states that increasing the water supply through groundwater sources and demand-side conservation measures is of utmost urgency to meet the needs of the growing population on a sustainable basis (Rustenburg Local Municipality (RLM), 2021).

The Rand Water case study can be examined through the lens of socio-hydrology by analysing how the utility's operations and interventions interact with the social and hydrological systems in its service area. For example, investigating the impact of Rand Water's rainwater harvesting initiatives on water availability and usage patterns in both rural and urban communities can provide insights into the socio-hydrological dynamics at play (Fanadzo & Ncube, 2019:336). Additionally, assessing the effects of Rand Water's infrastructure development and management practices on water quality and accessibility can further demonstrate the complex relationship between human interventions and hydrological outcomes. By examining the Rand Water case study through a socio-hydrological perspective, the study can gain a deeper understanding of the interplay between social, economic, and political factors and their influence on water resource management in the region.

3.6.3 Evaluation of Rand Water in relation to the water supply to Rustenburg Local Municipality (RLM)

Rand Water's significance in this study is rooted in its role as a major water utility in South Africa, supplying potable water to a broad population, including schools in the Rustenburg Local Municipality (RLM) and communities (Manganye, 2020:2). The challenges Rand Water encounters in managing water resources, of ensuring equitable distribution, and maintaining infrastructure, reflect the broader water and sanitation issues being investigated in the Rustenburg Local Municipality (RLM) (Nyam *et al.*, 2020:62). By examining Rand Water's strategies, successes, and failures, the study can glean valuable

insights into the complexities of water service delivery in South Africa, particularly within educational institutions (Tempelhoff, 2018).

Rand Water, Africa's largest water utility, supplies clean drinking water to millions of people across Gauteng, North West Province and other parts of South Africa. Water is sourced from various locations, purified, and delivered to municipalities, mines, schools and industries. Additionally, Rand Water is involved in sanitation services to ensure proper wastewater treatment within the Rustenburg Local Municipality (RLM).

The influence exerted by Rand Water (RW) in South Africa is multifaceted, spanning across issues such as water scarcity, sustainability, and efficient management of water resources. Rand Water, in modern parlance, is a bulk water services supplier to Rustenburg Local Municipality (RLM). Much of the water that is managed by Rand Water is water harvested in both natural and artificial reservoirs, where it is stored before being distributed to client communities (Manganye, 2020:2).

The study highlights the necessity of formulating corporate water strategies, recruiting adept personnel for water-related issues, and enhancing green infrastructure. Such insights are invaluable for guiding Rand Water in its collaborations with industrial stakeholders within the Rustenburg Local Municipality (RLM). The research study assumes that community education initiatives are integral to complementing technical interventions, such as leakage reduction measures, thereby advocating for a comprehensive approach that combines technical solutions with community and schools' engagement and awareness programmes.

3.6.4 Accelerated School Infrastructure Delivery Initiative (ASIDI)

The Accelerated School Infrastructure Delivery Initiative (ASIDI) was launched in 2010. The ASIDI seeks to remediate potable water and sanitation infrastructure shortfalls in South African schools. These shortfalls are the legacy of the country's apartheid history (Ndungane *et al*, 2024:2). Some of the worst (and historically longest-standing) deficits are found in rural areas, like the area around Rustenburg Local Municipality (RLM). Their educational facilities have been deprived of just about everything that would make them conducive to learning. Among these, and probably the most serious, is the absence of any kind of potable water. Maphalala and Khumalo (2023:312) note that the ASIDI

mandate is to bridge the infrastructure divide between the schools of the rich and the poor.

The provision of water under the ASIDI program was first introduced because of the urgent need for safe drinking water in schools. Its origins date back to a 2005 WHO report, that found that 35% of the pupils who had 10% of the educational attainment of a standard level of equality (and in terms of the number of years to achieve that equality) had health problems that were directly related to the pupils' not having access to safe drinking water and reasonable sanitary facilities (Mathase, 2021:14). Those facilities are a basic underpinning of health and are essential to the education of mostly rural and marginalised children who attend ASIDI-targeted schools. The ASIDI programme has precipitated several positive developments in the schools served by it, especially in terms of enhanced access to water. This, in turn, is expected to positively influence several other conditions, most importantly the health of learners, which is currently compromised by the long-standing absence of necessary facilities (Christie, 2021:1).

3.6.4.1 Evaluation of the programme

Rounding out the picture of ASIDI, it is important to note that the Accelerated Schools Program (ASP) is the element that most directly affects educators and has engendered trust among them. The informal control mechanisms deployed throughout the unified array of the ASP satisfy the initiative with a sense of purpose and have proven vital for the enhancement of the entire school educational system. The foursome of enhancement includes the direct effect on teachers, the building of trust, and a rationale for why these are important, combined in and with the title of the next section (Pillay, 2022:1).

When it comes to the tangible components of the education system, it is widely agreed among the people who care that the system is under threat, particularly in the developing world. This is an area that has many stakeholders, including not just national governments but also international non-profits and bilateral aid agencies. The consensus seems to be that educational infrastructure is especially vulnerable to natural disasters. Secretary of Education Miguel Cardona pointed to “the urgent need to build educational infrastructure that is safe and secure in the face of natural disasters and human-made threats” when he introduced an initiative that the World Bank is spearheading called the Global Program for Safer Schools (D'Ayala *et al.*, 2020:3).

Communities must be involved in the execution of ASIDI. In Anambra State, for instance, community involvement in school construction infrastructure has helped add over 200 much-needed classrooms to public schools across the state. Communal activities to improve the physical infrastructure of educational institutions have not only helped augment the much-maligned school infrastructure. They have also instilled a sense of ownership and accountability among local stakeholders concerning educational advancement (Umeji, 2024:248).

Like the ASIDI, other educational initiatives are proving their mettle across the world; if not always leading to straightforward successes, then certainly creating meaningful changes. One of these is the Punjabi Education and English Language Initiative (PEELI) in Pakistan. It operates in many of the same sorts of environments as ASIDI, and it too aims to enhance in the targeted, sustained way that ASIDI does teaching and classroom conditions (Naz, Jabeen & Rashid, 2020:332). Its outcomes so far are instructive, both for their positive assertions and for what they suggest about essential future actions. Indeed, the report authors found evidence of PEELI achieving its aims in significant measure. Still, this instance is meant to serve mainly as an example of the sorts of effects that comparable programmes may have, and not as a straightforward success story.

Effective strategic management in educational entities, exemplified by the ASIDI, can lead to meaningful improvements in the overall quality of education. This management approach involves closely monitoring the heads of educational entities and ensuring they have the training and support they need to lead their faculties in the provision of quality education. Moreover, it ensures that educational entities have the facilities and infrastructure necessary for the successful delivery of quality education. These strategies are directly aligned with ASIDI goals of enhancing educational quality in a meaningful way through the human and physical dimensions of education (Irmayani, Wardiah & Kristiawan, 2019:1316).

Furthermore, ASIDI deals with policies affecting educational facilities and infrastructure. Educational infrastructure is assessed according to criteria set by the government. Evaluations determine that a number, indeed a significant proportion of schools, achieving the set standards. This is a kind of gradient achievement that is not too far from the pole of full achievement because there are many steps into an environment that is

conducive to learning. These evaluations have emphasized in what ways the facilities are procured, maintained, utilised, and disposed of. The focus is also on the critical functions of infrastructure, and how those functions affect the learning environment (Ngindana, Alfajri & Hendrawan, 2021:533).

Recent progress, particularly the incorporation of fuzzy expert systems, has enhanced the evaluation of the urgency and importance of capital projects in educational institutions. This new approach adds a significant dimension to the old prioritisation problem. It does not just state the problem; it provides a way to analyse the multifaceted requirements of each project quantitatively (Pillay, 2022:3). The methodology is vital for the sorts of initiatives that ASIDI represents, where the amount of work is great, the number of resources is limited, and the umbilical cord leading from those resources to the attainment of educational goals, must remain tight for both efficacy and efficiency to be assured. Stakeholders can now make more sophisticated decisions with fewer informational knots tied in the decision-making pathway.

Parallel endeavours of Corporate Social Responsibility (CSR) and ASIDI have had a significant influence on the infrastructure of educational institutions. A particular CSR initiative in Bhopal, undertaken by BHEL, proved to be beneficial. The project involved building not only the school itself, but also its compound and several classrooms (Tiwari, 2022:1).

Programme evaluations focus on the various dimensions of child-friendly, secure, enjoyable, and healthy school environments. These dimensions include the context, inputs, processes, and outcomes of a programme. These evaluations are important because they guarantee that not only the ASIDI but also any educational and infrastructural programme complies with established standards and contributes in a meaningful way to the safety and health of learners (Christie, 2021:4).

3.7 Chapter conclusion

In summary, this literature review offered a comprehensive account of significant themes and research findings concerning potable water and sanitation management in South Africa. The review emphasised the critical nature of water access, water security, and water scarcity as pressing challenges confronting the nation. It explored various

theoretical frameworks, including socio-hydrology and water demand management, that yield valuable insights for understanding and addressing these challenges. The literature underscored the importance of integrated approaches that incorporate social, economic, and environmental considerations into water management strategies.

Furthermore, the review identified gaps in the existing literature, highlighting the need for additional research on the role of governance and policy frameworks in water management and the integration of indigenous knowledge and community participation in decision-making processes. These gaps present opportunities for future research endeavours to enhance our understanding of water management in South Africa.

Collectively, the reviewed literature underscored the urgent requirement for sustainable and equitable water management practices in South Africa. It explained the complex interplay of social, economic, and environmental factors that shape water access, security, and scarcity. The insights derived from this review can inform policy formulation and decision-making processes to ensure effective water resource management, address differences in access, and promote sustainable water utilisation for the betterment of all South Africans.

As South Africa continues to try hard to solve water-related challenges, it remains imperative to draw upon the knowledge generated through research and engage in evidence-based decision-making. This literature review lays the groundwork for further exploration and inquiry into water management practices, providing valuable insights and guiding future research endeavours. By building upon the existing body of knowledge, researchers, policymakers, and practitioners can collaborate to develop innovative solutions and strategies that will lead to enhanced water governance, heightened water security, and sustainable water management in South Africa.

The next chapter focuses on the research methodology (PAR) of the human rights and proper potable water and sanitation infrastructure management at the selected schools in the Rustenburg Local Municipality (RLM).

CHAPTER 4 THE EMPIRICAL RESEARCH DESIGN ON POTABLE WATER AND SANITATION INFRASTRUCTURE

4.1 Introduction

This chapter focuses on the research methodology used in the study. It covers the research design, target population, sampling procedure, the methods of data collecting employed, including secondary data generation from documents, literature reviews, personal observations, and primary data generation from informal discussions and in-depth informal discussions, and data processing techniques. Additionally, the chapter discusses validity as a measure of quality control in the study's epistemological phase of research. A thorough explanation of the study's ethical considerations, including respondent anonymity, was also given.

The research design is based on the principles of Participatory Action Research (PAR), a methodology that emphasises collaboration, reflection, and iterative problem-solving (Pain *et al.*, 2019:1). PAR is inherently transdisciplinary, incorporating diverse perspectives to tackle complex issues (Chevalier & Buckles, 2019:3). The research began with informal discussions with school administrators, educators, and local government representatives to identify and define the problem, aligning with the planning stage of PAR (Pain *et al.*, 2019:1). Subsequent phases, including data generation, analysis, and interpretation, correspond to the acting, developing, and reflecting stages of PAR (Muller, 2018). It is concluded that PAR and transdisciplinary research are integrated and mutually reinforcing, a perspective corroborated by Muller (2018). The initial phase of transdisciplinary research, which involves problem identification and structuring, aligns with the planning stages of PAR.

Data generation methods included informal discussions, observations, and documentary analysis. Observations focused on the delivery of potable water and sanitation, water metering, leakages, and hand washing at selected schools in Rustenburg Local Municipality (RLM) (Guest *et al.*, 2020:2). Documentary analysis provided a national and international perspective on the topic (Morgan, 2022:64). Data analysis involved thematic content analysis, a process of encoding qualitative information (Braun & Clarke, 2023:2). Codes were developed to label sections of data, highlighting the main themes of

responses to ensure that similar qualitative responses were grouped. The study's validity was ensured through accurate recording and reflection of respondents' thoughts and experiences, incorporating member checking and triangulation (Coleman, 2022:2042).

This study's methodology offers a comprehensive and rigorous approach to investigating the management of potable water and sanitation infrastructure in selected schools of the Rustenburg Local Municipality (RLM). The use of PAR, combined with a transdisciplinary approach, provides a framework for addressing complex issues. Data generation and analysis methods were designed to capture a wide range of perspectives and experiences, yielding a rich and fair understanding of the subject.

4.2 Research philosophy

4.2.1 Defining research philosophy

Research philosophy is a comprehensive framework that guides how data is collected, analysed, and interpreted in a study. It encompasses three main dimensions: ontological, epistemological, and axiological (Khatri, 2020:1435). Ontology explores the nature of reality, questioning whether it is objective and singular or subjective and multifaceted. It examines whether reality exists independently of human perception or is constructed through social interactions and individual interpretations (Glattfelder & Glattfelder, 2019:345). Epistemology, conversely, deals with the nature of knowledge and how it can be acquired. It investigates the relationship between the researcher and the research, asking whether knowledge is best gained through objective observation or subjective interpretation (Glattfelder & Glattfelder, 2019:345).

The connection between ontology and epistemology is crucial. It shapes a research philosophy. Ontology defines the nature of reality, which in turn influences epistemology, dictating how that reality can be known. For example, if reality is viewed as objective and singular, as in positivism, knowledge is best acquired through objective observation and measurement. On the other hand, if reality is seen as subjective and multifaceted, as in constructivism, knowledge is best obtained through subjective interpretation and understanding of individual experiences (Khatri, 2020:1435). Essentially, ontology lays the groundwork for epistemology, shaping the researcher's approach to understanding and acquiring knowledge.

The axiological aspect of research philosophy concerns the role of values in research and how they influence the conduct and understanding of the research. It addresses ethical considerations and the values of the researcher that may influence the research process and outcomes. Research philosophy is crucial. It underpins the research strategy and its methodology. It provides the philosophical background against which the research is conducted and provides the principles and guidelines by which the research is carried out and interpreted (Saunders, Lewis & Thornhill, 2019).

4.2.2 Different research paradigms

Research philosophy pertains to the generation of beliefs and the nature and character of human thinking about phenomena perceived in cultural and natural ecosystems of thought, concerning the nature of the reality under investigation. It is a broad framework that guides the approach towards data generation, analysis, and interpretation. Research philosophy is a vital element of research methodology as it directs how a study is conducted and shapes the way reality is understood and interpreted (Saliya, 2023:35). While its selection is influenced by practical considerations, it also reflects the researcher's underlying beliefs and values.

Four main research paradigms or philosophies exist: positivism, interpretivism, pragmatism, and realism. Each of these paradigms offers a different perspective on how research should be conducted, and they are often used to guide the choice of research methods and techniques (Thomas, 2022:1).

Positivism is a research paradigm that emphasises the use of quantitative methods and statistical analysis. It is based on the belief that reality is objective and can be measured and analysed in a detached, unbiased way. Positivists believe that knowledge is based on observable phenomena and their properties and relations. Thus, the role of the researcher is to use objective research methods to uncover the truth about the world (Park *et al.*, 2020:690). The positivist paradigm is based on an ontology in which an objective physical and social world exists independently of humans' knowledge of it. General laws, governed by principles of cause and effect, apply, and human behaviours can be objectively measured. Positivist research is concerned with the development and empirical testing of general theories that govern the natural and social world (Park *et al.*,

2020:690). The researcher remains objective, distant and 'outside' the phenomenon under investigation.

Interpretivism, on the other hand, is a research paradigm that emphasises the use of PAR methods and the interpretation of meanings. It is based on the understanding that reality is subjective and can only be understood by interpreting the meanings people attach to their experiences. Interpretivists believe knowledge is based on the subjective experiences of individuals, and the role of the researcher is to interpret these experiences to understand the world (Pervin & Mokhtar, 2022:419-420).

Pragmatism is a research paradigm that combines elements of both positivism and interpretivism. It is based on the belief that the choice of research methods should be driven by the research question, rather than by any preconceived notions about the nature of reality. Pragmatists believe that knowledge is based on the practical consequences of ideas. The role of the researcher is to use whatever methods are most effective in answering the research question (Feilzer, 2024:202).

Realism is a research paradigm that combines elements of both positivism and interpretivism, but with a focus on the existence of an independent reality. Realists believe there is a reality that exists independent of human perceptions and interpretations. The role of the researcher in realism is to uncover this reality by using both quantitative and qualitative methods (Bogna, Raineri & Dell, 2020:461).

The selection of the participatory paradigm as the preferred research philosophy for this study is justified by its alignment with the research objectives and the nature of the research problem. This study aims to investigate the management of potable water and sanitation infrastructure in schools in the Rustenburg Local Municipality's (RLMs) area of jurisdiction. It is a complex issue, with complex ties to social, political, and economic contexts. The participatory paradigm, with its emphasis on collaboration, empowerment, and social change, is particularly well-suited to address many such issues (Kemmis *et al.*, 2021:280). It facilitates a deep understanding of the problem from the perspective of those most affected by it, specifically school communities and local government officials. By actively involving stakeholders in the research process, the participatory paradigm ensures the research findings are not only academically rigorous but also relevant and meaningful to the community.

Moreover, the participatory paradigm's focus on action and social change aligns with the transformative goals of this study. The research aims to identify and implement solutions to improve potable water management and sanitation infrastructure in the selected schools within the Rustenburg Local Municipality (RLM). By empowering stakeholders to become co-researchers and agents of change, the participatory approach can facilitate the development and implementation of sustainable solutions that are owned and driven by the community itself (Szetey *et al*, 2021:2). This approach is especially pertinent in the context of water and sanitation, where community participation has proven crucial for the success and sustainability of interventions.

The participatory paradigm, as articulated by Heron and Reason (1997), is a collaborative research approach that emphasises the active involvement of respondents as co-researchers throughout the entire research process. Humphries, Mertens and Truman (2020:3) expand on this by describing PAR as a form of self-reflective inquiry undertaken by respondents in social contexts to enhance their practices, their understanding of these practices, and the conditions in which these practices occur. This cyclical process involves planning, acting, observing, and reflecting, with the goal to generate knowledge that is both practical and empowering for the respondents (Humphries, Mertens & Truman, 2020:4). The core principles of PAR include collaboration, participation, empowerment, and social change. This paradigm regards all respondents as co-creators of knowledge, which fosters a sense of ownership and empowerment among all (Wilkinson & Wilkinson, 2024:15).

Moreover, PAR is inherently action-oriented, aiming not only to understand a problem but also to implement actions to resolve it. This dual focus on knowledge creation and practical action makes PAR a powerful tool for fostering meaningful social change. The section below discusses the research paradigm, which is linked to the discussed research methodology of PAR.

4.3 Research design

Research design is a comprehensive framework that outlines the procedures for collecting, analysing, and interpreting data in a research study (Kumar *et al.*, 2019:1). It acts as a blueprint for the entire research process, from the formulation of research questions to the presentation of findings. A well-structured research design ensures

systematic and rigorous conduct of the research, enhancing the validity and reliability of the findings (Leavy, 2023:4). In this study, the research design is informed by the principles of PAR.

PAR is characterised by its cyclical and iterative nature, involving a continuous process of planning, acting, observing, and reflecting (Ronen, 2020:2). This cyclical process allows for the research design to be adapted and refined as new insights emerge, ensuring that the research remains relevant and responsive to the evolving context. In this study, the initial phase involved informal discussions with school administrators, educators, and local government representatives to identify and define the problem of potable water and sanitation infrastructure management in schools. This participatory approach ensured that research questions were grounded in the lived experiences and concerns of the community. Below is a visual representation of the combination of PAR and TDR.

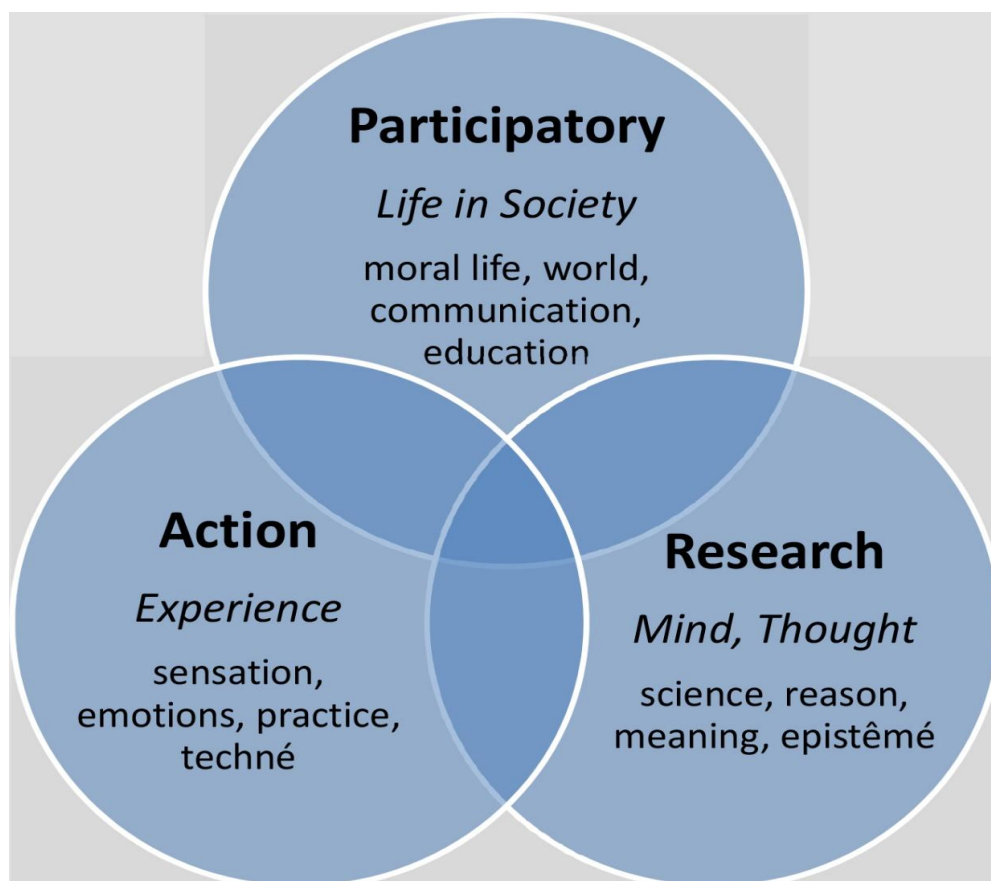


Figure 4.1: The link between PAR and TDR

Source: Pohl, Klein, Hoffmann, Mitchell & Fam (2021)

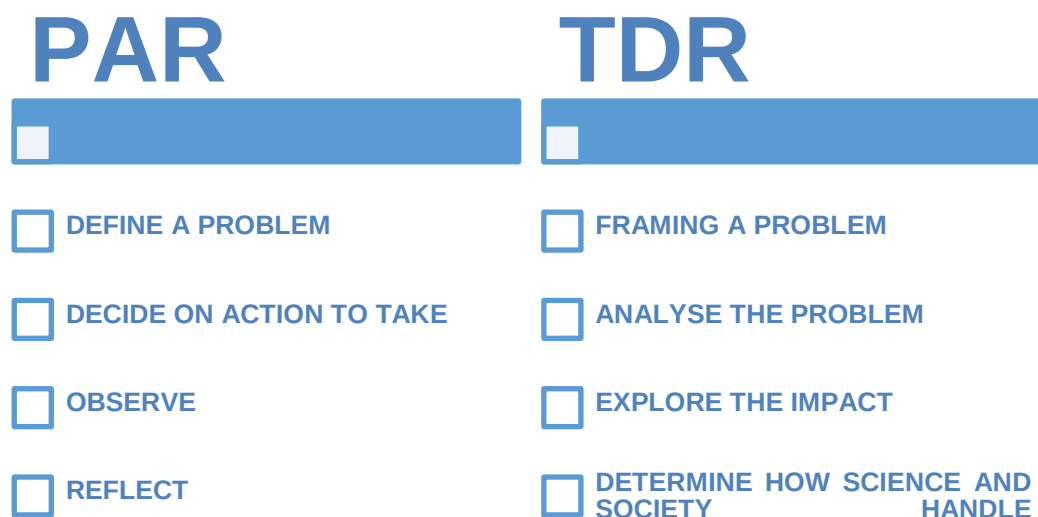


Figure 4.2: The link between PAR and TDR according to Pohl *et.al*.

Source: Pohl, Klein Hoffmann, Mitchel & Fam (2021)

Date of capturing 06.08.2024

Table 4-1: Participatory Action Research (PAR) Cycles and Implementation

PAR Step	Description	Implementation in Current Study
Problem Identification	Informal discussions with stakeholders to define challenges in water/sanitation.	Conducted informal discussions with school principals, governing bodies, and community representatives (p. 26).
Planning	Collaborative design of research objectives and methods.	Held formal meetings with Rustenburg Local Municipality (RLM) officials and school stakeholders to align PAR goals (p. 28).
Data Generation	Collection of qualitative/quantitative data through interviews, observations.	Used semi-structured interviews, GIS mapping (Figure 1.2, p. 20), and documentary analysis of municipal policies (p. 27).

PAR Step	Description	Implementation in Current Study
Analysis	Thematic coding and interpretation of data.	Coded data using NVivo software, identifying themes like "infrastructure decay" and "HRBA gaps" (p. 129).
Action/Development	Co-creating solutions (e.g., frameworks, policies).	Developed the EIWRM framework (p. 193) through workshops with municipal officials and school stakeholders (p. 195).
Reflection	Reviewing outcomes and refining strategies.	Hosted feedback sessions with participants to validate findings and adjust the framework (p. 196).

Source: author's own display

The methodological framework employed demonstrates the cyclical characteristics inherent to PAR implementation *vis-à-vis* water infrastructure. One observes that collaborative mechanisms facilitate stakeholder engagement through systematic procedural iterations. The research paradigm ultimately seeks to address potable water accessibility within schools in Rustenburg's jurisdiction. Data acquisition protocols encompass diverse methodological approaches. Stakeholder insights are sought through informal engagements and empirical observation (De Oliveira, 2023:287-288). This iterative process manifests through the systematic identification of problematic variables and the subsequent recruitment of relevant actors. The paradigmatic framework enables community-centred solution generation through collaborative engagement between diverse stakeholders. Research indicates that PAR methodology facilitates enhanced stakeholder buy-in whilst simultaneously generating pragmatic frameworks for sustainable resource management (Cornish *et al.*, 2023:36). The methodological approach therefore catalyses enhanced community engagement through iterative solution generation. Additionally, PAR is a powerful tool for capacity building and community empowerment. By actively involving respondents in the research process, PAR equips them with knowledge, skills, and confidence to advocate for their needs and participate in decision-making processes affecting their lives and wellbeing (Chevalier &

Buckles, 2019:3). This empowerment is essential for sustainable development, as it enables communities to take ownership of their development and work towards solutions that are both effective and culturally appropriate.

4.4 Research Methodology

To describe fully and investigate the social legal reality surrounding water and sanitation management as contained in the problem statement and aims in Chapter 1 would have called for a qualitative research design. While participatory research includes both quantitative and qualitative methods, these methods are often adapted for the participatory research process (ICPHR, 2013). This was deliberately chosen for its ability to provide rich and in-depth insights into the perception, challenges, and lived experiences of school communities and municipal officials. The follow-up subsections set forth the individual methods used in this research study, which include case study design and data generation techniques deemed appropriate to ensure the depth, context and richness of data gathered for answering research questions. This informs the interpretivist paradigm upon which the present research is grounded, i.e., it seeks to understand the social world from the subjective experience of the participants (De Oliveira, 2023: 287) and thus gives the depth needed in the fulfilment of the study's goals.

4.4.1 Defining Participatory Action Research (PAR)

Participatory Action Research (PAR) represents a collaborative research methodology that actively involves respondents as co-researchers throughout the entire research process. It follows a cyclical model comprising planning, acting, observing, and reflecting phases, aimed at generating knowledge that is both practical and empowering for respondents (Pain *et al.*, 2019:1). The foundational principle of PAR is that those people most affected by a problem are best suited to understand and address it. Therefore, priority is given to the voices and experiences of respondents, simultaneously empowering them to take ownership of both the research process and its outcomes (Chevalier & Buckles, 2019:3).

The essential principles of PAR encompass collaboration, participation, empowerment, and social change (Morales, 2019:317). In contrast to traditional research methods, where the researcher assumes the role of an expert and respondents are treated as

subjects, PAR regards all respondents as co-creators of knowledge (Twalo, 2019:269). This collaborative framework fosters a sense of ownership and empowerment among respondents, which leads to more sustainable and impactful research outcomes. Furthermore, PAR is intrinsically action-oriented, aiming not only to understand a problem but also to implement measures to address it. This emphasis on social change and distinguishing of PAR from other research methodologies renders it an effective approach for tackling complex social issues (May & Perry, 2022:2).

4.4.2 Rationale for adopting Participatory Action Research (PAR)

The choice to implement PAR methodology in this study is justified by several compelling reasons. PAR, as a collaborative and participatory approach, is exceptionally suited to investigate complex social phenomena such as the management of potable water and sanitation infrastructure in schools. It facilitates a deep understanding of the issue by actively involving stakeholders as co-researchers throughout the research process (May & Perry, 2022:3). This participatory approach not only produces rich, contextually relevant data but also empowers stakeholders to take ownership of the research and its outcomes, thereby fostering more sustainable solutions.

PAR is especially beneficial in exploratory research where existing knowledge is limited. It allows for the discovery of new insights and the development of grounded theories through an iterative cycle of planning, acting, observing, and reflecting (Pain *et al.*, 2019:3). This cyclical process ensures that the research design can be adapted and refined as new understandings emerge, maintaining the research's responsiveness to the evolving context and the needs of the respondents. In this study, PAR's exploratory capacity is vital for uncovering underlying factors contributing to the challenges in managing water and sanitation infrastructure in schools. The figure below shows the PAR model used.

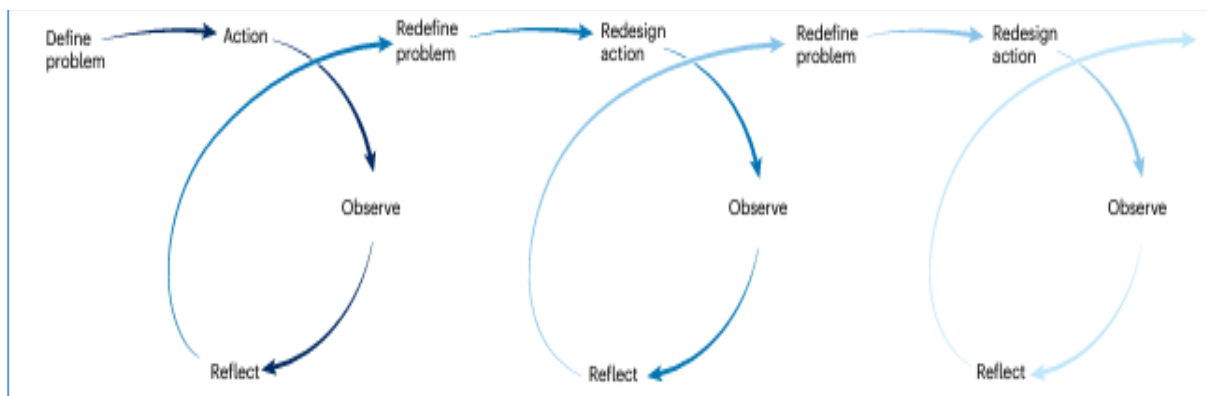


Figure 4.3: Participatory research cycles

Source: Participatory Research Action Research (2023:4)

Furthermore, PAR's emphasis on collaboration and participation fosters a strong rapport between the researcher and respondents. This collaborative relationship is built on trust, mutual respect, and a shared commitment to addressing the research problem (Chevalier & Buckles, 2019:3). It facilitates open and honest communication, leading to richer and more detailed data. The participatory nature of PAR ensures that research findings are relevant and meaningful to the community, as they actively shape research questions, data generation methods, and interpretation of findings.

Additionally, PAR's focus on social change aligns with the study's objectives, which aim not only to understand the challenges in water and sanitation infrastructure management but also to identify and implement solutions. By actively involving stakeholders in the research process, PAR empowers them to become agents of change, resulting in more sustainable and impactful interventions. This action-oriented approach is particularly pertinent in the context of water and sanitation, where the lack of access to these basic services has profound implications for health, education, and overall wellbeing.

4.4.3 Advantages of Participatory Action Research (PAR)

PAR offers distinct advantages. It is a useful methodology for investigating complex social issues, as in the context of water and sanitation management at schools (De Oliveira, 2023:287). One of PAR's primary strengths is its capacity to generate knowledge that is both contextually relevant and empowering for respondents. Unlike traditional research approaches, where researchers often remain detached from their subjects, PAR actively involves respondents as co-researchers, valuing their lived experiences and perspectives

(Wedemeyer-Strombel *et al.*, 2019:1). This collaborative approach ensures that research findings are grounded in the community's awareness of empowering respondents to take ownership of the research process.

A significant advantage of PAR is its focus on social change. It aims not only to understand a problem but also to identify and implement solutions that can bring about positive change in communities (Chevalier & Buckles, 2019:3). This action-oriented approach is particularly relevant in the context of water and sanitation, where inadequate access to basic services profoundly impacts health, education, and overall well-being. By involving stakeholders in the research process, PAR empowers them to become agents of change, resulting in more sustainable and impactful interventions.

Moreover, PAR offers a flexible and adaptable research design. Its cyclical process of planning, acting, observing, and reflecting allows for continuous learning and adaptation throughout the research process (Pain *et al.*, 2019:4). This flexibility is crucial in complex social settings, where unexpected challenges and opportunities may arise. The iterative nature of PAR enables researchers to respond to these dynamics in real time, ensuring that the research remains relevant and responsive to the evolving context.

4.5 Respondents

The research population refers to the total group of individuals from which the sample might be drawn (Levitt, 2021:1). It is a well-defined generation of individuals or objects known to have similar characteristics. All individuals or objects within a certain population usually have a common, binding characteristic or trait. Because it is representative of the target group, researchers must choose a subset of the population (Tracy, 2013). As a result, as a researcher, I found and chose volunteers who were experienced in the water infrastructure field and in touch with the spheres of potable water and sanitation on a daily basis, as in utilisation. Considering their backgrounds and potential contributions to the study, research respondents were chosen and categorised based on the research questions. I then used purposive sampling to choose thirty (30) respondents who were representatives of the Rustenburg Local Municipality (RLM), Education Department, Bojanala Public Works, and community members whose schools were selected for the purpose of this study. To ensure a diverse representation of context, I purposely selected six schools for this study, two from rural areas, two from informal settlements and two

from urban settings. According to Maree (2010), Tracy (2013), and Palinkas *et al.* (2013), purposive sampling is a non-probability sampling technique in which respondents are chosen based on their responsibilities and levels of knowledge about a study's subject. One example of purposive sampling is expert sampling, which calls for a researcher who wants to fully understand the information provided by respondents with specialised knowledge. Subsequently, the researcher also chose respondents by determining their backgrounds in potable water and sanitation infrastructure management from their time in the Rustenburg Local Municipality (RLM). The respondents were engaged in extensive informal discussions and were expected to share their thoughts and experiences in the context of potable water and sanitation infrastructure management to make the greatest possible contribution to the research study. I received information from the respondents that supported the study's purpose and goals. Below is a table with the respective respondents and their numbers.

Table 4-2: List of Respondents

Type of Respondent	Number	Justification
Principals of selected schools	Six	Principals, as school leaders, have first-hand experience with the challenges of managing water and sanitation infrastructure within their schools. Their insights are crucial for understanding the practical implications of these challenges on the school environment and learning.
Governing body chairpersons of selected schools	Six	Governing body chairpersons represent the community's interests in school governance. Their perspectives are essential for understanding community perceptions and expectations regarding water and sanitation provision in schools, as well as their role in advocating for improved services.
Teachers, one from each selected school	Six	Teachers directly experience the impact of inadequate water and sanitation facilities on their teaching and their learners' learning. Their insights are valuable in understanding the practical challenges faced in the classroom and the potential consequences for educational outcomes.

Type of Respondent	Number	Justification
Water and Sanitation Services Manager of Rustenburg Local Municipality (RLM)	One	The Water and Sanitation Services Manager is responsible for planning and implementation of water and sanitation services in the municipality. His experience and participation in the research are crucial for understanding policies, strategies, and challenges faced by the local authority in providing municipal services to schools.
GIS Specialist of water and sanitation in Rustenburg Local Municipality (RLM)	One	The GIS Specialist possesses technical expertise in mapping and analysing water and sanitation infrastructure. Mapping insights are valuable for understanding the spatial distribution of water resources and infrastructure, identifying areas of need, and informing potential solutions.
General workers at the Infrastructure Unit in Rustenburg Local Municipality (RLM)	Two	General workers are directly responsible for the installation and maintenance of water and sanitation infrastructure. Their perspectives have shed light on understanding the practical challenges and limitations in implementing and maintaining these services at schools.
Unit Manager at the Department of Public Works in Bojanala District	One	The Unit Manager oversees the maintenance of school facilities, including water and sanitation infrastructure. His perspective is important for understanding the challenges and constraints faced in maintaining these facilities and ensuring their proper functioning.
General workers at Bojanala Public Works	Two	Like the general workers at the Infrastructure Unit, these workers are directly involved in the maintenance of school facilities. Their perspectives provide insights into the practical challenges and limitations in maintaining water and sanitation infrastructure in schools.
Director at Bojanala Department of Education responsible for school infrastructure	One	The director is responsible for overseeing school infrastructure development and maintenance. The perspective is crucial in understanding the policies, strategies, and challenges faced by the Department of Education in ensuring adequate water and sanitation facilities at schools.

Type of Respondent	Number	Justification
Community Members	Four	Community members are directly affected by the local water and sanitation situation at schools. Their perspectives are essential for understanding community perceptions, needs, and expectations regarding these services, as well as their potential role in advocating for and participating in solutions.
Total	30	

4.6 Recruitment

Recruitment in a Participatory Action Research (PAR) project on water and sanitation management in schools should be inclusive and strategic to ensure meaningful engagement of all relevant stakeholders. Key participants would include school staff (principals, teachers, and maintenance personnel), community members of the surrounding school, parents, and representatives from the local Department of Education and or environmental services. Selection should be based on both their lived experiences and their potential to contribute to identifying problems and co-creating solutions. Emphasis must be placed on involving those directly affected by poor water and sanitation conditions, such as schools and surrounding communities, who often face additional challenges related to hygiene and dignity. Recruitment methods may include invitations during school meetings, workshops, or through existing school communication channels, ensuring voluntary participation and informed consent.

It is essential that the recruitment process reflects the values of PAR, particularly inclusivity, collaboration, and empowerment. Participants should be made aware that they are not simply subjects of research but co-researchers whose knowledge, opinions, and actions will shape the project's direction. Efforts should be made to create safe spaces for participation, especially for learners, to voice concerns without fear of judgment or reprisal. By carefully selecting and supporting a diverse group of participants, the research can yield context-specific insights and foster sustainable improvements in potable water and sanitation practices within the school community.

4.6.1 Defining recruitment

Recruitment represents a fundamental aspect of any research study, entailing the selection of a subset of individuals from a larger population to participate in a study (Clark *et al.*, 2023:4). This step in the research process has a direct influence on the degree to which the researcher can apply the results of the study to a broader context and validity of the study findings (Thomas, 2022:2). The objective of recruitment is to secure a representation that accurately mirrors the characteristics of the population of interest (Campbell *et al.*, 2020:653). The table above represents the recruitment frame from which the study respondents were drawn.

4.6.2 Purposive recruitment

This study employs purposive recruitment, a non-probability recruitment technique. Purposive recruitment, also referred to as judgmental or selective recruitment, involves the deliberate selection of respondents based on specific characteristics or qualities (Cooksey *et al.*, 2019:827). This method proves particularly useful when a specific subset of a population is to be studied. In such cases, judgment is used to select respondents who are most representative or informative about the phenomenon under scrutiny (Palinkas *et al.*, 2019:423).

Purposive recruitment offers several advantages for this study. First, it allows for the selection of respondents who have rich and relevant information about the phenomenon under study. It enhances the depth and quality of data collected (Campbell, Greenwood, Prior, Shearer, Walkem, Young & Walker, 2020:652). Second, it enables a focus on specific characteristics of the population that are pertinent to the research question, thereby improving the efficiency of the study. Last, it facilitates the exploration of complex phenomena within contexts, aligned with the objectives of this study (Palinkas *et al.*, 2019:423).

The data generation process for research studies involves several steps to ensure the ethical and effective gathering of information. Prior arrangements with potential respondents are crucial to the success of the data-gathering process (De Jockheere & Vaughn, 2019:1). These arrangements involve identifying potential respondents, reaching out to them, and scheduling a time for data generation. This step is important.

It allows for the establishment of a bond of trust between the researcher and the respondent, leading to more honest and comprehensive responses. It also allows respondents to prepare for the data generation process, ensuring they are in the right frame of mind and have allocated sufficient time for the process (Wray, 2022:44).

Once contact with respondents has been established, the next step is to explain the research study. This involves providing respondents with an overview of the study, its purpose, and what their participation will entail. The researcher should also discuss the potential risks and benefits of participation, ensuring the respondents are fully informed before they agree to participate. This process is often formalised using a respondent consent form, which respondents sign to indicate their understanding and agreement to participate (Wray, 2022:45). Informed consent is a key element in ensuring the ethical character of any research involving human subjects. It involves three elements: validity, communication of information, and deliberation. The process of obtaining informed consent must be accompanied by the administrative procedure for completing a consent form signed by both the respondent and the researcher (Moreira, Miguel & Frade, 2022:55).

4.7 Data generation

4.7.1 Data generation techniques

Data gathering is a systematic process of collecting and measuring information on variables of interest in an established and organised manner. This process enables researchers to answer research questions, and evaluate outcomes (Wray & Barrett, 2022:44). As a critical aspect of any research study, the accuracy of data gathering methods can significantly influence the study's results and potentially lead to invalid conclusions, if not conducted properly (Johnson, Adkins & Chauvin, 2020:2). Therefore, it is essential that data gathering methods must be planned, while also providing for the opinions and insights of research respondents to be given priority (Ekoto, Zubkov & Asok, 2022:345-346).

According to Gray (2014), obtaining the respondents' unfiltered information on potential solutions to the study's issues is part of the data generation process. Among the traits of PAR data gathering techniques include their propensity for informal discussion and less

organised protocols, their increased dependence on interactive informal discussions, and the fact that conclusions cannot be extrapolated to any particular group (Greeff, 2010; Mare, 2010) This research study used two forms of data gathering techniques: primary and secondary data generation methods:

4.7.1.1 Primary data generation

The researcher conducted in-depth, informal discussions with the selected respondents to gather primary data. The researcher was able to delve further into each respondent's opinions, emotions, and experiences, thanks to the informal discussions (Cath *et al.*, 2017). The informal discussion questions and discussions were formulated by the researcher in a way that allowed respondents to answer all questions, allowing the researcher to comprehend responses (Creswell & Creswell, 2017). The target population of this research study is then outlined in Table 4-1.

Informal discussions were conducted with 30 respondents. These respondents were recruited by highlighting the significance of the study about the management of potable water and sanitation infrastructure at some schools in Rustenburg Local Municipality (RLM) and how their involvement would result in findings that would assist in the municipality's management of potable water and sanitation infrastructure for healthy living, as described in the Constitution.

4.7.1.1.1 Informal discussions

In this research study, informal discussions were used as primary data generation method. Informal discussions, while somewhat structured, are guided by a broad set of open-ended questions, allowing the researcher the flexibility to delve deeper into specific areas of interest (Swain & King, 2022:2). This method facilitates an in-depth exploration of respondents' perspectives and experiences and provides opportunities for the informal discussion to probe for more detailed information and clarification (Swain & Spire, 2020:1).

There are several advantages to using informal discussions in research. Firstly, they allow for a comprehensive understanding of respondents' experiences and perceptions, particularly useful when exploring complex or sensitive issues (Swain & King, 2022:2). Secondly, the flexibility inherent in informal discussions enables the researcher to adapt

the informal discussion guide to each respondent, potentially uncovering new information, not anticipated at the study's outset (Deterding & Waters, 2021:708). Lastly, informal discussions can help establish rapport between the researcher and respondents, leading to more honest and detailed responses (Brown & Danaher, 2019:76).

The discussions in this research study were conducted personally through direct face-to-face communication between the formal respondent and the informal respondent. A tape recorder was used and after getting the appropriate permission, the recordings were later transcribed. This method allows for a more personal connection and understanding, as the informal respondent can observe non-verbal cues and adjust the informal discussion process based on the respondent's reactions and responses (Jain, 2021:541). Conducting informal discussions personally offers several advantages, including the ability to establish rapport, the opportunity to clarify and probe responses, and the capacity to observe non-verbal cues (Goyes & Sandberg, 2024:1).

4.7.2 Secondary data generation

Secondary data generation is the process of obtaining and evaluating information that has previously been gathered by others, as opposed to first hand data generation (Brown & Danaher, 2019). The first steps in this research study process usually involve determining the goals of the study and identifying pertinent data sources, including publications, scholarly studies, observations, reports, organisational records, and internet databases. After that, the correctness, relevance, and reliability of the data are assessed to make sure it serves the intended purpose in the research study. Search engines and digital archives are two examples of technological tools that are frequently crucial for maintaining and gaining access to secondary data. In this research study, the Rustenburg Local Municipality (RLM) Integrated Development Plan and Potable Water and Sanitation Infrastructure Management Policy assessment served as the secondary data gathering method. The review by the researcher of written materials, which can include personal and non-personal papers such as archives, annual reports, and policy documents, is one component of a typical document review study (Mohajan, 2018).

To comprehend the challenges of the Rustenburg Local Municipality (RLM)'s developing potable water sanitation infrastructure management, the researcher reviewed the documents. This was also done to find out how much the Rustenburg Local Municipality

(RLM) encourages, controls, and influences how potable water and sanitation infrastructure assets are used in a municipality. Consequently, the researcher was able to obtain historical data regarding potable water and sanitation infrastructure management. The researcher used such a review to confirm the information obtained from the informal respondents.

4.7.2.1 Observation

The observation of the municipality's potable water and sanitation infrastructure management systems served as a source of secondary data for this research study. The potable water and sanitation infrastructure management system selected was observed at first hand, as well as online. Attention was given to how the municipality manages infrastructure, from data conversion and upload to analysis and report generation. The literature review served as an additional secondary data gathering approach, providing evidence to back up respondents' statements, as well as reporting on wastewater treatment and potable water systems. According to Lapan *et al.* (2012) and Rubin and Rubin (2012), the literature review broadens an examination of secondary sources to address the study's salient issues. In this study, secondary sources were useful to determine what has been done in the field of water and sanitation at schools in South Africa, and elsewhere. These sources provided a key to relevant observations to look for in the Rustenburg area.

Observation offers several advantages. It also allows for the generation of data that might not be easily captured through other methods such as informal discussions or surveys. Non-verbal cues, interactions, and behaviours of respondents may not be consciously aware of, or do not accurately report on, can then potentially be observed and recorded (Mulisa, 2022:113). Secondly, observation enables understanding of the context in which behaviours or events occur. It provides a richer understanding of the phenomenon under study (Raskind *et al.*, 2019:32). Thirdly, it allows for the study of processes over time, which can be particularly useful in understanding changes and dynamics in the field of research study.

In the context of this research study, observation complements the informal discussions by providing an additional layer of data for cross-checking and validation, a process known as triangulation (Natow, 2020:160). The use of observation as a data gathering

technique in this research study does not only provides a more comprehensive and exquisite understanding of the phenomena under study but also enhances the credibility and validity of the research findings through triangulation. In the research study, observational procedures were followed to take note of the position of water points on the premises of the schools visited. Attention was also given to the situation within the schools regarding the supply, use and management of water. By capturing data from multiple angles, observation enriches the overall dataset and ensures a better analysis and interpretation of the research outcomes (Coleman, 2022:2041). An observation checklist, appended as an annexure, was used to collect the observation data.

4.7.2.2 Document analysis

One of the data generation methods used in this study is document analysis. One observes, through careful deliberation, that the methodological approach towards document analysis necessitates a nuanced understanding of both digital and textual artefacts (Asdal & Reinertsen, 2021:3). Whereas qualitative research paradigms demonstrate inherent complexities, document analysis facilitates triangulation with observational data points and informal discussion narratives, thus enabling comprehensive phenomenological understanding (Creswell & Poth, 2018:186). In accordance with established protocols, researchers must employ varied cognitive processes, including superficial examination, thorough perusal, and hermeneutic interpretation, to extract salient thematic elements pertinent to the research objectives (Kuckartz & Rädiker, 2023:4).

The investigative scope encompassed diverse documentary sources pertaining to potable water accessibility and sanitation infrastructure within the selected schools of Rustenburg Local Municipality's (RLMs) jurisdiction. Through conformity to the examination of departmental policies, legislative frameworks, including the National Water Act, and municipal documentation such as Integrated Development Plans, one may clearly explain systemic patterns. Various institutional records, maintenance documentation, inter-organisational correspondence, and facility-specific reports were subjected to thorough analysis. Contemporary academic discourse, civil society publications, and documented community deliberations regarding water provision will

undergo scrutiny to facilitate a more comprehensive understanding of the phenomenon being studied.

Document analysis demonstrates considerable methodological advantages whilst complementing alternative data acquisition strategies employed herein. The methodology enables historical contextualisation and verification of empirical evidence through triangulation protocols (Morgan, 2022:64). Furthermore, documentary analysis reveals macro-level policy implementation differences that might direct observational methodologies or respondent narratives. Thus, this approach bridges the empirical, facilitating a holistic comprehension of potable water and sanitation infrastructure management operationalisation within educational contexts (Wood, Sebar & Vecchio, 2020:456).

4.7.3 Data analysis

Primary data analysis is the process of examining first-hand information gathered by techniques like surveys, experiments, or observations, for a given research project (Creswell & Poth, 2018). Although it can be expensive and time-consuming, data analysis gives the researcher more control over data generation, procedures and guarantees. Importantly, the data are in line with the goals set at the time of observation. This information reflects insights gained at the time of information collection (Creswell, 2009). Using pre-existing data gathered by others for distinct objectives, such as for the purposes of government reports, scholarly research, or databases, may conflict with secondary data analysis in pursuit of different goals. Secondary analysis provides less control over the breadth and quality of the data, which may limit its applicability to the researcher's particular needs, despite it being quicker and more economical to use.

Annexure D provides the matrix of the data collection tools, research questions, same interview questions and the analysis methods used to demonstrate the relevance of the research questions to the study research.

Table 4.3: Summary of data generation, analysis linked to research questions matrix

DATA GENERATION TECHNIQUE	DATA ANALYSIS	RESEARCH QUESTION ANSWERED	SAMPLE INTERVIEW QUESTIONS POSED TO RESPONDENTS
Informal Discussions; Documentary Analysis	Thematic & Content Analysis	RQ1: What is the fundamental link between a Human Rights-Based Approach (HRBA) and effective service delivery in the management of potable water and sanitation at schools?	1. (To Municipal Officials) In your view, is the provision of water and sanitation to schools a service or a basic human right that the municipality is obligated to fulfil? 2. (To School Principals) Do you feel that the school community is aware of and empowered to claim their right to safe and clean water from the local municipality? 3. (To all respondents) How do you think a focus on human rights could change the way water and sanitation services are prioritised and delivered to schools?
Informal Discussions	Thematic Content Analysis	RQ2: How do school communities perceive the current management practices regarding potable water supply and sanitation infrastructure provided by Rustenburg Local Municipality (RLM)?	1. (To Teachers/Principals) Can you describe the typical process you follow when you report a fault, like a burst pipe or a blocked toilet, to the municipality? How responsive are they? 2. (To School Governing Body) How does the municipality communicate with the school regarding planned water interruptions or the maintenance schedules for sanitation facilities? 3. (To community members) From your perspective, who is truly responsible for ensuring that the school has a consistent supply of clean water and functional toilets?
Informal Discussions; Documentary Analysis	Thematic Content Analysis	RQ3: What is the technical capacity of Rustenburg Local Municipality (RLM) in	1. (To Municipal Officials) What are the main challenges that hinder water provision to schools based on your current water infrastructure assets? 2.

DATA GENERATION TECHNIQUE	DATA ANALYSIS	RESEARCH QUESTION ANSWERED	SAMPLE INTERVIEW QUESTIONS POSED TO RESPONDENTS
		providing consistent and adequate potable water and sanitation infrastructure services to schools?	(To Municipal Officials) With the current challenges of load-shedding, how does it affect the functioning and condition of the water management assets that service the schools? 3. (To Municipal Officials) Do you believe Public Works has sufficient infrastructure assets and skilled personnel to deal with potable water and sanitation emergencies in all the schools you service?
Informal Discussions; Observation	Thematic Content Analysis & Observational Analysis	RQ4: What specific challenges do schools within Rustenburg Local Municipality (RLM) encounter regarding the provision and management of potable water and sanitation services?	1. (To School Principals) Can you describe the most significant water-related challenge you face at this school on a weekly or monthly basis? 2. (To Teachers) How does the state of the sanitation facilities, the toilets and hand-washing stations, impact the daily school life and hygiene of the learners? 3. (To all respondents) In your experience, what is the single biggest obstacle to having reliable water at this school , is it funding, ageing infrastructure, water scarcity, or poor maintenance?
Informal Discussions; Documentary Analysis	Thematic Content Analysis	RQ5: Which service delivery mechanisms can be identified and recommended to effectively improve the potable water supply and sanitation infrastructure at schools?	1. (To Municipal Officials) Based on the challenges mentioned, what are the best strategies or solutions that can be used to better manage water infrastructure assets for schools? 2. (To School Governing Body) What role could the school community and parents play in partnership with the municipality to improve the management of water and sanitation resources? 3. (To all respondents) In

DATA GENERATION TECHNIQUE	DATA ANALYSIS	RESEARCH QUESTION ANSWERED	SAMPLE INTERVIEW QUESTIONS POSED TO RESPONDENTS
			your opinion, what is the one thing that should be done differently to ensure the present water system is made more sustainable and is managed efficiently in schools?
Documentary Analysis; Informal Discussions	Content Analysis & Thematic Analysis	RQ6: What guidelines should be proposed for developing a school environmental policy that effectively integrates and supports water and sanitation education into the existing curriculum?	1. (To Teachers) Do you feel the current curriculum (CAPS) provides enough practical opportunities to teach learners about water conservation, hygiene, and their rights? 2. (To School Principals) How could a formal, written school policy on water and sanitation help you and your staff manage these resources and educate learners more effectively? 3. (To all respondents) What topics or activities do you believe are most important to include in an educational program for learners about protecting and conserving water at school and at home?

Source: author's own

"Data analysis is the process of providing order, structure, and meaning to the mass of acquired data," according to Schurink *et al.* (2011:397). "The process of data analysis entails creating sense out of text and picture data," according to Creswell (2009:182). This entails delving deeper into the data to prepare it for analysis. Since the researcher anticipated that the PAR would be extensive, the data had been properly analysed to gain insight and advance knowledge (Tracy, 2013). I employed thematic analysis to examine the data for the research study. The process of encoding qualitative data, known as thematic data analysis, involves the researcher creating codes, words, or phrases that function as labels for data selection (Miles *et al.*, 2014; Merriam & Tisdell, 2016). I arranged the information gathered following the informal discussions.

To fully comprehend and confirm the information provided by the respondents, I listened to the audio recordings of the informal discussions several times while noting all the points in a book. The audio recordings made sure that I did not overlook anything important. I always consulted the audio recordings to confirm the information stated after realising that there was something I did not understand (Berazneva, 2014). I numbered and labelled each respondent's data and arranged it in file folders according to the four kinds of informal discussion questions that were previously indicated. He used the data to establish links between categories and find associations between codes once the data had been categorised according to its themes (Schurink *et al.*, 2011:413).

To maintain confidentiality, the researcher assigned each respondent a number rather than disclosing names. This supported the claim made by Moore and Liompart (2017) that following a process of textual data analysis, respondents must be given an identity code. The purpose and goals of the study served as a guide for the researcher when transcribing the data. After familiarising myself with the data through multiple readings of the transcript, I began the coding procedure. To create a narrative within a data set, I made sure the data was within the parameters of the study's purpose and objectives (Stuckey, 2015).

Baralt (2017) and Schurink *et al.* (2011) propose that coding is a way to organise and sort data. This procedure enables the compilation and arrangement of material in a way that facilitates comprehension. Prior to starting the analysis for this study, I typed up the raw data that I gathered. By arranging the data into words and phrases, I were able to manage the data more simply. To give the data legitimacy, he incorporated direct quotes from the respondents into the data analysis and conversations.

4.7.4 Thematic analysis

Thematic analysis is a widely used method in qualitative research that involves identifying, analysing, and interpreting patterns or themes within data (Braun & Clarke, 2006). In the context of water and sanitation management in South African schools, thematic analysis provides a structured way to explore the experiences and perceptions of key stakeholders such as learners, teachers, and support staff. Through coding and categorising qualitative data such as interviews, focus group discussions, and observation notes, researchers can uncover recurring issues such as poor infrastructure,

inadequate hygiene education, lack of menstrual hygiene support, and safety concerns. These themes not only highlight practical challenges but also provide insights into how these issues affect dignity, health, and learning outcomes (Department of Basic Education, 2019).

Using thematic analysis in my research study allowed me to make sense of complex and context-specific challenges systematically. For example, themes such as “broken and locked toilets,” “unequal access to hygiene facilities,” and “learner-led solutions” emerged, each pointing to gaps in service delivery and school management. These findings were used to inform actionable recommendations tailored to the needs of the school community. Thematic analysis is particularly valuable in participatory action research because it centres the voices of participants, making their experiences the foundation for reflection and change (Nowell *et al.*, 2017). In this way, the method contributes to a deeper, more inclusive understanding of water and sanitation issues in South African schools.

4.7.5 Content analysis

Content analysis was employed to analyse secondary data. Content analysis is a research method used to identify patterns and themes within and across documents, and to interpret the meaning of these thematic patterns (Selvi, 2019:440). It involves coding and categorising the data to reveal prevalent ideas or concepts. Within the context of the current study, content analysis is advantageous as it provides a systematic and objective means of describing phenomena. This method is beneficial in analysing large volumes of textual information, where it can help identify trends, patterns, and relationships among the data (Lindgren, Lundman & Graneheim, 2020:2).

By employing these complementary analytical methods, this study aims to provide an interpretation of the data, ensuring a comprehensive understanding of the management of potable water and sanitation infrastructure in the selected schools of Rustenburg Local Municipality (RLM). The combination of thematic and content analysis allows for a thorough exploration of both informal discussion data and secondary literature, enhancing the overall reliability and depth of the research findings.

4.8 Research quality

Ensuring research quality in action research on water and sanitation management in schools requires careful attention to various forms of validity that align with the participatory and transformative nature of the study. Process validity is essential, as it ensures that the research cycle, planning, acting, observing, and reflecting, is carried out rigorously and ethically, with active involvement from all stakeholders. Participatory validity strengthens the research by valuing the knowledge and experiences of schools' management, teachers, support staff, and communities who are directly affected by water and sanitation issues. Dialogic validity is achieved through open discussions and collaborative reflection, which help to co-construct meaning and ensure that multiple perspectives are represented. Outcome validity assesses whether the research leads to practical, sustainable improvements in school sanitation and hygiene practices. Lastly, catalytic validity is crucial in determining whether the research process has empowered participants, deepened their understanding, and motivated further action. Together, these forms of validity help ensure that the research is credible, inclusive, and impactful in addressing real-world challenges.

4.8.1 Validity

Research validity pertains to the extent in which a study accurately addresses its intended research question, ensuring that the research design, methods, and analyses are suitably aligned to achieve reliable and credible outcomes (Rose & Johnson, 2020:432). It also pertains to the degree to which a research study accurately addresses the research question it was designed to answer (Bolarinwa, 2015). It serves as a measure of the suitability of the research design, methods, and analyses in responding to the research question. As described by Bolarinwa (2015), validity is categorised into seven types: Democratic Process Validity, Creating Communicative Space for Dialogue, Participatory Validity, Process Validity, Dialogic Validity, Outcome Validity and Catalytic Validity

4.8.2 Democratic Process Validity

According to democratic validity, research should represent the many viewpoints and opinions of people who are directly involved in the investigation. The validity of the study is increased and results are guaranteed to reflect collective ownership of knowledge

rather than being dominated by a single authoritative viewpoint by involving participants in decision-making (Herr & Anderson, 2005).

4.8.3 Creating Communicative Space for Dialogue

Establishing a communicative space as a means of establishing validity guarantees that participants have an equal and transparent conversation in which concepts can be discussed and improved without dominance. This method, which draws inspiration from Habermasian principles, fosters inclusive discussions that advance knowledge and open the door to more genuine and revolutionary research findings (Kemmis, 2001).

4.8.4 Participatory Validity

The active participation of participants at every stage of the research process, from problem definition to result analysis, is essential to participatory validity. By recognizing participants as co-creators of information rather than passive subjects, this method promotes empowerment and increases the research's relevance and applicability (Reason & Bradbury, 2008).

4.8.5 Process Validity

Process validity pertains to the honesty and reliability of the actual research process, emphasizing whether the investigation is carried out thoroughly and in accordance with its objectives. This validity improves the study's overall reliability and enhances the trustworthiness of the results by making sure that the techniques are both flexible and systematic (Herr & Anderson, 2005).

4.8.5.1 Dialogic Validity

Peer review and critical discussion throughout the study process are essential for dialogic validity because they allow researchers to improve their interpretations through helpful criticism. According to Lincoln and Guba (1985), these dialogic interactions promote reflexivity, lessen bias, and guarantee that conclusions are influenced by group reflection rather than individual presumptions.

4.8.5.2 Outcome Validity

Whether the research results in significant and useful change for the participants and their environments is the focus of outcome validity. Outcome validity demands that the study solve practical issues or enhance procedures in ways that directly benefit persons involved, rather to only producing theoretical insights (Anderson & Herr, 1999).

4.8.5.3 Catalytic Validity

The transformational potential of research is the main emphasis of catalytic validity, which evaluates whether it encourages participants to critically examine their situation and take action toward change. It honors the emancipatory aspect of research, in which information is not only produced but also acts as a stimulant for social change and empowerment (Lather, 1991).

4.8.6 Credibility

Credibility and Trustworthiness guarantee that the results accurately represent respondents' lived experiences, hence they are included as criteria of validity in participatory action research. Participatory approaches emphasize authenticity and collaborative meaning-making, which demand high credibility, in contrast to traditional research, which places a higher priority on objectivity. By proving that interpretations are reliable, consistent, and jointly developed with participants, trustworthiness also protects the research process. By bringing knowledge production into line with democratic and ethical ideals, these standards strengthen the validity

Credibility pertains to the trustworthiness of research findings. It evaluates how accurately the findings represent the data collected (Creswell & Guetterman, 2019:261). Credibility can be enhanced by employing several research methods, ensuring respondents are representative of the studied population, and providing a comprehensive and accurate description of the research context and procedures (Leavy, 2023:170).

4.8.7 Trustworthiness

Trustworthiness relates to the quality and integrity of the research process and findings. It measures how well the research has been conducted and how well the findings are supported by the data (Munthe-Kaas, Nøkleby, Lewin & Glenton, 2020:2). Enhancing

trustworthiness involves maintaining a clear record of all research activities and decisions, using rigorous methods, and offering a detailed and accurate description of the research context and procedures (Leavy, 2023:168).

4.9 Ethical considerations

The research was conducted following ethical guidelines. "A set of moral principles which are suggested by an individual or group, subsequently widely accepted and which offer behavioural expectations about the most correct conduct towards experimental subjects and respondents' employers, researchers, assistants, and learners" is how Strydom (2011:114) defines ethics. Fleming and Zegwaard (2018) stress that a research ethics committee must approve the data generation procedure prior to the commencement of respondent data generation, because approval cannot be granted after data generation has begun

4.9.1 Ethical care of respondents

Securing the approval to conduct research will happen in several stages. First, consent was sought from the relevant scientific committee at North-West University. This was followed by approval from the Ethics Committee. After that, consent was sought from the DBE and then from principals of participating schools. Lastly, consent was sought from the participating schools, the local municipality, and the public works. The research respondents received a Consent Form that provided additional details about the study's purpose and objectives. An Ethical Clearance letter, and a Permission letter from the Rustenburg Local Municipality (RLM), Department of Education and Bojanala Public Works formed part of the ethical clearance process. These documents served as evidence of the study's validity and authenticity. Informed consent is a contract that is signed at the beginning of the research study, according to Human-Vogel and Coetzee (2011). According to Strydom (2011:117), the individual providing consent will depend on the primary respondent at that specific time. All approvals were secured from the parties mentioned and appended, in basic format, as an annexure to the thesis.

Securing approval from the appropriate NWU ethics committee was a prerequisite for initiating any research, particularly those involving artificial intelligence. This committee ensured that the proposed research adhered to the ethical guidelines and principles

established by the institution and the wider academic community (Jobin, Ienca & Vayena, 2019:389). As a rule, the committee's role encompasses reviewing the research proposal, including the methodology and the potential impact of the research on human subjects and society. This process is integral to maintaining the integrity of the research and ensuring alignment with the ethical standards of the university and the field of study (Hagendorff, 2020:99).

The principle of voluntary participation is fundamental to research ethics. It mandates that respondents engage in research willingly, without any form of compulsion or undue influence (von Kriegstein & MacDonald, 2024:50). This principle is especially crucial in educational research, where individual data may be utilised. Respondents must have the autonomy to decide whether to participate and the freedom to withdraw at any point without facing any adverse consequences.

The respondents will sign consent forms, which, amongst other things, indicate that they were briefed about the research and participated voluntarily.

Informed consent is a cornerstone of ethical research, requiring that potential respondents receive comprehensive information about the study. This includes the research's purpose, procedures, potential risks and benefits, and respondents' rights (von Kriegstein & MacDonald, 2024:52). The information should be conveyed clearly and understandably to enable respondents to make an informed decision about their involvement. Ensuring that consent is genuinely voluntary and free from compulsion or deception is paramount (Dabrock, 2020).

Anonymity is critical in the study, particularly when dealing with sensitive information. Researchers must ensure that data collected cannot be traced to individual respondents. Techniques such as removing identification information from the data and fictitious names were employed to protect respondents' privacy, thereby minimising the risk of harm, including identity theft or confidentiality breaches (Hofy, 2022:223).

Confidentiality involves safeguarding respondent information from unauthorised access or disclosure. Every person has the right to privacy, according to Strydom (2011:119), and they have the freedom to choose how, when, where, and to what degree their attitudes, beliefs, and behaviours are made public. The researcher will always protect the

respondents' identities and privacy, and will act sensitively when subject privacy is at stake. Given the extensive data often involved in research, maintaining confidentiality can be challenging. Researchers must implement secure data storage solutions and strict data access policies to ensure that only authorized individuals can access the data (Dash, Sharma & Ali, 2022:1). When disclosures were made at the time of informal discussions, because of the sensitive nature of the investigation, I opted to code the name(s) of persons who chose to remain anonymous. It could then be KMPA, Confidential disclosure (CD) and date.

Researchers must consider and mitigate the potential for harm in their studies. This includes both physical and psychological harm, such as stress or discomfort from participation. Efforts should be made to minimise these risks. Potential hazards must be clearly communicated to respondents during the informed consent process (Shaw, 2022:1).

Non-financial incentives can effectively encourage participation in research. These may include opportunities to contribute to knowledge advancement, learn about specific topics, or receive feedback on research findings. It is essential to ensure that these incentives do not unduly influence individuals to participate against their better judgment (Różyńska, 2022:449).

4.9.2 Ethical care of data

Data storage is a significant ethical consideration in research. Researchers must secure data to protect respondents' confidentiality and privacy, often using encrypted storage systems and strict access policies. Additionally, the duration of data storage should be communicated to respondents during the informed consent process (Dash, Sharma & Ali, 2022:4).

4.9.3 Ethical communication of research results

Communicating research results to respondents is important. Respondents have the right to be informed of the study's outcomes. This should be done in a manner that maintains respondents' anonymity and confidentiality. Researchers should also transparently communicate the potential implications of the findings, whether positive or negative (Schöpfel, Azeroual & Jungbauer-Gans, 2020:2).

4.10 Elements of ethical quality

Trustworthiness can be defined as a set of principles established to examine the consistency of the study, according to Bryman (2012:717). By doing this, the researcher can make sure that the work exhibits accuracy, conformability, integrity, and transferability (Sussane, 2012:1). Credibility, transferability, reliability, and conformability are all components of trustworthiness. The same in-depth informal discussions were used to informal discussion the carefully selected respondents, and adequate time was allocated to them to ensure the study's trustworthiness. Believability, correctness, truthfulness, and reliability are all procedures to be considered while employing credibility to assess the calibre of data gathered, according to Ahmad and Jan (2018).

Informal discussions were audio recorded with respondents' consent to capture the verbatim responses to preserve credibility. This gives the researcher complete faith and confidence in the data. Kennedy-Clark (2012) asserts that confirmability ensures that the research's conclusions are the result of respondent thoughts rather than those of the researcher. To verify the objectivity of the data in this research study, I made sure that the conclusions drawn from the data analysis reflected the opinions and thoughts of the research respondents and that the data was not tampered with or changed. This was done to verify its legitimacy.

4.11 Quality of the findings

Obtaining high-quality knowledge and using inquiry to explain the phenomenon are the primary goals of the research study (Tracy, 2010). The informal discussion questions were designed by the researcher so that respondents could easily comprehend and respond to them without difficulty. According to Neuman (2014:212), validity pertains to the veracity of the research. The data supplied represents the concerns being investigated because the data gathered during in-depth informal discussions and document reviews were in line with the study's goals and objectives to validate the data analysis.

4.12 Limitations of the study

One of the limitations of this research study was that the researcher had to postpone the informal discussions along the way since respondents were not keeping to scheduled

times and dates. However, the researcher persevered and was patient with the individuals in spite of the limitations.

4.13 Chapter conclusion

The study was led by a research technique that has been described in this chapter. The study employed an interpretative research paradigm to gain a thorough understanding of the management of potable water and sanitation infrastructure by interacting with respondents, who are workers of the Department of Education, Bojanala District Public Works, Rustenburg Local Municipality (RLM) and local community members where the schools are located. A PAR approach was employed. Document studies, literature reviews, in-depth informal discussions, and observations of the municipality's infrastructure asset management systems were used to gather data. Thirty (30) respondents were chosen by non-probability sampling with an emphasis on purposive sampling, and their signed consent was used to conduct informal discussions and capture audio. Additionally, covered in this chapter was the process of creating themes and codes through the use of thematic analysis to process the data. This chapter also emphasised that the research investigation was carried out following approval of the ethical clearance.

This chapter outlined the research methods employed to gather empirical data for the study. The application of a PAR methodology in this research study offers an adaptable framework for exploring complex phenomena under investigation. By using informal discussions and observation as data generation techniques, the study facilitates a deep, delicate understanding of respondents' experiences and perceptions. Thematic and content analysis techniques were employed to identify patterns and themes within the data, yielding valuable insights pertinent to the research question. The outlined ethical considerations ensured the safeguarding of respondents' rights and the integrity of the research process (Creswell & Poth, 2018).

The findings from this study could potentially enhance the existing body of knowledge by providing a comprehensive understanding of the phenomenon under investigation. Insights derived from this research in the field under investigation may potentially inform policy development, practice, and future research in the field. The next chapter focuses on the empirical findings on human rights and proper potable water and sanitation

infrastructure management at the selected schools in the Rustenburg Local Municipality (RLM).

CHAPTER 5 EMPIRICAL RESEARCH FINDINGS ON HUMAN RIGHTS, POTABLE WATER, AND MANAGEMENT THROUGH PARTICIPATORY ACTION RESEARCH

5.1 Introduction

The analysis of results is presented in this chapter in accordance with the study's goals and objectives. This chapter provides an in-depth analysis of data collected from a series of discussions with respondents in the Rustenburg Local Municipality (RLM) and selected schools, focusing on human rights and proper management of potable water and sanitation infrastructure. The discussions, which were central to this PAR research, involved a diverse array of respondents, including school administrators, educators, local government representatives, and pertinent personnel. This diversity offered a comprehensive and varied perspective on the challenges and intricacies of water and sanitation infrastructure in educational settings. The discussions with respondents in the research study are crucial for comprehending the practical implications of policy and infrastructure decisions, providing valuable insights into the day-to-day realities of maintaining essential services in schools.

The findings from the discussions are discussed in conjunction with relevant academic literature, thereby contextualising and enhancing the understanding of the issues identified. This approach effectively bridges theoretical and practical aspects, offering a detailed perspective on the challenges and possible solutions in the realm of water and sanitation infrastructure management in schools. This chapter discusses each theme that emerged from the study's goals, providing an analysis of respondents' opinions from the informal discussions. The themes that emerge from the discussions are evaluated against the backdrop of extant research, explaining the effectiveness of current methodologies and policies, and identifying areas in need of focus and improvement. Thus, this chapter serves not only as a presentation of primary data but also as a forum for wider discussion on the complexities of service delivery in educational environments, contributing to an enriched and comprehensive understanding of this vital issue.

5.2 Discussion of themes

In this study, I used an inductive coding approach in which codes were derived from the data. I conducted informal discussions with 30 purposively selected respondents, as indicated in the table below:

Table 5-1: Respondents' coding

INSTITUTION	CATEGORY	CODE
Education Sector	a. Department of Education Director for school infrastructure b. School Principals c. School Governing Body Chairpersons d. School teachers	DEDSI 1 P 1 – 6 SGBC 1 – 6 ST 1 – 6
Rustenburg Local Municipality (RLM) Officials	e. Water and Sanitation Services Manager f. Geographic Information System Specialist g. General workers of Infrastructure Unit	RLMWSSM 1 RLMGISS 1 RLMIW 1 - 2
Bojanala District Public Works Department	h. Unit Manager in the Public Works Department i. General Workers in the Public Works Department	BDMPWDM 1 BDMPWGW 1 - 2
	j. Local Community Members of the selected schools for the research project	LCM 1 - 4

Respondents' responses were coded into eight themes:

1. Challenges with water supply and sanitation infrastructure
2. Impact on education and health
3. Role of local governance and management
4. Community and Parental Involvement
5. Infrastructure maintenance and Improvement needs
6. Resource allocation and budgetary constraints
7. Environmental factors and external influences, and
8. Education and awareness

This chapter discusses each theme that emerged from the study's goals to analyse respondent opinions from formal and informal discussions. The purpose of the research

study was to investigate the human rights and proper potable water and sanitation infrastructure management at selected schools in the Rustenburg Local Municipality (RLM). Respondents were questioned to gather the data. This chapter discusses each theme that emerged from the study's goals in order to give an analysis of respondent opinions from the formal and informal discussions.

5.2.1 Theme 1: Challenges with water supply and sanitation infrastructure

The investigation into the theme of "Challenges with Water Supply and Sanitation Infrastructure" at educational institutions in the Rustenburg Local Municipality (RLM) reveals a complex scenario. It is characterised by recurrent water shortages and substandard sanitation facilities. These issues necessitate the use of provisional solutions, such as the undesirable use of bucket systems.

Educational establishments in the Rustenburg area, mirroring wider patterns across South Africa, experience substantial obstacles in securing a stable water supply. This scarcity is acutely experienced in educational environments, where the water demand is increasing of the growing number of learners and staff members and the entire school community. The absence of a consistent water supply, attributed to infrastructure deficiencies, resource allocation issues, and environmental conditions such as drought, poses significant challenges in the planning and administration within these institutions. This is supported by a local community leader serving on a school governing body, who explained:

"We don't have a maintenance plan for our facilities or schools." (SGBC 1)

Parallel to the issue of water scarcity is the problem of insufficient sanitation facilities at these schools. Sanitation, an essential human requirement and right, is significantly compromised in these educational settings, leading to severe health hazards. Inadequate sanitation infrastructure systems at these institutions serve as potential hotbeds for disease accumulation, particularly endangering the health of children. Additionally, the insufficiency of these facilities violates the privacy and dignity of learners, with a pronounced impact on female learners, potentially resulting in diminished attendance and engagement in educational activities.

“Drinking water is wasted due to water leakages that are not repaired in time.”
– BDMPWDM 1

In response to these water and sanitation challenges, schools frequently resort to temporary measures such as the implementation of bucket systems. While these measures address immediate needs, they are far from being optimal solutions. They are labour-intensive, unhygienic, and violate basic human dignity. Moreover, they impose extra responsibilities on the educational staff, removing them from their primary educational duties of teaching, learning and assessment.

A statement by ST 1, explains the difficulties at a school:

We do have toilets, and they are flushing toilets; however, right now we are using a bucket water system in our toilets due to unavailability of water.

It briefly captures the immediate, practical challenges faced due to water scarcity. Despite the presence of infrastructure such as flushing toilets, their functionality is compromised by the lack of a consistent water supply. Further highlighting systemic issues, another respondent states:

The municipality lacks the necessary infrastructure to support the development and maintenance of local capacity... Infrastructure for water and sanitation in many South African schools is typically below standard (P 1).

These comments highlight the imperative for sustainable, long-term solutions to address the issues of water and sanitation in educational settings, underscoring the urgent need for appropriate infrastructure and resource management. The harshness of the problem is also captured by one of the school principals:

The absence of a consistent water supply and adequate sanitation facilities in educational institutions presents more than a logistical dilemma; it significantly influences both the educational process and the health of students (P 2).

This is noted by a municipal official who responded that:

Water is wasted due to water leakages that are not repaired in time (RLMWSSM 1).

Interruptions in water availability frequently led to disruptions in the school schedule, such as early dismissals, which can negatively impact the academic progress of learners. The health risks associated with insufficient sanitation are particularly acute in densely

populated settings like schools, where the propagation of diseases and infections is a heightened concern, especially for younger children who are more susceptible to health complications.

Furthermore, deficiencies in potable water and sanitation infrastructure give rise to social challenges, notably pertaining to gender disparities. The absence of private and sanitary facilities disproportionately affects female learners, hindering their attendance and participation, notably during their menstrual periods. This situation deepens gender inequality, highlighting the need for inclusive and gender-sensitive solutions. This was confirmed in the quote below by a water and sanitation municipal manager:

Like I said, most of the schools do not have access to these basic services. It is where we are having a challenge of underground water tables and the same problem being experienced by municipality because the municipality ... is struggling to provide water to the community. Their water infrastructure was there, but (it is) dry. So, the two systems. Our borehole in the school and municipal infrastructure (are both dry) compromising that service and it leads to tinkering. It leads the school into buying water from the people who are serving water with tanks....The municipality is also trying in some instances to truck water, but you will recall or remember that ... we are not sure of the cleanliness or the quality of this water. But those are the interventions that we have been doing with municipality. In cases where we have water challenges in those areas (RLMWSSM 1).

At the systemic level, these challenges mirror broader concerns of governance, resource allocation, and infrastructural development. The dependence on provisional solutions, such as bucket systems, underscores the urgent need for a holistic approach to infrastructure planning and development. This situation also emphasises the need for robust governance frameworks that ensure accountability and effective allocation and utilisation of resources.

Addressing these issues necessitates integrated approaches involving various stakeholders, including governmental entities, local communities, and educational institutions. The development of sustainable strategies that extend beyond temporary fixes and target the underlying causes of water and sanitation inadequacies is crucial. Such strategies may encompass investments in infrastructure enhancements, the implementation of innovative water management and conservation methods, and the introduction of educational initiatives focusing on hygiene and health awareness.

5.2.1.1 Putting the theme in the context of existing literature

In South Africa's fight against water scarcity, the tightly linked absence of potable water and sanitation in educational settings has truly far-reaching consequences. Potable water and sanitation are basic amenities without which the educational process can scarcely function. Their absence negatively impacts not only attendance, but also academic performance and, ultimately, educational attainment (Matseke, 2020:90). Literature amplifies the critical role of these two elements in the conducive learning environment that everyone should have the right to. It also emphasises the adverse health and wellbeing effects that disproportionately affect the very populations (both in terms of location and socioeconomic status) that we hope to serve through the provision of quality education (Bazaanah & Mothapo, 2024:142).

These difficulties go well beyond simple inconvenience and create real health risks, especially for at-risk populations like children. Without access to clean water and sufficient sanitation, the kinds of easily preventable diseases that spread through contaminated water are all but guaranteed, and the resultant sick days undermine educational attainment. Betsu *et Madibengal* (2024) highlights various dimensions of this problem by saying that:

Inadequate sanitation and poor menstruation hygiene management (MHM) can affect girls' health, comfort, dignity, and safety, as well as their education and attendance.

Female learners are affected by the availability of "adequate" restrooms in a manner the boys do not have to worry about.

The effect of poor water and sanitation facilities is felt most acutely in disadvantaged communities. Here, the type of inequality that is found in many societies is made worse by the unsatisfactory provision of these basic services. Learners from these communities carry an extra burden as they try to learn in schools where water and sanitation were not part of the original funding formula. Further examples can be drawn from the rural areas in the Limpopo and Eastern Cape provinces, where most rural schools are located. Ensuring the right to education necessitates providing even the most fundamental of human needs first, like access to clean water and proper sanitation.

During informal discussions with LCM 1, the rights of the children were made very clear. The community member described the actual consequences, such as inadequate infrastructure and hostile learning conditions. These issues complicate the lives of learners.

Based on the above discussion I had with LCM 1, who originally comes from the Eastern Cape, it was easy for him to make a comparison on challenges about water supply and sanitation infrastructure in schools, as it affects teaching and learning. In this regard, his current experience in Rustenburg Local Municipality (RLM) does not differ much from his former experience in the Eastern Cape.

In potable water management and sanitation infrastructure in schools research, the theoretical framework and literature review are closely related since the framework is the prism through which the literature is examined and understood. The theoretical framework, namely, HRBA and the System Theory of Service, describes the main ideas, models, and tenets that direct the study. Integrated water resources management (IWRM), and sustainable development. These theories influence the queries and viewpoints that are applied to the literature. A synthesis of previous research is then provided by the literature review, which also highlights controversies, trends, and gaps that support and confirm the selected theoretical approach. This collaboration guarantees that the research study of human rights and proper potable water management and sanitation infrastructure in the selected schools of Rustenburg Local Municipality is based on existing information while providing fresh perspectives within a logical framework. Below is a graphical representation of the IWRM framework.

Integrated Water Resource Management

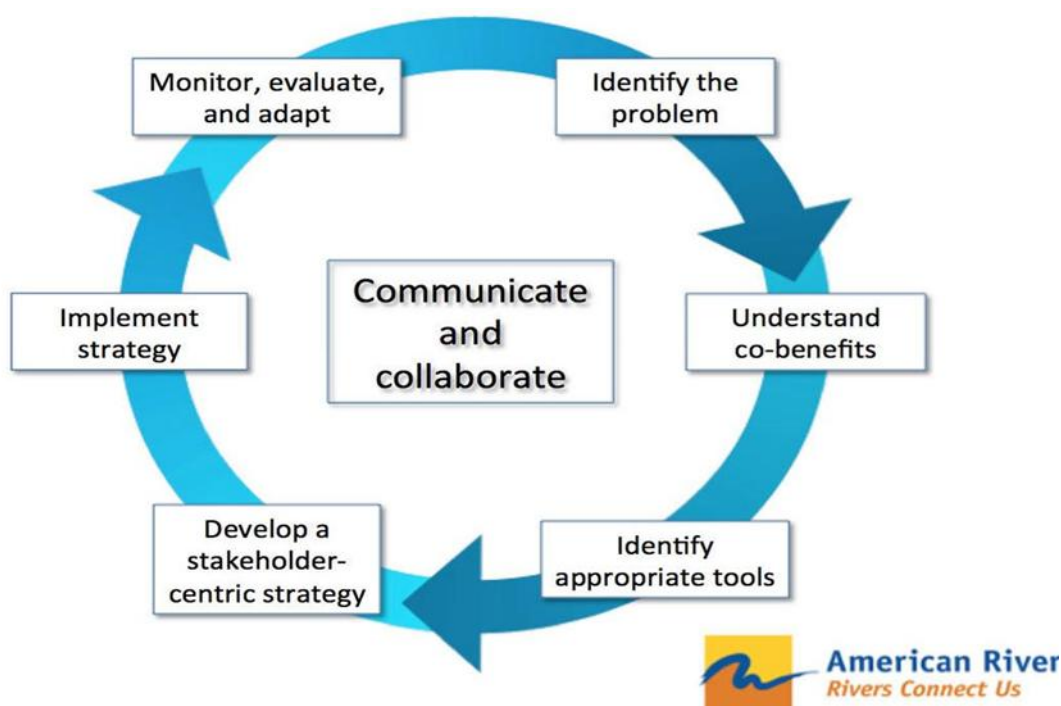


Figure 5-1: The process of Integrated Water Resource Management IWRM

Source: Mugambiwa & Chitongo (2023)

5.2.2 Theme 2: Impact on education and health

The operational challenges faced by schools due to water scarcity, including early closures, significantly disrupt the regular academic schedule. This disruption adversely affects the learning process and educational outcomes. Teacher 2 indicated that schools are sometimes compelled to close prematurely due to the absence of water, a situation particularly problematic when accommodating large numbers of learners.

Yes, we do have challenges because sometimes the municipality can take some days and weeks to supply water in our school. So, learning, teaching and assessment is hampered (ST 2).

Furthermore, health hazards arising from inadequate sanitation facilities are a matter of great concern. Schools with limited and over-utilised toilet facilities often find themselves in unsanitary conditions, posing serious health risks to both learners and educators. These conditions not only threaten physical health but also impact behavioural attitudes and the overall learning environment. My proposal brings to light the reality that inferior

sanitary conditions in schools can worsen educational and health-related challenges, thereby hindering effective learning opportunities. The infrastructure of the school is under pressure because it is no longer able to sustain the communities due to the physical urban expansion. This was explicitly stated by a municipal official:

The infrastructure that was built for our schools is not coping with the numbers of learners due to the growth of the community. What I have experienced, that has happened with myself now.... We should go back as department and make a survey of the schools. ... we need to give them extra sanitation facilities to overcome this thing because it's a challenge that we have the high number of learners in schools versus the lower number of toilet seats that were provided for a particular school, and that one also makes maintenance to become a burden to the school because once you've got more learners using smaller facilities of sanitation, it means the maintenance cost will go high because the facilities are not meant for (the) number that it is catering for. The same goes with water, but with water, we are trying our best to give the schools tanks so that they can have enough storage ... for drinking and for sanitation purpose(s)" (RLMGISS1)

These observations underscore the need for efficient solutions to address the challenges of water and sanitation in educational settings. Such solutions are imperative not only for the improvement of health and wellbeing of learners and staff but also to ensure an environment conducive to learning.

5.2.2.1 Putting the theme in the context of existing data

South Africa, a nation grappling with water scarcity, faces substantial challenges in delivering clean water and sanitation services to all societal sectors, including schools. These challenges stem from inadequate maintenance and investment in water infrastructure, recurrent droughts, disparities in water and sanitation access, declining water quality, and a shortage of skilled professionals in the sector. Such factors significantly impede education, restricting growth and development opportunities, and adversely impact learners' capacity to assimilate knowledge, their health, and dignity. The scarcity of clean water negatively influences learners' academic performance and attendance, leading to dehydration, the proliferation of waterborne diseases, and compromised hygiene standards, thus hindering the operation of educational programmes.

The absence of adequate sanitation in schools, compounded by broader community sanitation issues, exposes learners to considerable health risks, including elevated

coliform levels due to open defecation. Inadequate sanitation facilities contribute to various detrimental effects within the educational environment, such as teachers and learners falling ill from waterborne diseases, increased dropout rates (particularly among female learners due to the lack of menstrual hygiene facilities), and aversion to using toilets due to the absence of sanitation and privacy. These conditions aggravate the risk of continence-related issues and impede regular and efficient attendance at school.

The pressing need for safe and hygienic sanitation in schools has gained prominence, particularly during the COVID-19 pandemic of 2020-2022. However, solutions implemented, such as emergency water tankers and mobile toilets, are temporary and underline the historical issue of insufficient sanitation infrastructure in educational institutions. The costs associated with these emergency solutions are substantial, utilising budgets initially allocated for planned infrastructure projects. The reliance on borehole water in many schools, while a sustainable alternative, often fails to fully address water and sanitation needs due to inadequate piping and infrastructure. Data from the National Education Infrastructure Management System (NEIMS) reveals a significant number of schools lacking proper sanitation infrastructure, complicating the provision of sustainable sanitation solutions.

The legal and policy frameworks emphasise the essential connection between sanitation and learners' educational capabilities. Cases such as *Rosina Komape and others vs the Minister of Education* (CASE NO: 1416/2015), demonstrate the failure of authorities to provide adequate sanitation facilities, constituting not only a rights violation but also an impediment to educational progress. Efforts by organisations like SECTION27 to secure structural interdicts aim to compel education authorities to assess the state of sanitation and formulate plans to eliminate unsafe sanitation, emphasising the necessity for systemic and sustainable solutions.

In summary, the literature underscores the imperative need for comprehensive, sustainable solutions to address the issues of water scarcity and inadequate sanitation in schools. These solutions must recognise the interrelated nature of these challenges with educational outcomes, health risks, and legal and policy frameworks. Collaboration and investment from stakeholders, including government bodies, educational institutions, and

civil society, in sustainable infrastructure and policy interventions are essential to effectively mitigate these challenges.

5.2.3 Theme 3: Role of local governance and management

The perceived inadequacy of local governance in effectively addressing portable water and sanitation infrastructure challenges within educational institutions is a concern. This is partly attributed to local municipalities, including mismanagement and corruption. One of the respondents (LCM 1) voiced frustration with the local municipality's ward councillor, suggesting that politicians' involvement in corrupt activities impede service delivery. Despite possessing the technical capability to provide water in schools, local municipalities often fail to fulfil this responsibility effectively, thereby exacerbating the difficulties faced by educational institutions.

Respondents, at the time of informal discussions, articulated concerns regarding the shortcomings of local governance, particularly highlighting problems within the local municipality. One respondent's statement, "(The system) *fails because, of our ward councillors, some are looting in the municipality*" (LCM 2). It reflects dissatisfaction with local governance, identifying corruption and mismanagement as primary obstacles to efficient service provision.

The necessity for enhanced collaboration and communication between schools, local municipalities, and other relevant stakeholders is paramount in tackling water and sanitation issues. A respondent from the Rustenburg Municipality stressed the importance of establishing a more robust working relationship between Public Works and the Department of Education. This relationship should empower Public Works with the necessary resources for maintenance and involve the development of a comprehensive maintenance plan for each school, as suggested by the respondent from the Public Works department. Such collaboration would ensure the regular upkeep and functionality of water and sanitation infrastructure in schools, thereby facilitating more effective management of crucial services.

A public works worker of Rustenburg Municipality highlighted the critical need for improved communication and collaboration, particularly between Public Works and the Department of Education. The worker suggested,

... Public works need to have powers to have all the maintenance materials for education. They need to have maintenance team and maintenance plan for each school” (BDMPWGW 1).

His statement underlines the need for a structured and resource-equipped approach to manage potable water and sanitation infrastructure in educational settings. The inadequacy of local governance in addressing water and sanitation challenges in schools calls for a strategic realignment towards more effective and accountable systems. This realignment should involve the establishment of defined roles and responsibilities for municipal officials and school management teams. It is essential to ensure transparency in operations and to implement stringent measures against corruption and mismanagement.

In addition, there is an urgent need for enhanced collaboration and communication between schools, local municipalities, and other stakeholders, including the Department of Education. This collaboration could entail regular joint meetings, the formulation of integrated plans for water and sanitation management, and the establishment of a system for the timely reporting and resolution of issues. Such a collaborative approach is critical in streamlining efforts and ensuring the efficient utilisation of resources and expertise from various entities to effectively tackle the challenges at hand. A municipal official at the local municipality also made the following recommendation:

I think we must have some strategies to try and use water safely... By ensuring that our systems they do not leak because leakage(s) also can lead to loss of water that could have been spared for the next two days or three days to come. And have some systems that are able to control water. Like, for example, there are some toilet systems that I have seen somewhere in Gauteng. That toilet system it doesn't keep water in the system. You help yourself and then after helping yourself there is a button that you press. It is (water of this kind that) comes into the bucket system and then flushes the toilet. So, you see it minimises the water in the system and (prevents wasteful consumption). So, the water is tightly closed and it only flushes once you finish helping yourself. So, (if) we can have such sub-systems ... I think it was better also (for) maintenance because our schools are always complaining of the maintenance issue. We do not maintain our pipes. (They) are leaking the clean water and as well as waste pipes. When you ask why we are not maintaining. There's complaints that we do not have enough money to maintain (RLMWSSM1).

Through improved governance and fostering collaboration, significant progress can be made in managing water and sanitation issues. This progress is crucial for enhancing the educational environment and safeguarding the health and wellbeing of learners.

5.2.3.1 Putting the theme in the context of existing literature

Empirical data on the role of local government and management is also consistent with findings in literature, which shows that the struggle to secure clean water is not limited to Rustenburg. Water and sanitation service delivery is a severe and direct problem for educational institutions, and inadequate infrastructure is a reality that every school in the municipality faces (Sishawu, 2023). The severity of these conditions links and resonates with concerns noted in the literature regarding the more generalised "water governance crisis" that communities throughout South Africa are facing (Asoba *et al.*, 2020:2). When this crisis also affects schools, it affects a community's human capital, the educational attainment of the next generation and their overall wellbeing.

Respondents' expressions of health hazards tied to the lack of sanitation facilities were more than just unreliable. Their views are backed up by significant research. The literature links poor sanitation with harmful waterborne diseases, especially in the always-populated environment of a school (WHO/UNICEF JMP, 2020:1), not to mention that these serious health risks affect all learners, contribute to school absenteeism, and may also reduce the likelihood of learners being fully present, engaged, and performing during their time at school (Archibald, 2015). The discussions with role players in local education and governance provided a clearer picture of the context. By including some of the serious risks and challenges faced by female learners, especially during that time of the month when making do is not an option, it is a matter of grave concern.

The discussions illuminated some of the wider, more systemic issues that make it difficult for schools to obtain and manage water and sanitation resources. Delays in getting repair materials, lack of a maintenance plan, and general strain on local resources, all these points, not surprisingly, contribute to architecture problems in the water and sanitation sector (Golson, 2020). Our school research undoubtedly benefits from what has been uncovered in the sector over recent years. The empirical findings affirm the need for better governance, more effective resources, and sustainable infrastructure development so that reliable access to services becomes the norm.

Repeatedly raised in both discussions and the written word, the financial weight of attending to these problems is an unmistakable pattern (Dithebe *et al.*, 2019:556). The situation becomes more desperate in places where added resource strains make it hard

to carry on with even the basic educational functions. One way to carry on innovatively and sustainably, given that some places have little rainfall and, in some places, it surely pours, is to use rainwater harvesting as part of the school's overall water supply system.

Discussions with community members show the value placed on community partnership and engagement when tackling schools' water and sanitation problems. All discussions suggested that decision-making processes, as well as the implementation of solutions, should significantly involve parents and other community members. Their involvement is proposed in line with research findings that emphasise the importance of participatory approaches in not only making interventions more effective and suitable but also ensuring their sustainability (Rana & Piracha, 2020:102).

The informal discussions in Rustenburg's Local Municipality shine a light on the complex problems confronting local schools with the means and management of adequate water and sanitation setups (Susela, 2022). They show a direct pathway to the reality of the situation being experienced by the schools. The discussion findings make a pointed appearance alongside the evidence gathered in the existing literature. Together, they unreservedly call for effective resolutions to ensure a space where learners learn is equitable to all other spaces and meets necessary health standards.

5.2.4 Theme 4: Community and parental involvement

The active involvement of parents and the community plays a crucial role in developing practical and innovative solutions to challenges in water and sanitation. SGBC 2 emphasised this point by stating:

"Yes, they must be involved because without them we will not get good ideas that can be used to resolve these issues" (SGBC 2).

This statement underscores the essential contribution of community and parental input in effectively tackling these challenges.

The engagement of parents and the community can also help in bridging the gaps in resource allocation and planning. A respondent highlighted the disconnection between the departments of Education and Public Works in terms of maintenance, planning and the provision of resources. A respondent observed:

The maintenance team will go to assess what the problem is and what materials are needed to repair or fix the problem. However they only make a list and (do) not provide required materials. (BDMPWGW 2).

This comment sheds light on the difficulties present in existing management practices and suggests the potential benefits of increased community involvement in addressing these challenges.

The active participation of community members and parents in addressing water and sanitation challenges within educational institutions is not merely beneficial for bringing a variety of perspectives and solutions; it also cultivates a sense of ownership and responsibility among stakeholders. When parents and community members are actively involved, their likelihood of supporting and sustaining these initiatives increases. This collective approach has the potential to yield more sustainable and effective solutions by applying the collective knowledge, skills, and resources of the community.

Furthermore, the inclusion of parents and community members in decision-making processes ensures that the solutions devised are contextually appropriate and more likely to receive acceptance and support from those directly impacted by these challenges. Such involvement is critical in creating an environment that prioritises the health and wellbeing of learners, consequently enhancing the overall educational experience.

5.2.4.1 Putting the theme in the context of existing literature

Recent scholarly works have increasingly focused on the role of community members and parents in managing and resolving water and sanitation issues within school environments. Mkhize and Nkomo (2018) explore the crucial role of community involvement in combating corruption and inefficiencies in water and sanitation services in South African schools. Their research underscores the potential of community participation in fostering transparent and effective resource management. Similarly, Smith *et al.* (2019) point out the importance of community engagement in the enhancement of school water systems, arguing that the active involvement of community members not only introduces a variety of perspectives but also cultivates a sense of ownership and responsibility, which contributes to the sustainability of solutions.

Additionally, the significance of parental involvement in the broader spectrum of educational contexts has been emphasised in the literature. Ananga (2017) examines the positive impact of parental participation in school governance on the management of school facilities, including water and sanitation. This involvement is noted to improve resource allocation and the maintenance of facilities. Echoing these sentiments, Naidoo (2018) points out the crucial role of parents in governance, particularly in addressing infrastructural challenges in schools. One of the challenges when it comes to infrastructure is that municipal water is shared with informal settlements, which puts pressure on the municipal water supply, resulting in shortages as indicated in the verbatim quote below by one of the school principals:

The shortage of water sometimes is because of a lot of informal settlements around the Rustenburg Local Municipality (RLM) to cater for the entire community including the schools. So, it will mean that from the municipality point of view, they must build enough reservoir to cater. As informal settlements are now booming, but in terms of the infrastructure, we don't see any direction of water reservoirs. Yes, or back up" (P 2).

Furthermore, contemporary studies underscore the necessity for collaborative approaches that incorporate both parents and the community in the management of resources, especially concerning water and sanitation. Naidoo and Patel (2018) discuss the implementation of sustainable technologies in school water management, underlining the essential role of community and parental engagement in such initiatives. O'Brien and Hart (2018) also emphasise the importance of interdepartmental collaboration, which includes the active participation of community members, for efficacious school sanitation management.

Lastly, research highlights the profound impact of community and parental involvement on educational outcomes. Levy and Shumane (2018) investigate how community participation in water and sanitation management can enhance educational outcomes. They contend that the involvement of community members and parents ensures that solutions to water and sanitation issues are more likely to be effective and sustainable, thereby positively influencing the quality of education. BMC Public Health (2021) supports this perspective by demonstrating that educational programmes involving parents and the community in water, sanitation, and hygiene (WASH) interventions can markedly enhance learners' knowledge and practices in these areas.

5.2.5 Theme 5: Infrastructure maintenance and improvement of needs

The topic "Challenges with Water Supply and Sanitation Infrastructure" in educational institutions, which primarily focuses on frequent water shortages and insufficient sanitation facilities, represents a significant concern in these settings. An official in the education sector articulated that:

Yes, we do have toilets, and they are flushing toilets; however, right now we are using a bucket water system in our toilets due to the unavailability of water(ST 2).

This statement succinctly illustrates the grave situation many schools encounter, namely the necessity to adopt makeshift solutions, like bucket systems, owing to inconsistent water supplies. Such conditions not only hinder basic hygiene standards but also impinge upon the dignity and learning environment of learners. The ongoing water shortages underscore a larger infrastructural challenge that extends beyond the confines of the educational institution and encompasses municipal and governmental responsibilities.

The dependence on provisional solutions such as bucket systems in response to erratic water supply is indicative of the resilience of schools in managing daily operations under challenging circumstances. Yet this reliance also points to a systemic failure in providing fundamental services. The mentioned discussant (ST 2) emphasised the harshness of the situation with the use of buckets due to water unavailability. This scenario highlights not only immediate health and hygiene concerns but also the broader implications for educational outcomes. The preoccupation of learners and staff with necessities detracts from educational focus, potentially leading to increased absenteeism and a decline in the overall quality of education, disproportionately affecting the most vulnerable learners.

The lack of adequate sanitation facilities in schools poses a significant challenge, impacting health and the educational experience. Sanitation, an essential human requirement and right, is significantly compromised in these educational settings, leading to severe health hazards. This insufficiency in sanitation facilities extends beyond an infrastructural issue, posing serious health risks, especially for children. Substandard sanitation conditions can become hotbeds for disease, adversely affecting learners health and attendance. This situation particularly affects learners and school community members, impinging on their privacy, dignity, and engagement in education. The absence

of suitable sanitation facilities can discourage learners from regular attendance, thus aggravating the lack of proportion in education. This issue underscores a vital deficiency in meeting basic human needs within educational environments, necessitating immediate attention and resolution.

The adoption of temporary measures such as bucket systems starkly illustrates the desperate efforts to confront these challenges. This is noted in the following quote:

They manually have to flush them. We keep 20-litre water containers inside the toilet so that when we do not have water, then we are only relying on that measure to keep them clean (P 6).

Although these temporary solutions meet immediate demands, they are fundamentally insufficient and often compound the problem. They demand extensive labour, lack hygiene, and infringe upon human dignity. Additionally, such measures place extra burdens on educational staff, diverting them from their primary educational responsibilities and diminishing the quality of education provided. This reliance on inadequate and temporary solutions signals deeper systemic issues, including inadequate funding, poor infrastructure planning, and the absence of a comprehensive policy for sustainable water and sanitation solutions in schools.

One of the issues that came up during discussions with the school officials is that the problem of infrastructure, specifically concerning toilets, was not limited to water from the municipality. Instead, there were also instances of vandalism, which served to compound the problem. This was indicated by one of the education sector officials:

(W)e have about 3 toilets that are for learners but the fact that the other toilet was vandalised the condition of the toilet was perfectly fine when it was handed over, we realised that the problem was the piping system, so that says every time they flush then the sewage will come back and then it will lift up. So, it was not a good thing to use. You realise that it was risking the health of the school community. We indicated that to the contractor, but they took time to come over and make some repairs because they are complaining. The whole problem was the piping system which is in the community and that's the area where they cannot go. So now, the same toilet vandalised because it's not in use" (P 3).

The significant health hazards arising from inadequate sanitation facilities in educational institutions are of critical concern. Substandard sanitation amenities not only pose an immediate threat to the health of learners and staff but also cultivate an environment that

is detrimental to learning. This issue is particularly concerning given that schools are intended to be secure environments conducive to learning and development. The health risks associated with poor sanitation can result in increased absenteeism among learners, complicating existing educational inequalities. Children from disadvantaged backgrounds, who are already more susceptible to educational barriers, are disproportionately impacted by these unsatisfactory conditions. This situation highlights the necessity for a comprehensive approach to address water and sanitation issues in schools, considering the broader implications for learners' health and educational outcomes.

The repercussions of these challenges are not limited to the physical health of learners but also extend to their psychological wellbeing and dignity. Inadequate sanitation facilities, particularly affecting learners and school community members, can lead to a loss of privacy and dignity, resulting in profound psychological effects. These circumstances can provoke feelings of embarrassment and shame, potentially hindering learning and participation in school activities. The psychological burden of these conditions can be substantial, with potential long-term effects on self-esteem and academic achievement. Furthermore, the additional responsibilities imposed on educational staff in managing these temporary solutions divert their focus from their principal role of teaching and mentoring. This redirection of resources and attention away from educational priorities underscore the urgent need for sustainable and long-term resolutions to the water and sanitation challenges in schools.

The difficulties presented by water supply and sanitation infrastructure in schools, characterised by frequent water shortages and a reliance on provisional solutions such as bucket systems, constitute a complex and multifaceted issue with extensive implications. Addressing these challenges necessitates a holistic approach that encompasses not only the enhancement of physical infrastructure but also the consideration of the broader impacts on health, education, and the wellbeing of learners and staff. This situation demands concerted efforts from various stakeholders, including governments, educational authorities, and communities, to ensure that all learners have access to safe and adequate water and sanitation facilities, thereby supporting their fundamental right to a quality education and a dignified learning environment.

5.2.5.1 Putting the theme in the context of existing literature

The significance of consistent maintenance of water and sanitation facilities in educational environments is a key theme in contemporary research. A UNESCO report from 2017 underlines that without regular upkeep, even well-designed water and sanitation facilities can deteriorate rapidly, thereby nullifying their intended benefits (UNESCO, 2017). This issue is particularly pronounced in resource-constrained settings, where the initial investment in infrastructure often fails to be complemented by ongoing maintenance funds. In parallel, a study by O'Reilly (2018) examines the health consequences of poorly maintained sanitation facilities in schools, establishing a connection with increased disease transmission and adverse health outcomes for learners.

Recent academic discussion also explores various sustainable solutions for enhancing water and sanitation infrastructure. Brown and Damania (2019) highlight the efficacy of rainwater harvesting systems in schools as a means to mitigate water scarcity issues. These systems not only offer a sustainable water source but also function as educational tools for learners on sustainable practices. Additionally, the World Health Organisation (2016) advocates for the implementation of solar-powered water systems in schools, presenting them as reliable and eco-friendly water sources, particularly beneficial in areas without grid access.

The challenge of limited budgets and resources for maintaining and upgrading infrastructure is extensively discussed in scholarly literature. O'Reilly and Louis's (2018) study addresses the financial constraints faced in sustaining school infrastructure, especially in low-income nations, suggesting that budget limitations often result in the lower prioritisation of infrastructure upkeep. SECTION27 emphasises how resource allocation decisions in educational contexts frequently overlook long-term infrastructure needs in favour of immediate concerns.

The influence of environmental factors on water and sanitation infrastructure is an additional topic in recent research. Barrett and Beardmore (2018) explore how climate change intensifies water scarcity challenges, necessitating adaptive measures in school infrastructure. They propose that infrastructure should be resilient to evolving environmental conditions to ensure its sustained utility and effectiveness. Moreover, a

UNICEF report from 2019 highlights the impact of environmental factors on water and sanitation infrastructure in schools, advocating for the development of infrastructure capable of adapting to a range of environmental challenges.

5.2.6 Theme 6: Resource allocation and budgetary constraints

The topic of "Resource Allocation and Budgetary Constraints" concerning water and sanitation infrastructure in schools is a complex issue, with significant implications for the quality of education. A discussion respondent highlighted a challenge associated with limited budgets and resources for proper maintenance and upgrades of infrastructure:

We don't have a maintenance plan for our facilities or schools. Moreover, if there is a problem, for example, a burst pipe, our maintenance team only provides labour and not materials and will wait for the department of education to do a quotation for the material, and meanwhile, the water continues to flow out, and the infrastructure gets damaged (BDMPWDM 1).

This statement brings to the forefront the systemic issue of underfunding and the absence of effective maintenance planning in educational institutions. The lack of a comprehensive and sufficiently financed maintenance plan results in extended periods of deterioration, compounding the problem and leading to additional damage. Such negligence not only compromises the functionality of water and sanitation systems but also poses health risks to learners and staff, while interrupting the educational process.

Moreover, the consequences of these constraints on the capacity to provide consistent water and sanitation services are substantial. As indicated in the discussions, the slow movement between the Departments of Education and Public Works creates a bottleneck in efficiently addressing infrastructural problems:

There is a delay between the Department of Education and Public Works (BDMPWDM 1).

This delay is not merely a logistical concern but indicates a deeper issue of misaligned priorities and ineffective resource allocation. Limited budgets often force schools to prioritise immediate educational necessities over infrastructural maintenance, continuing a cycle of degradation and disrepair. This scenario is deepened by administrative processes and a lack of synchronisation between various departments responsible for school infrastructure, resulting in significant delays in resolving critical maintenance

issues. The cumulative impact of these budgetary and resource limitations severely undermines the provision of consistent and reliable water and sanitation services in schools, directly affecting the health and educational achievements of learners.

5.2.6.1 Putting the theme in the context of existing literature

Contemporary research has increasingly concentrated on the influence of environmental factors, such as climate change and drought, on water scarcity in educational environments. A study by Barrett and Beardmore (2018) investigates the effects of climate-induced water scarcity on school infrastructure and attendance, particularly in arid regions. The findings indicate that extended drought conditions intensify water scarcity in schools, leading to infrastructural strain and a rise in absenteeism. Likewise, a report by the World Bank (2018) underscores the necessity of adapting educational infrastructure to cope with environmental changes, especially in regions with limited water resources.

Socio-economic disparities also significantly influence the structure and quality of water and sanitation facilities in schools. BMC Public Health (2021) examines the impact of socio-economic variations on water and sanitation facilities in schools. The research reveals that institutions in lower socio-economic areas often experience inferior infrastructure, which adversely affects the health and education of learners. The 2019 UNICEF report "Water under Fire" delves into how conflict and economic instability amplify the challenges in providing adequate water and sanitation facilities in schools, highlighting the need for solutions tailored to specific contexts.

The rapid growth of urban areas and the increase of informal settlements are additional external elements affecting water and sanitation infrastructure in educational institutions. Patel and Jha (2019) explore the implications of swift urbanisation in developing countries on water and sanitation systems in urban schools. The study contends that inadequate planning in informal settlements frequently results in substandard infrastructure in nearby schools. Furthermore, the 2020 WHO/UNICEF Joint Monitoring Programme (JMP) for Water Supply, Sanitation and Hygiene report explains the difficulties encountered by schools in urban slums, where access to water and sanitation is often constrained and of poor quality.

Recent literature emphasises the critical role of educating learners and communities about water conservation and sanitation practices. O'Reilly and Louis (2018) discuss the benefits of educational programmes in schools that promote sustainable water usage and hygiene practices. Such programmes not only enhance knowledge and behaviours regarding water and sanitation but also cultivate a sustainability mindset among learners. The 2020 UNESCO "Global Education Monitoring Report" confirms this stance, affirming that education is essential for heightening awareness about water scarcity challenges and the significance of conservation practices, particularly in regions severely impacted by environmental alterations.

5.2.7 Theme 7: Environmental factors and external influences

The influence of environmental factors, notably drought, in intensifying water scarcity in educational environments is an important issue. Educational institutions, particularly in locales such as Rustenburg, reflect broader patterns across South Africa, where securing a stable water supply presents a substantial challenge. This challenge is described by an official from the education sector, who disclosed that:

Yes, we do have challenges because sometimes when the municipality can take some days and weeks to supply water in our school. So, learning and teaching, which is scamped (ST 3).

This scarcity is profoundly felt in schools, where the requirement for water is magnified by the needs of numerous learners and staff members. Drought conditions, worsened by infrastructural deficiencies and resource allocation issues, present significant obstacles in the planning and administration of these institutions. The lack of a consistent water supply not only hinders the educational process but also poses serious health risks. Interruptions in water availability often result in disruptions to the school schedule, such as early dismissals, which adversely impact the academic development of learners. Furthermore, the health risks associated with inadequate sanitation, particularly in densely populated environments like schools, are elevated, especially affecting younger children who are more vulnerable to health issues.

The impact of broader socio-economic conditions on water and sanitation infrastructure is considerable. In underprivileged areas, the lack of clean water and proper sanitation facilities constitutes a significant threat to children's health, influencing their academic

performance and attendance. The significance of the challenge is captured in the quote below:

In the past, there have been days when learners had to depart early from school, and this happens a lot in summer. So, when there's no water and toilets are not being flushed and the heat is also there, it provides a great challenge with having to relieve oneself and the running of the school (ST 4).

Learners in these regions frequently discontinue their education due to infrastructural deficiencies, leading to increased dropout rates, particularly among female learners' post-puberty. The lack of sanitation facilities leads to health issues for both learners and educators, disrupting educational activities. Nevertheless, progress has been made in improving Water, Sanitation and Hygiene (WASH) facilities in schools, especially in urban areas. This improvement is largely attributed to urbanisation and the active involvement of the private sector. However, substantial efforts remain necessary, particularly in reaching the most disadvantaged communities, to ensure equitable access to water and sanitation facilities.

The expansion of informal settlements poses a distinct challenge to water and sanitation infrastructure. As indicated in a discussion, the unanticipated demand from informal settlements was likely not considered during the initial system design, leading to increased water shortages. This surge in demand frequently overwhelms existing infrastructure, unprepared for the rapid and unplanned growth characteristic of informal settlements, resulting in strained resources and worsening water shortages. The challenge encompasses not only the heightened demand but also the exclusion of these settlements from formal planning and resource allocation processes. Consequently, schools in or near these areas often face considerable difficulties in accessing consistent and safe water supplies, impacting learner health and education.

The socio-economic conditions prevalent in informal settlements further complicate the situation. Although improvements in WASH facilities in schools have been noted, particularly in urban areas due to urbanisation and private sector engagement, these advancements are not uniformly distributed. Schools in less advantaged areas, including those near or within informal settlements, continue to struggle with substandard water and sanitation facilities. This disparity underscores the necessity for inclusive and equitable solutions that address the specific challenges encountered by schools in

underprivileged regions. Addressing these issues requires substantial investment in water infrastructure and a multi-faceted approach involving various stakeholders, including government entities, the private sector, and community organisations.

The theme "Environmental Factors and External Influences" recaps the complex interaction between environmental changes, such as drought, and socio-economic factors, like the growth of informal settlements, in shaping the water and sanitation infrastructure in schools. Tackling these challenges demands a comprehensive strategy that considers both environmental and socio-economic contexts, ensuring equitable access to water and sanitation for all learners.

5.2.7.1 Putting the theme in the context of existing literature

The growing emphasis on integrating water conservation and sanitation education into school curricula is a notable trend in recent academic literature. A study by O'Reilly & Louis (2018) underscores the significant impact educational interventions in schools can have on enhancing knowledge and practices related to water conservation and sanitation. This research posits that schools are prime environments for instilling sustainable water use and hygiene habits. Supporting this viewpoint, the UNESCO report "Education for Sustainable Development Goals: Learning Objectives" (2017) underlines the importance of educational programmes that incorporate water conservation and hygiene practices, asserting that such education is vital for achieving broader sustainability objectives.

Specific educational initiatives focusing on hygiene practices have been identified as effective in promoting healthy behaviours among learners. McMahon *et al.* (2018) discuss the positive outcomes of hygiene education programmes in schools, including significant improvements in learner hygiene practices and overall health. According to this research, these programmes also play a role in reducing the spread of infectious diseases in educational settings. This is supported by the World Health Organisation's "Guidelines on Sanitation and Health" (2018), which describes the essential role of hygiene education in enhancing health outcomes and preventing disease transmission within educational contexts.

Additionally, the broader implications of sustainability education on water usage behaviours are explored in the literature. Patel and Jha (2019) investigate how

sustainability education in schools can lead to more responsible water usage behaviours among learners. They contend that such education not only increases awareness about the significance of water conservation but also empowers learners to act as change agents in their communities. The UNESCO "Global Education Monitoring Report 2019" further highlights the role of education in fostering sustainable development, including sustainable water management, emphasising that it is critical in cultivating a sustainability mindset in future generations.

The effectiveness of educational interventions in raising awareness about water and sanitation challenges is a central theme in contemporary scholarly discourse. For instance, Barker *et al.* (2017) demonstrate how targeted educational interventions can substantially improve learner comprehension and consciousness of potable water and sanitation issues. These interventions are deemed essential for nurturing informed and responsible attitudes towards these matters. Furthermore, UNICEF's Advancing WASH in Schools Monitoring report (2018) stresses the significance of school-based water, sanitation, and hygiene education in promoting healthy practices and establishing an informed and proactive learner body.

5.2.8 Theme 8: Education and awareness

The imperative of educating learners about water conservation and sanitation practices transcends mere knowledge transfer; it is also a method of nurturing a culture of responsibility and sustainability. The official in the Education sector, in a discussion, emphasised the significance of education as a tool for addressing various challenges:

Education is the most important tool that we can use to deal with any problem. Learners need to know the importance of water in their lives and how they can conserve this precious resource (DEDSI 1).

This statement emphasises the necessity for an educational approach that extends beyond traditional academic curricula to encompass practical life skills and environmental stewardship. The incorporation of lessons on water conservation and the significance of sanitation within the educational framework enables schools to significantly influence the attitudes and behaviours of upcoming generations. This strategy not only addresses immediate concerns but also contributes to the long-term sustainability of water resources.

The role of educational programmes in fostering sustainable water usage and hygiene practices has implications that reach beyond the educational environment. These initiatives are essential in elevating awareness and altering behaviours on a broader scale. An awareness campaign mentioned in the discussions exemplifies this when a respondent observed:

They provide awareness campaigns to schools and the communities at large... they send a message on how to use water efficiently and also how to use wastewater facilities efficiently (RLMWSSM 1).

Campaigns of this nature are vital for disseminating knowledge and skills regarding efficient potable water use and sanitation practices, extending not only to learners but also to their families and wider communities. Engaging broader communities in these educational endeavours can bring about widespread changes in perceptions and management of potable water and sanitation, significantly impacting community health and environmental wellbeing.

The significance of educating learners and communities about water conservation and sanitation practices is underscored in the discussions. A discussant from the awareness department stated that:

"We do have an awareness department within our unit... they provide awareness campaigns to schools and the communities at large... on how to use water efficiently and also how to use wastewater facilities efficiently" (RLMWSSM 1).

This underscores proactive measures for community education, highlighting the understanding that awareness and education are fundamental in promoting sustainable water and sanitation practices. Such campaigns are instrumental, not only in imparting knowledge, but also in transforming attitudes and behaviours towards water usage and sanitation. Targeting both educational institutions and the wider community, these initiatives seek to generate more extensive and enduring transformations in the management and conservation of water resources.

Furthermore, the discussions reinforce the role of educational programmes in promoting sustainable water usage and hygiene. A teacher detailed that:

There's health, social, and environmental responsibility in the life orientation curriculum... addressing pollution and how to care for oneself and the environment... carried into subjects such as geography" (ST 5).

This suggests the integration of these topics within the existing curriculum, rather than a separate, dedicated program for hygiene and water management. By weaving these themes into subjects like life orientation and geography, educational institutions are positioned to educate learners about the importance of water conservation and hygiene from an early age. This integrative approach not only equips learners with essential knowledge but also instils a sense of environmental and community responsibility.

The incorporation of potable water conservation and sanitation practices into school curricula transcends mere knowledge transfer, focusing on moulding future generations' attitudes towards environmental stewardship. As highlighted in a discussion, the awareness department is dedicated to conducting campaigns in schools and communities, emphasising the efficient use of water and wastewater facilities. This strategy is crucial as it goes beyond the confines of conventional education, engaging the community in the educational process. By adopting this method, the principles of water conservation and efficient usage are disseminated more widely, potentially leading to changes in community behaviour. These educational campaigns are fundamental in fostering a society that is more conscious of water conservation, where each member appreciates the value of water and the need to preserve this essential resource.

Additionally, the role of educational programmes in promoting sustainable water usage and hygiene extends from formal education to broader societal consciousness. The integration of these themes into subjects such as life orientation and geography within school curricula demonstrates the comprehensive approach required to tackle environmental issues. This method educates learners about the significance of water conservation and hygiene while preparing them to be informed and responsible global citizens. It underscores the interrelation of environmental issues with other facets and encourages learners to critically evaluate their role in conserving natural resources. Such education is instrumental in nurturing a generation that is not only cognisant of environmental challenges but is also capable of contributing to sustainable solutions.

The theme "Education and Awareness," as reflected in the discussions, intensifies the role of educational initiatives in promoting water conservation and sanitation practices

among learners and the wider community. Through awareness campaigns and the integration of these concepts into the curriculum, these initiatives strive to instil a culture of sustainability and responsibility towards water usage and hygiene practices. This approach is essential for securing long-term environmental stewardship and cultivating a society committed to the sustainable management of water resources.

5.2.8.1 Putting the theme in the context of existing literature

Recent academic literature has increasingly focused on the challenges posed by limited budgets and resources for the maintenance and upgrades of infrastructure, particularly in educational settings. Muralidharan (2019) highlights the difficulties encountered by educational institutions in low-income countries, primarily due to financial limitations. These constraints frequently result in inadequate maintenance of school infrastructure, including critical potable water and sanitation facilities. Additionally, Malbon and Parkhurst (2023) illuminate the tendency of limited resource allocation in education to neglect long-term infrastructure needs, with a propensity to concentrate on more immediate issues.

The effects of budgetary and resource limitations on the capacity to deliver consistent water and sanitation services constitute another significant area of inquiry in the literature. Barrett and Beardmore (2018) discuss how these constraints aggravate water scarcity problems in educational environments, especially in regions impacted by environmental changes such as drought. They contend that the absence of investments in resilient water infrastructure undermines the provision of essential services. Furthermore, the 2018 World Bank report "Beyond Scarcity: Water Security in the Middle East and North Africa" emphasises the necessity for sustainable investment in water infrastructure to counteract the impacts of climate change and ensure a reliable water supply in schools.

The need for long-term and sustainable approaches to managing potable water and sanitation infrastructure within the constraints of budgetary limitations is also addressed in the literature. Brown and Damania (2019) suggest adopting innovative and sustainable technologies, like rainwater harvesting, to alleviate water scarcity in schools. The authors underscore that such strategies can be both cost-effective and sustainable over the long term. In a similar vein, Patel and Naidoo (2018) advocate green infrastructure and water-

efficient systems in schools. These measures can help mitigate the challenges posed by limited budgets while ensuring the sustainability of water and sanitation services.

Furthermore, the significance of governance and policy in resource allocation for water and sanitation infrastructure is a focal topic in current studies. The 2017 UNESCO report, "WASH in schools: A global status report", underscores the criticality of robust governance frameworks for effective resource allocation and utilisation in school infrastructure. This report assumes that strong governance is crucial for bridging gaps in resource allocation and ensuring that investments yield sustainable outcomes. Correspondingly, Smith *et al.* (2019) stress the importance of enhanced collaboration among schools, local municipalities, and other stakeholders for efficient resource management. They highlight the potential benefits of community engagement in surmounting infrastructural challenges.

5.3 Analysis of research results

The data analysis and the interpretation display the responses of the participants on portable water and sanitation infrastructure in schools according to the following objectives:

5.3.1 Analysis of results in the context of Research Objective 1 states that:

Critically examine the fundamental link between a Human Rights-Based Approach (HRBA) and service delivery in managing school water and sanitation.

5.3.1.1 Establish a fundamental link between a Human Rights-Based Approach (HRBA) and service delivery in the management of potable water and sanitation infrastructure of schools in the Rustenburg Local Municipality.

The discussion transcripts from schools in the Rustenburg Local Municipality offer valuable insights into the practical challenges and experiences concerning the management of potable water and sanitation infrastructure. An analysis of these discussions through the lens of the Human Rights-Based Approach (HRBA) provides an understanding of the realisation, or lack thereof, of rights-based principles in this specific context.

5.3.1.2 HRBA in the context of water and sanitation challenges

The HRBA framework emphasises the state's obligation to respect, protect, and fulfil human rights, inclusive of the rights to potable water and sanitation. Analysis of the discussions indicates a scenario where these rights are frequently compromised due to infrastructural and governance challenges. For instance, a discussion mentioned the utilisation of a water bucket system due to water unavailability, which underscores issues of accessibility and adequacy. This scenario directly contradicts HRBA principles, which advocate for reliable and safe water access for all, as detailed in General Comment No. 15 by the Committee on Economic, Social and Cultural Rights (CESCR, 2002).

5.3.1.3 Governance and participatory decision-making

HRBA underscores the significance of participatory decision-making in resource management. The discussions, however, suggest a gap between educational institutions and local governance structures. For example, the noted delays between the Department of Education and Public Works in addressing infrastructural needs (Sanitation Plumber Discussion) point to a deficiency in effective collaboration and participation, fundamental elements of HRBA. These findings echo those in studies like that of Brown and Damania (2019) who call for enhanced governance in resource management.

5.3.1.4 Education and empowerment

Empowerment and capacity building are central tenets of HRBA. The discussions display initiatives in this area, with the municipality conducting awareness campaigns to educate schools and communities about efficient water usage (Discussion with Water and Sanitation Officer). This initiative is in alignment with HRBA's focus on education, recognising that informed and empowered communities are more capable of asserting their rights. This aspect is corroborated by research by O'Reilly and Louis (2018), which underscores the transformative role of education in water conservation.

5.3.1.5 Challenges and recommendations

Despite these initiatives, ongoing challenges highlight the necessity for a more comprehensive application of HRBA principles. The discussions suggest an urgent need for sustainable infrastructure investment, enhanced governance, and augmented

community engagement. The proposal to install boreholes in schools for consistent water supply (SGBC 4), for example, resonates with HRBA's emphasis on sustainable and rights-based solutions. This recommendation agrees with the advocacy by Naidoo (2018) for sustainable infrastructure in educational settings.

5.3.1.6 Summary

The discussion transcripts from Rustenburg schools reveal the varied nature of potable water and sanitation management in educational contexts. While there are endeavours that align with HRBA principles, significant deficiencies persist, particularly in the realms of governance, participation, and sustainable infrastructure development. To address these deficiencies, a concerted effort from all stakeholders is required, guided by the HRBA framework, to ensure the comprehensive realisation of water and sanitation rights in these school communities.

5.3.2 Analysis of results in the context of Research Objective 2 states that:

Assess the perceptions of school communities regarding water and sanitation management.

A prominent theme identified in the discussions is the role of education in addressing water-related challenges. One teacher highlights the importance of educating learners about water conservation, stating:

Education is the most important tool that we can use to deal with any problem. Learners need to know the importance of water in their lives and how they can conserve this precious resource (ST 4).

This viewpoint aligns with academic research emphasising the role of education in promoting environmental stewardship and awareness, as evidenced in studies by O'Reilly and Louis (2018) among others. Furthermore, the implementation of awareness campaigns in schools and communities, as referenced in the discussions, demonstrates recognition of the necessity for widespread engagement in water conservation efforts.

5.3.2.1 Impact on educational activities

The discussions also shed light on the direct impact of water and sanitation challenges on educational activities. A common response from officials in the education sector is that:

Sometimes when there is no water the school knocks off early, and learners are instructed to go home, and that affects teaching and learning as teachers was behind in their ATP (ST 1, ST 3 & ST 4).

This observation underscores the essential relationship between a sufficient water supply and the efficient operation of educational institutions, a correlation noted in academic literature (UNESCO, 2017). Disruptions in academic routines due to water shortages exemplify the practical consequences of inadequate infrastructure, highlighting the need for dependable water services in schools.

5.3.2.2 Sanitation challenges

Sanitation emerges as another critical issue in the discussions. A respondent remarked: *"Yes, if many learners use these toilets too much, the main hall toilets get blocked"* (P 4), reflecting the struggles schools encounter in managing sanitation facilities, particularly with high usage. This comment underlines the necessity for durable and sustainable sanitation infrastructure, extensively discussed in academic circles, focusing on the influence of sanitation on health and educational outcomes (WHO/UNICEF JMP, 2020).

5.3.2.3 Proposed solutions and community involvement

Regarding potential solutions, the proposal to drill boreholes in schools to secure a consistent water supply is notable. This suggestion represents a community-centric approach to addressing water scarcity, consistent with sustainable development principles and local empowerment. Such community-based solutions are advocated in various academic studies, underscoring the efficacy of localised and participatory methods in water management (Patel & Jha, 2019).

5.3.2.4 Summary

The perspectives of residents and learners in the Rustenburg sub-district, as elucidated through the discussions, provide valuable insights into the challenges and prospective

solutions for managing potable water and sanitation infrastructure in educational settings. These viewpoints resonate with and enrich the broader scholarly discussion on water management in educational environments, emphasising the significance of education, community engagement, and sustainable approaches in ensuring effective water and sanitation service management.

5.3.3 Analysis of results in the context of Research Objective 3 states that:

Evaluate the technical capacity of Rustenburg Local Municipality (RLM) (RLM) to provide potable water and sanitation infrastructure management to schools.

The examination of discussion transcripts from schools within the Rustenburg Local Municipality sheds light on the technical capacity and challenges faced in providing potable water and sanitation infrastructure. The discussions clarify a range of issues encompassing infrastructure maintenance, resource allocation, and systemic obstacles within municipal and educational frameworks.

5.3.3.1 Infrastructure maintenance and management

A prominent challenge identified through the discussions is the absence of a systematic maintenance plan for school facilities, inclusive of potable water and sanitation infrastructure. As highlighted in a discussion, the lack of a maintenance plan is evident, and issues such as burst pipes experience delays in acquiring necessary repair materials. This absence of proactive maintenance planning and the ensuing delays contribute to infrastructure degradation and inefficient resource utilisation. The observation that timely maintenance could enhance infrastructure longevity resonates with academic research emphasising the significance of regular maintenance for the durability of infrastructure.

5.3.3.2 Holistic network and resource allocation

Schools are integrated into the broader system responsible for water supply to residents, as indicated in a discussion. Nonetheless, internal challenges within municipalities, such as limited resources and an inadequate fleet for operations, impede the effective provision of services. These difficulties mirror wider issues in resource allocation and infrastructure management that are prevalent in many municipalities, as explored in scholarly works on public service delivery and infrastructure management.

5.3.3.3 Systemic challenges and water shortages

Widespread issues like pipe leaks play a substantial role in water shortages and inefficiencies in water distribution. Addressing these leaks could markedly enhance water availability and minimise wastage. This scenario reflects broader structural challenges in infrastructure management, where preventative maintenance and prompt repairs are critical. The proposal to allocate maintenance budgets or assign custodianship of infrastructure to public works departments suggests a need for more cohesive and efficacious management strategies.

5.3.3.4 Summary

The discussions from Rustenburg sub-district schools paint a detailed picture of the technical capabilities and challenges in ensuring potable water and sanitation infrastructure. Key challenges include the lack of maintenance planning, resource limitations, and systemic issues within both municipal and educational settings. To overcome these challenges, there is a necessity for not only augmented resources and enhanced maintenance practices but also systemic modifications in the management and upkeep of water and sanitation infrastructure. The findings from these discussions, contextualised within the broader academic dialogue, highlight the imperative for more effective and integrated approaches to infrastructure management in schools to guarantee consistent access to potable water and sanitation services.

5.3.4 Analysis of results in the context of Research Objective 4 states that:

Analyse challenges schools face in the provision of effective potable water and sanitation management under Rustenburg Local Municipality (RLM) (RLM)'s jurisdiction.

The discussion transcripts from schools within the Rustenburg Local Municipality (RLM) provide vital insights into the challenges these institutions encounter in securing potable water and sanitation services. These challenges encompass a range of issues, from systemic difficulties within the municipality to direct impacts on the school environment.

5.3.4.1 Systemic and infrastructure challenges

A primary issue identified in the discussions is the lack of a consistent maintenance plan for school facilities, particularly water and sanitation infrastructure. This deficiency is

aggravated by delays in procuring the necessary materials for repairs, resulting in extended periods of infrastructure deterioration. Such circumstances mirror wider concerns in the realm of infrastructure management, especially in environments with high water usage like schools. Moreover, the discussions underscore the problem of water wastage due to unaddressed leakages, emphasising the necessity for prompt maintenance to ensure infrastructure longevity. These challenges align with academic research emphasising the importance of regular maintenance and efficient infrastructure management (Naidoo, 2018).

5.3.4.2 Technical and resource limitations

The discussions also disclose limitations in technical capacity and resources within the municipality. Challenges such as an inadequate number of vehicles for operational needs impact the timely delivery and maintenance of services. Additionally, systemic issues, including widespread pipe leaks, intensify water shortages and contribute to inefficiencies in service provision. These findings are in line with scholarly discussions on the effects of resource constraints on the quality-of-service delivery (O'Brien & Hart, 2018).

5.3.4.3 Governance and budgetary constraints

Governance and budgetary constraints are identified as significant factors influencing the provision of potable water and sanitation services. The discussions indicate a requirement for improved allocation and management of maintenance budgets to effectively tackle infrastructure challenges. This aspect reflects the broader academic discourse on the necessity of governance and financial management in ensuring sustainable water and sanitation services (Shelare *et al.* 2023).

5.3.4.4 Summary

The insights from Rustenburg Local Municipality (RLM) schools shed light on various critical challenges in providing potable water and sanitation. These encompass systemic and infrastructural issues, technical and resource limitations, as well as governance and budgetary constraints. To effectively address these challenges, a multi-dimensional strategy is required, entailing improved maintenance planning, enhanced resource allocation, and strengthened governance and financial management. These findings contribute to a more profound comprehension of the complexities in delivering essential

services to schools and highlight the need for comprehensive approaches to ensure reliable access to potable water and sanitation.

5.3.5 Analysis of results in the context of Research Objective 5 states that:

Explore, assess and recommend service delivery mechanisms to improve water and sanitation infrastructure in local schools.

Discussions conducted in schools within the Rustenburg Local Municipality (RLM) provide insightful perspectives on potential service delivery mechanisms to ameliorate the condition of potable water and sanitation infrastructure. These insights describe the prevailing challenges and accordingly offer recommendations for the enhancement of service delivery in the local educational context.

5.3.5.1 Implementing sustainable solutions

A principal recommendation derived from the discussions is the adoption of sustainable solutions, such as the installation of boreholes at schools. This suggestion is in line with the principles of sustainable water management outlined in academic studies (Patel & Jha, 2019). The establishment of boreholes would enable schools to have a more dependable and self-sufficient water supply, thereby reducing reliance on municipal services. This strategy not only secures a consistent water supply but also fosters environmental sustainability.

5.3.5.1.1 The state of the borehole in the Rustenburg Local Municipality (RLM)

Rustenburg Local Municipality (RLM) and the DWS are in charge of borehole drilling and water distribution, while the Department of Health is in charge of preventing waterborne illnesses and ensuring public health safety, especially in vulnerable communities where water quality may be compromised (Rustenburg Local Municipality (RLM), 2021/2022). Water scarcity and dependence on boreholes raise the danger of waterborne infections, particularly if water is acquired or stored in unsanitary conditions. In relation to Rustenburg's persistent borehole and water shortage difficulties, the Department of Health is essential in helping to address water-related health concerns.

In order to assist the prevention of the spread of diseases like cholera, which have been documented in comparable high-risk circumstances throughout South Africa, the

Department of Health intervenes by teaching locals safe water storage and hygiene techniques (Swatuk & Cash, 2022). In areas like Rustenburg Local Municipality, where locals frequently turn to alternate water sources that might not receive routine monitoring, this community outreach is crucial. To stop the spread of diseases from contaminated sources, this help involves evaluating the water quality from newly dug and renovated boreholes. The risk of waterborne illnesses is increased by water scarcity and reliance on boreholes, especially if water is obtained or stored in unhygienic settings. In order to stop the spread of diseases from contaminated sources, this help involves evaluating the water quality from newly dug and renovated boreholes. To monitor and control health problems associated with water scarcity, the department also works with nearby clinics and hospitals.

Health professionals can provide prompt interventions and notify the municipality to prioritise borehole repairs or water supplies in impacted regions by keeping an eye on incidences of illnesses, such as gastrointestinal infections, that may be connected to inadequate water access. This health-focused data generation lessens the possible health impact on Rustenburg's citizens and schools by assisting authorities in identifying certain areas with pressing water and sanitation needs. For example, the Department of Health issues advisory warnings and, in certain situations, assists in setting up mobile water tankers to guarantee residents have access to safe drinking water while repairs are being made when boreholes in specific areas exhibit indications of contamination or malfunction (Mathase, 2021). The Department of Health works with the Rustenburg municipality to address water contamination situations as addition to preventive measures. Their health-focused contributions highlight the vital connection between public health and water infrastructure, intending to shield Rustenburg's citizens from the detrimental health effects of the water crisis. During times of water constraint, this collaboration guarantees that both short-term and long-term health demands are met. In general, the Department of Health's involvement in the borehole crisis in Rustenburg emphasises how crucial it is to provide public services in an integrated manner when there is a water shortage.

5.3.5.2 Addressing infrastructure maintenance

A recurrent theme in the discussions is the challenge of water wastage due to unaddressed pipe leaks. To address this, the implementation of a comprehensive maintenance plan is indispensable. The discussions propose equipping public works with the necessary resources for timely maintenance and repair works. In accordance with public infrastructure management research, regular and efficient maintenance is crucial for extending the lifespan of water and sanitation infrastructure and minimising resource wastage (O'Brien & Hart, 2018).

5.3.5.3 Proactive management and planning

The formulation of an all-encompassing maintenance plan is imperative for the sustenance and efficacy of water and sanitation infrastructure. This plan should encompass regular inspections, prompt repairs, and proactive resource management. Such a strategy is consistent with best management practices in public service delivery, underscoring the importance of anticipatory and preventive methods in infrastructure management (Shelare *et al.*, 2023).

5.3.5.4 Summary

The examination of discussions from Rustenburg Local Municipality (RLM) schools indicates that the improvement of potable water and sanitation infrastructure in educational settings demands a multifaceted approach. This approach should integrate sustainable solutions like borehole installation, robust maintenance of infrastructure, and proactive management and planning. The implementation of these recommendations is likely to significantly elevate the standard and reliability of water and sanitation services in schools, thereby enhancing the health and educational outcomes for the learner population.

5.3.6 Analysis of results in the context of Research Objective 6 states that:

Propose guidelines for a school environmental policy that supports potable water and sanitation infrastructure management in the education curriculum.

The analysis of discussion transcripts from schools within the Rustenburg Local Municipality (RLM) offers insights into the implementation of environmental education in school curricula, although a distinctly defined school environmental policy is not explicitly mentioned in the transcripts. Nonetheless, inferences can be drawn from discussions regarding environmental practices and educational methods in these institutions.

5.3.6.1 Inclusion of environmental education in the curriculum

A prominent theme from the discussions is the integration of environmental education within the school curriculum. For example, one respondent discussed the inclusion of topics related to health, social, and environmental responsibility in the life orientation curriculum, encompassing aspects such as pollution and environmental care. This integration indicates an acknowledgement of the significance of environmental education, even in the absence of a formalised school environmental policy. This approach is in line with global educational trends, where environmental education is progressively integrated into a variety of subjects to promote a comprehensive understanding of environmental challenges (UNESCO, 2017).

5.3.6.2 Awareness and action plans

The discussions also underscore efforts to cultivate awareness about environmental concerns, including water conservation and efficient resource utilisation. Such endeavours are critical in fostering learners' comprehension and valuation of environmental issues. However, the absence of a detailed action plan or strategy for the implementation of these educational initiatives suggests a possible area for enhancement. The necessity for well-structured environmental policies and action plans in educational settings is emphasised in scholarly literature, advocating that organised approaches can facilitate more effective and enduring environmental education outcomes (O'Reilly & Louis, 2018).

5.3.6.3 Challenges in policy implementation

While the discussions reflect an understanding of environmental matters and some degree of incorporation into the curricula, they also unveil challenges in policy implementation. Complications like water shortages and infrastructural inadequacies can hinder the efficacious delivery of environmental education. Addressing these obstacles

necessitates not merely educational initiatives but also improvements in infrastructure and resources, as indicated in the discussions and corroborated by academic research (Brown & Damania, 2019).

5.3.6.4 Summary

The discussions conducted in schools of the Rustenburg Local Municipality (RLM) reveal an awareness of environmental concerns and a degree of integration of environmental education into the curriculum. However, the absence of an expressly articulated school environmental policy in the discussions signals a potential deficiency. To augment the efficacy of environmental education, it would be beneficial for schools to develop and implement a formal environmental policy, encompassing specific strategies and action plans. Such an approach would ensure a more systematic and thorough inclusion of environmental education within the school curriculum, aligning with international educational trends and best practices.

5.4 Chapter conclusion

This chapter presented an extensive analysis of discussions with stakeholders from schools within the Rustenburg Local Municipality (RLM), offering profound insights into the complex challenges associated with providing potable water and sanitation infrastructure. The analysis brings to light the varied experiences and perceptions of key respondents, ranging from school administrators to local government officials, thus offering a comprehensive portrayal of the current state of water and sanitation services in educational contexts. Key issues highlighted include inadequate infrastructure, budgetary limitations, and the necessity for sustainable and efficacious service delivery mechanisms. Moreover, the incorporation of academic literature into the discussion enriches the understanding of these challenges' practical implications and underscores the need for holistic and integrated improvement strategies.

This chapter underscores the urgent need for collaborative action in addressing the challenges identified. It calls for joint efforts among all stakeholders, including local authorities and school communities, to develop and execute robust policies and action plans. Such collaborative actions should aim to resolve not only the immediate infrastructural and resource challenges but also to cultivate an ethos of environmental

awareness and sustainability within educational environments. The insights derived from this analysis are crucial for policy development and implementation, offering a valuable resource for stakeholders in crafting effective solutions to improve the quality and reliability of water and sanitation services in schools. This chapter, therefore, makes a significant contribution to the broader discourse on the essential role of adequate infrastructure in fostering health, well-being, and educational success in school communities. In the next chapter, the water potable and sanitation infrastructure management framework for the Rustenburg Local Municipality (RLM) is outlined.

CHAPTER 6 WATER MANAGEMENT FRAMEWORK FOR RUSTENBURG LOCAL MUNICIPALITY (RLM)

6.1 Introduction

Chapter 6 begins with the open reintroduction of the six research objectives of the study, so that every argument that follows can be traced back to these guiding questions set out in Chapter 1. The main objective of the study is to design an Integrated Water Resource Management (IWRM) framework that realises effective access to drinking water and dignified sanitation for learners across schools in Rustenburg, as entrenched in the constitution. The secondary objectives require the study to consider the following issues: (1) interrogating how a human-rights-based approach should shape equitable service delivery in the education sector; (2) capturing learner, parent and educator perceptions and lived experiences; (3) evaluating municipal technical, financial and management capacity; (4) enumerating practically faced challenges schools encounter in satisfying WASH standards; (5) establishing a context-sensitive service-delivery model; and (6) transcribing into policy guidelines and curriculum tools subject to monitoring over time. In such a framing, the research becomes congruent with UNGA Resolution 64/292 on the human right to water and sanitation and well within the embrace of Sustainable Development Goal number six, which obliges states to work toward universal access by 2030. Such objectives are not simply academic milestones but rather an explicitly laid roadmap for converting global legal commitments to verifiable local outcomes.

The current chapter addresses the water management challenges facing the Rustenburg Local Municipality (RLM). It attempts to develop an environmental and integrated water resources management (EIWRM) plan for the municipality, based on insights from earlier discussions. The EIWRM plan addresses specific regional challenges by pairing targeted implementation strategies with a monitoring and evaluation framework to drive progress toward their resolution. The next section outlines Rustenburg's water management context. Following the context description, the chapter outlines IWRM principles, as well as basic elements of integrated management that comprise the plan. Then the chapter details practical applications of the plan. This not only describes how the plan targets the resolution of problems but also shares with readers the essence of the plan that targets

the management of potable water for the benefit of the people of Rustenburg in a manner that is socially just and environmentally sustainable.

The earlier chapters have laid the groundwork for comprehending the really important issues tied to managing water resources in Rustenburg. They have confronted and highlighted significant challenges the municipality faces. These include water availability, pollution and quality, infrastructure and resource management, and intensive industrial activities, particularly mining. Together, these factors jeopardise an effective water management system, and place huge demands on the already underfunded and overextended municipality. Given the amount of water supplied meets the immediate demands placed on it, essentially the quantity and quality needed to maintain an acceptable standard of public health, that availability was seriously compromised, unless actions are taken to greatly reduce the amount of polluted run-off that flows directly into local water bodies, and to extend the quantity and quality of the water supplied to the municipality (Biswas & Tortajada, 2018:2).

Chapter 6 weaves the two theoretical lenses that ground the HRBA thesis and General Systems Theory (GST) to present a strong and adaptable model for Environmental and Integrated Water Resource Management (EIWRM). HRBA provides evaluative criteria: participation, accountability, non-discrimination and transparency in conformity with UN human rights systems. In an attempt to change its focus, GST originally articulated by Ludwig von Bertalanffy explains how complex organisms manage their internal activities and how their mechanisms of self-regulation can be refashioned to showcase phenomenon feedback between political mandates, budget cycles, technical operations and community behaviour in municipal service delivery. Contemporary public-administration scholars insist that system approaches are essential to solve these post-modern "wicked" cases of infrastructure problems because they highlight leverage points where small policy adjustments could trigger outsized improvement. The position for the EIWRM model has therefore been built on the normative clarity of HRBA and broad analytical insights of GST to take on rights violations while remaining aware of the dynamic interactions, which it may put in jeopardy during implementation.

Then followed a finely nuanced situation of Rustenburg Local Municipality (RLM) pointing towards an integrated rights-centred system needed with immediacy. Recent evidence in the Voluntary Local Review has it that hasty urban sprawl, heaps of toxic solids left behind by mining activities and droughts as a result of climate change all account for chronic water stress; thus, most households and schools do not have reliable access to water. Evidence collected through field work for the thesis confirms this general picture: existing infrastructures, especially in peri-urban and informal settlement schools, are unfit for basic health and safety standards due to factors such as old pipes, interruptions in supply and under-staffed maintenance units. Several illustrative research investigations state that the picture is no better nationally, noting that one in four South African schools still lacks reliable water services and that pit latrines are still prevalent despite the several court orders to abolish them. Absenteeism was higher, health costs incurred were greater, and disparities based on gender were greater for many school children the same results of development-finance analyses that show how poor WASH facilities are linked to worse academic performance. These converging data points justify this chapter's focus on rights-compliant, whole-system reform rather than piecemeal technical solutions.

Approaching the Human Rights-Based Approach (HRBA) in terms of development as a process of realising legally binding rights instead of delivering discretionary benefits. The United Nations' 2003 "Common Understanding" has anchored HRBA in international law, affirming that participation, accountability, non-discrimination, transparency and human dignity should be integrated into all programmes (UN, 2003). Such norms would ensure water and sanitation initiatives, going forward, better equity and quality of service (Vitkova, 2018; Vandenhole, 2024). Thus, SDG 6 more explicitly now framed in rights terms rather than as a conventional policy aspiration by global water-governance actors (Human Right 2 Water, 2020) - also inscribed into recent analytical South Africa, whereby "water equity" is said to be a constitutional imperative for post-apartheid service delivery (Mattei, 2022). These sources thus establish a normative baseline in the present study for focus on the access to potable water and sanitation facilities in Rustenburg schools, thereby ensuring empirical queries on the infrastructure are assessed against the universals rather than local sensibilities or fiscal convenience (OHCHR, 2023).

The mapping of these rights principles onto the study objectives further illuminates the causal pathways that are interrogated in this research project. The first objective - to craft an Integrated Water Resource-Management (IWRM) model for Rustenburg - draws directly on HRBA's requirement for duty-bearers to adopt holistic, rights-responsive governance tools (SIWI, 2016). Objectives 2-4 (assessing community perceptions, municipal capacity and school-level challenges) operationalise HRBA principles of participation and accountability through the use of learners, parents and local officials as co-producers of rights outcomes (Mamokhere & Meyer, 2022). Objective 5 (model development) aligns with the HRBA imperative of non-discrimination by prioritising historically marginalised rural and informal-settlement schools (Gumbi, 2020), while Objective 6 (policy guidelines) mirrors HRBA transparency requirements through explicit monitoring and redress mechanisms (UNSDG, 2024). In this way, each of these empirical tasks advances a specific HRBA norm, embedding the thesis in a coherent conceptual architecture.

To bring rights norms into actionable strategic frameworks, the integrated framework marries General Systems Theory (GST) to an HRBA. GST assumes that the results of the service emerge out of an active dynamics of loop feedback among interdependent subsystems rather than the consequence of linear inputs (von Bertalanffy, 1968). Thus, applying GST in the context of municipal water is concerned with interaction, reinforcing failures, and sometimes coupling between the political dictates, the budget cycles, technical operations, and community behaviours in Rustenburg schools (Reynolds & Holwell, 2020). Most recently, Carr-Chellman defined "negentropy" as how learning throughout the system can keep an infrastructure from decay through multiple infusions of information and energy at leverage points (Carr-Chellman *et al.*, 2020). Diffusion studies by O'Callaghan also bear this out; they endorse the understanding that the adoption of water technologies happens much more quickly when systemic barriers have been mapped and addressed iteratively (O'Callaghan *et al.*, 2019). OECD case studies illustrate as well how public sector reform is made more resilient and agile through systems approaches (OECD, 2017). Combined, all of these support pairing the normative clarity of HRBA with the analytical breadth of GST for designing such an adaptive, rights-compliant IWRM model.

These Russians would approve this intellectual framework. A global systematic review linking poor WASH resources in schools to poor health and sickness (McMichael, 2019) finds support in those studies about vulnerability in South Africa to shocks and maintenance failures related to climate in rural areas (Momborg *et al.*, 2021). Field evidence also indicates that poor governance in participatory processes, especially weak community forums, prevents HRBA accountability in slow SDG 6 progress (Mamokhere & Meyer, 2022). Systems-level assessments show that incorporating school maintenance guidelines supported by GIS-enabled tracking can create positive feedback loops for stabilising performance delivery (Ross *et al.*, 2025). Finally, caution raised from studies on "water apartheid" warns that without explicitly coercive non-discrimination measures, infrastructure investment may serve more to entrench rather than redress historical inequities (Nyahunda, 2021; Mattei, 2022). The cumulative weight of all of these insights highlights the need for a rights-framed and systems-informed conceptual framework to guide the transformation of Rustenburg's service delivery from being fragmented to equitable, sustainable water and sanitation for every learner.

6.2 Principles of environmental and integrated water resources management

The Environmental and Integrated Water Resources Management (EIWRM) principles are based on a comprehensive, systematic, and combination of systems approach to managing water resources that recognises the complex interrelations among water, land, and other associated resources (Nagata *et al.*, 2022:897). EIWRM is more than a set of principles for managing supplies of water; it is a philosophical framework that envisions an "integrated" future for water, land, and associated resources, especially those in river basins. As indicated by Biswas and Tortajada (2018), the principle must feature sustainable, equitable, and participatory decision making among stakeholders at all levels.

Integrated Water Resource Management (IWRM) identifies water not only as a basic and invaluable resource but also as a multifunctional resource. It sees water as a biophysically and chemically controllable factor within an environment; a vital component of every ecosystem, whose conservation and effective management in quality, quantity, and timing are key to the sustainable development of any society; and a resource over which

individuals, communities, and nations have fought and continue to fight. Hence, the need to develop policies aimed at using this resource effectively, conserving it, and achieving social equity, considering when using water in development programmes (Moumen *et al.*, 2019).

The IWRM principles also strongly favour a river basin approach to water resource management, which is arguably the most fundamental and effective unit for coherent and efficient management strategies (Dirwai *et al.*, 2021). This "water basin perspective" encourages coherent assessment of water resources within the natural confines of a watershed, forces management to transcend political or administrative boundaries, and brings all key stakeholders, most importantly, river basin communities themselves, into the decision-making process. The IWRM principle that emphasises "adaptability" is another key to its potential effectiveness (Julio *et al.*, 2021). Recognising the inherent fluidity of both water systems and water resource societies, IWRM calls for flexibility and adaptive decision-making, in "water scarce as well as water abundant regions," to embrace an often highly variable range of environmental, social, and economic conditions.

The Rustenburg Local Municipality (RLM) faces both an imperative and consistent challenge in applying integrated water resource management (IWRM) (Malherbe *et al.*, 2020:2). Much of the municipality's water resource management problems are dominated by the mining sector (Lagercrantz & Khabbaz, 2019:12). The mining activities in Rustenburg are extensive (especially Platinum Group Metals [PGM]). These have a direct impact on the availability and quality of local water resources, primarily surface water, but also groundwater (Brovko, 2020:8). The IWRM principles emphasise that the mining sector must be part of the solution and local communities (including those in Rustenburg) must be part of the governance system.

In Rustenburg, the implementation of IWRM is vital. The municipality is on the edge of a water crisis that threatens not only to undermine its sustainability efforts but also cause significant harm to the local economy (Mahlatini, 2019). The IWRM strategy addresses just about everything a local water authority might need to consider, and its principles are tailored to the authority's particular circumstances, not just its physical, geographical, and hydrogeological conditions, but also its social, political, and economic environment. The

IWRM strategy is in the hands of the authorities when it comes to considering future developments in and around the town, and they badly need to follow it. The use of IWRM principles in Rustenburg is not just about finding technical solutions. It is also about a broader, more inclusive way of addressing water issues that transcend the common environmental, social, and economic "triple bottom line" dimensions of water resource management, all of which are supposedly key to effective integrated water resource management.

6.3 Review of global water resource management models

Efficient global models for managing water resources exist, even if dramatic variation in context limits their immediate applicability. The Integrated Urban Water Management (IUWM) model, for example, operates quite successfully in Melbourne, Australia, and has also been applied in other areas (Hart *et al.*, 2014:101). Its approach is to integrate not just various water management functions, such as supply and drainage, but also to integrate a comprehensive range of urban planning functions that impact the natural, built, and social environments relevant to water. In contrast to IUWM's almost overly comprehensive approach, two models developed in Europe for managing water resources in basins, *Flussgebiet Management* (in Germany) favour a more compartmentalised approach of engaging with key stakeholders (Wagner, 2024).

The way these models work usually depends on how well they can deal with regional problems. Singapore's Water Sensitive Urban Design (WSUD) model tackles the problem of managing water in the urban environment and emphasises the conservation and quality of urban water resources (Radcliffe, 2019). The River Basin Management model, effective in the European Union under the Water Framework Directive, promotes management of water resources at the basin level and takes an integrated approach, working beyond political and administrative borders (Skoulikaris & Zafirakou, 2019:14837). Despite their different emphases, and even their different effective locations (both are effective in areas with certain kinds of urban water challenges), these two models share many principles and even specific governance structures.

Rustenburg faces unique problems, especially concerning the availability and quality of water. Here the mining sector, particularly platinum mining has played a major role in shaping the current water situation (Lagercrantz & Khabbaz, 2019:12). The chapter will

outline integrated intervention frameworks that may guide Rustenburg's local authorities toward better governance of the urban water cycle. In so doing, it will present three models for effective urban water governance that we believe could be relevant for Rustenburg, despite its specific environmental and socio-economic context. These three models differ in both approach and focus. However, there are also common elements: an integrated approach to water-resources management (not just urban water supply and disposal); and a meaningful role for community members and stakeholders.

For Rustenburg, combining features of the Water Sensitive Urban Design (WSUD) and River Basin Management models could yield dividends. The WSUD's prime concern with urban water conservation fits well with what Rustenburg requires: a system that manages its water resources across urban and industrial domains (Radcliffe, 2019:18). The comprehensive stance taken by the River Basin Management model suits Rustenburg's context: the area has a river basin running through it and governance across various authorities and several stakeholders to coordinate. Adopting this combination of models in a blended manner could suit Rustenburg as well as any place that finds itself in a similar situation (Radcliffe, 2019:19).

6.4 Case Study: Olifants Water Management Area (WMA) Integrated Water Quality Management Plan (IWQMP)

The principle of water quality management provides a view on an effective and efficient manner of preserving water even for future generations. Established in South Africa in 2018, the IWQMP for the Olifants Water Management Area is a prime example of an effective integrated water management approach (Kyei, 2019:2). It faces up to the area's acute water quantity and quality problems in a way that is designed to work with the governance framework within which the catchment area functions (DWS, South Africa, 2018:1). Integrated water quality management in the Olifants WMA aims to address the substantial and diverse issues relating to pressures on the area's water resources through governance that embraces all sectors.

The IWQMP is built on basic principles. These principles encompass not just water quality protection but also pollution prevention, which is the most effective and least expensive way to achieve desired results (Potgieter, 2019:141). The IWQMP cuts across various water uses, from drinking water to irrigation to industrial use, and even "virtual water"

embedded in the products we consume. Lastly, the programme actively seeks public participation, which is essential and, in many ways, a precondition for success.

6.4.1 Source protection strategies in IWQMP

The IWQMP takes a three-dimensional approach to source protection, with clear diversion strategies to maintain water quality at its origin. In this context, the plan makes good use of land use planning, which helps to keep pollutants from agricultural and other activities away from the water (Atangana, 2023: 105001). By reducing runoff, effective land-use policies keep water bodies clean. Relating to zone management is half the story; the other half is looking after the watershed and addressing problems as they arise. Another critical area is wetland management. The plan aims to conserve and, where necessary, restore wetlands. Wetlands are natural water filters and purifiers; when in good condition, they help keep surface waters clean. The Olifants WMA has some of the most polluted surface water in the country, necessitating anything that can be done to reduce or eliminate that problem. For instance, acid mine drainage, linked to extensive mining across the WMA, has severely degraded water quality, a problem that healthy wetlands could help mitigate.

6.4.2 Wastewater treatment enhancements in IWQMP

The IWQMP places top priority on improving the quality of treated wastewater. Upgrading occurs in existing treatment facilities, which serve both technological and educational purposes. It brings all systems up to a high standard of treatment (Kyei, 2019:3). The plan also incorporates decentralised treatment systems, such as septic tanks or constructed wetlands, for use in places like small towns or rural environments that are not practical for a central treatment works. The end goal is the same: use attendance to quality control and operator training as a bridge to achieving the programme's higher standard of accepted treatment.

6.4.3 Monitoring and evaluation in IWQMP

The Olifants Water Management Area Integrated Water Quality Management Plan (IWQMP) has a component that is clear-cut and comprehensive. Olifants water management's monitoring and evaluation component is designed to ensure the plan is effective and achieve its many stated goals (Namakando, 2020:12). The framework

prompts regular examination of a host of water quality parameters throughout the WMA. The data yield a picture of the current quality of water and trend lines that suggest where quality might be heading. Performance metrics for wastewater treatment plants are monitored like the State of the Union, from the outside looking in, and to stunning effect. Overall effectiveness of different plants and the efficiency of pollutant removal give us a clear picture of how well these plants are functioning and what impact they're having or not having on the water quality throughout the WMA.

6.4.4 Stakeholder participation and implementation challenges

The inclusive method that largely determines the IWQMP's efficacy might well be its most commendable quality. The development and execution of the plan benefit from stakeholder input, with ample opportunity for relevant groups to express their viewpoints (Kyei, 2019:3). This early and ongoing integration of stakeholders, including communities, industry, and governmental entities, might make the IWQMP the most relevant and effective plan imaginable. In a sense, it also makes the plan more politically palatable because it draws upon a shared vision. Bill, Carl, and Jon (2005) point out some main obstacles to implementing plans like the IWQMP: multi-stakeholder coordination, long-term funding, and technical complexity. The authors of this section are also challenged by these three issues, mainly because of the scale of the problems being worked on and their water quality management technicalities.

6.4.5 Lessons learned and applicability to other regions

The Integrated Water Quality Management Plan for the Olifants Water Management Area holds valuable lessons for other regions grappling with similar water quality problems. One of these is that confronting complex, interrelated problems in multiple water uses and sectors demands an integrated approach. That seems evident from the attempt to ensure that mechanisms for protecting the source watershed work effectively in concert with advanced water treatment systems, that is, with systems that present a technological panoply for ensuring that the water is safe for its many, varied uses. Another lesson from the Olifants IWQMP is the significant role of collaboration among stakeholders in the implementation of the plan. Conference respondents emphasised this role in no uncertain terms.

6.4.6 Integration with broader environmental and social goals

The Integrated Water Quality Management Plan (IWQMP) for the Olifants Water Management Area (WMA) goes beyond just dealing with water quality problems; it works to achieve wider environmental and social aims. This interaction is fundamental to the sustainable development of both the Olifants River basin and its surroundings. The IWQMP has a large focus on protecting the natural habitats of the area, from wetlands to riparian zones (Atangana, 2023:105). This focus helps not only with sustainable development but also with another important goal: the conservation of biodiversity, ecological resilience, and significant ecological habitats. Furthermore, the plan highlights sustainable land use and mining practices, which affect the environmental conservation of a watershed with extremely limited land and habitat. They could help keep the area's rapidly rising human population from more seriously degrading the area's vegetation, soils, and streams. The area's lowland rivers could also benefit from the plan's emphasis on public health; for example, by ensuring the riverbanks are planted with trees and shrubs that help keep the river's water clean.

6.4.7 Economic impacts and sustainability

The Olifants WMA IWMP has sweeping economic effects, shining a light on the plan's sustainability and the role it plays in the local economy. The direct enhancement of water quality and the assurance of a reliable water supply have significant beneficial impacts on agriculture, the region's key economic sector. The plan strengthens agricultural productivity. By the same token, the benefits the plan confers are not confined to agriculture. The greater water quality aspect of the plan reduces the water treatment and health care costs borne by public and private entities. Consequently, the plan yields significant economic benefits for both sectors.

In addition, concentrating on sustainable mining practices provides long-term economic benefits by avoiding the messy, costly, and environmentally damaging problems that can result when mines close. The plan's strategies for wastewater reuse and water resource management advocate conservation. The plan is economically advantageous because it reduces the overall water demand and the costs associated with that demand. These strategies also are environmentally responsible. They ensure that the region's water

resources can support the many activities that underpin its economy, while also being available to sustain the environment for future generations.

6.4.8 Challenges and opportunities for future development

The Olifants WMA IWQMP, while successful, still encounters many ongoing challenges and opportunities for future development. A major challenge is ensuring that stakeholders remain engaged and committed to the collaborative, effective implementation of the plan. The environmental and socio-economic conditions that affect the water management area are so dynamic that they require the plan to be increasingly adaptable and responsive (Dube *et al.*, 2021:2). Technological advances in areas such as water treatment and water quality monitoring, if they are incorporated into the plan, can, and in some places already do, augment its effectiveness. Another future development opportunity lies in expanding community-based initiatives, which promise to enrich the plan's local, on-the-ground feasibility and enhance its effectiveness. By acting as a model for other places, both in South Africa and elsewhere, that are pursuing integrated water resource management, the IWQMP also has some prospect of multiplier effects, which means other places might follow suit and do something similar.

6.4.9 Implications for Rustenburg's IWRM Plan

Rustenburg's Environmental and Integrated Water Resources Management (EIWRM) plan can benefit from the insights offered by the Olifants Water Management Area (WMA) Integrated Water Quality Management Plan (IWQMP). This case study emphasises that involving diverse stakeholders and adopting an integrated approach to the entire water cycle are essential to success. The authors of the EIWRM plan sought inspiration from the successes and challenges of the Olifants WMA IWMP and found many of the aspects on which the Olifants WMA IWQMP focuses to be pertinent. These include source protection, stakeholder participation, and the integration of environmental and social objectives. The adaptability and responsiveness of the Olifants WMA IWMP are also characteristics that the EIWRM plan's authors deem critical to the success of their plan.

6.5 Case Study: Sanitation appropriate for education (SAFE) initiative

The Department of Basic Education in South Africa launched the Sanitation Appropriate for Education initiative directly addresses the pressing need for improved sanitation

facilities at schools and serves as a key intervention in the education system's sanitation crisis. Education directors say the initiative is a response to the situation of schools that lack adequate basic hygiene facilities, which pose a serious threat to the wellbeing of the schools' learners and a virtual guarantee that affected learners will underperform as long as they are in an unhygienic academic environment (Department of Basic Education, 2021:2)

The SAFE initiative started with an initial number of 3898 schools but was later reassigned to 2806 schools. This change was due to a few reasons: the rationalisation of educational institutions (both the necessary consolidation and closing of ineffective schools) and the elimination of sites assessed as ineffective. The adjustments to this number over a relatively short period highlight the initiative's overall fluidity, the ongoing necessity of evaluation and modification to determine efficacy, and the establishment of appropriate sanitation facilities that ensure accessibility and long-term viability (Muanda, Goldin & Haldenwang, 2020:238).

So far, the SAFE initiative has succeeded in getting sanitation projects completed at 1723 schools. These establishments now contain a comprehensive suite of appropriate and completely functional restrooms. This is a giant step toward realising the universal availability of adequate sanitation in this country's schools (Nkosi & Tabit, 2021:1). The Department of Basic Education has 1083 sanitation projects still in train, and these are slated for completion before the end of the 2022/23 fiscal year (DBE, 2021).

The SAFE initiative is part of the far-reaching framework of the Sustainable Development Goals (SDG2030), and it focuses on providing healthy, adequate sanitation in educational facilities (Omotayo *et al*, 2021:631). This is, to put matters in a very commendable way, part of the effort to ensure that the sixth goal of the SDGs, far-removed from the realpolitik of both domestic and foreign policy. The sixth SDG is: "Ensure availability and sustainable management of water and sanitation for all" (Hakimdavar *et al.*, 2020:1634). The initiative is aligned with the SAFE initiative. At its core, the SAFE initiative represents a crucial step in the direction of alleviating the sanitation crisis among South African schools. Its fruits, thus far, are impressive. Yet we have not arrived at our ultimate destination: ensuring that every school has sanitation facilities that are not simply in place, but also in working order. That would require, not merely the most limited interpretation of "adequate facilities" but

instead a commitment to something closer to universal access to "better" sanitation, something that very few people can define and that fewer have the means to pursue.

6.5.1 Evaluation of the SAFE programme

The detailed work of the SAFE initiative has brought a salutary change to the inhumane sanitation conditions in too many South African schools. Its work targets schools using pit latrines; those are not safe, not clean, and not private. For the 2017 to 2021 period, 1 723 schools that were using either unsafe or unsafe-enough-for-privacy latrines were converted to usable sanitation conditions. That means 177 000 learners now have safe and private latrines and access to opportunities to tend to their hygiene needs (Department of Basic Education, 2017; 2021).

Critiques of the initiative mostly concern problems encountered during its implementation, especially the slow pace and the not-so-great quality of the established facilities. They assert that the planning and evaluative phases of the initiative were not done at all or not done well, as evident in the shifting of the target that was reduced from 3 898 to 2 806 schools (Department of Basic Education, 2021). Questions were also raised regarding the resources and logistics that might be affecting the initiative, as the completion of 1 083 encore projects (for the previously established projects halfway through set up, a counterforce was needed to say 'no' to unsanctioned shutdowns) has been delayed (Department of Basic Education, 2021).

The SAFE initiative has the potential to significantly improve health and educational results for the people it serves. Still, some critics contend that the initiative could be hindered simply because it concentrates heavily on building infrastructure. They worry that without a more thorough and wide-ranging approach, which would involve not just construction but also significant amounts of hygiene education, for starters, and maybe even some behaviour modification, the initiative might not get people to the desired result of using the new facilities and maintaining them properly. Moreover, critics question how well the initiative will serve marginalised and vulnerable demographic groups, including learners with disabilities (Pillay, 2020:37).

The initiative has received both praise and blame for the way it has directed the resources made available to it. Infrastructural development is important, and the initiative's choice

of establishing new sanitation facilities is indeed a good one. Yet, what about maintaining those facilities we already have? What about maintaining the new ones so they do not degrade? (Muanda, Goldin & Haldenwang, 2020:239).

In addition, distributing resources to the SAFE initiative must be balanced with other vital demands within the educational sector, such as teacher training, curriculum development, and educational materials (United Nations, 2020:1). Some critics have called for a more comprehensive approach that tackles the interconnected parts of the educational system if we are to see enduring improvements in school sanitation (McGranahan, 2015).

The SAFE initiative highlights the importance of involving communities and local stakeholders in the decision-making processes of sanitation projects (Omotayo *et al*, 2021:632). It insists on a participatory planning and design process to align the facilities being constructed with the specific requirements and preferences of the communities being served. It also promotes a sense of ownership among community members that is, in principle, more or less compliant with community members being served, and who was living with the choices made on their behalf. This is supposed to equal better maintenance outcomes and more durable facilities than those made without engaging the served community.

Despite this positive assessment, there are some who question the consistency and presence of community engagement in the SAFE initiative. Observers have noted that decisions about the design and siting of sanitation facilities sometimes seem to be made without adequate consultation with the school community, resulting in facilities that serve those communities imperfectly (Cronk *et al.*, 2021:2). Failure to engage the community could align with the initiative's not-so-positive understanding of the "Building Back Better" mandate, which is aimed at achieving its programme goals. Involving stakeholders is crucial to the SAFE initiative. It is necessary to get everyone from various government departments and non-governmental organisations to private sector entities working together towards the initiative's common goals. Whether they do or not, however, is another question, and one that SAFE might have trouble answering in its own case.

Unless it reduces some of its activities, SAFE would require at least five years to achieve its objectives. Even with the unhampered progress of stakeholders towards those objectives, the initiative might be unable to avert the deaths of 100 000 children a year

(Department of Basic Education, 2021:1). In addition, for the long-lasting sustainability of sanitation facilities, it is essential that local communities and the management teams of educational establishments take an active part in the sustainability and preservation of the facilities. It has been contended (Muanda *et al.*, 2020:240) that these communities and teams should receive training or capacity enhancement so that they can administer and maintain the facilities to the point where these facilities are functional and serving the communities for the long term.

Advocates of the SAFE initiative acknowledge its congruence with national policies and legislation that emphasise the necessity of providing safe and adequate sanitation in educational institutions. The initiative aligns with the commitment of the South African government to safeguard the rights of children to a secure and healthy educational environment, as described in the Constitution of South Africa, 1996. Moreover, the initiative contributes to the nation's endeavours to fulfil the Sustainable Development Goals, with a particular focus on Goal 6, which aims at ensuring the availability and sustainable management of water and sanitation for all (United Nations, 2020:1).

On the other hand, critics contend that despite the policy and legislative framework laying a foundation for the initiative, deficiencies in its execution and enforcement persist. There is a coherent necessity for the formulation of more conformity policies and regulations, specifically designed to confront the distinct challenges associated with sanitation in educational settings. Such policies ought to cover not merely the construction of facilities but also their maintenance, accessibility, and be combined with wider educational and health objectives (Cronk *et al.*, 2021:2).

Moreover, the efficacy of the SAFE initiative is dependent on the uniformity and coherence of policies across various governmental ranks. Obstacles in policy implementation frequently emerge due to discrepancies between national policies and the actual conditions at the local level, resulting in contrasts in the quality and durability of sanitation facilities across different regions (Muanda, Goldin & Haldenwang, 2020:239). The translation of policies into effective practice necessitates enhanced coordination and cooperation among national, provincial, and local government entities (Department of Basic Education, 2021).

6.6 Proposed EIWRM Plan for Rustenburg Local Municipality (RLM)

The Environmental Integrated Water Resources Management plan suggested for the Rustenburg Local Municipality (RLM) strategically and comprehensively addresses the area's present problems while leveraging its inherent strengths. The complicated nature of the space necessitates community involvement, as well as the integration and conservation of sustainability principles across development efforts, mining endeavours, and local governance. This plan's adoption of an integrationist approach decidedly and positively reflects a global trend toward more holistic and comprehensive water management, decidedly what Biswas and Tortajada (2018) call "a must". Given Rustenburg's unique constellation of mining, urbanisation, and natural water systems, such an approach is truly essential.

The plan also emphasises the indispensable role of communities in water management, noting that local knowledge and engagement are essential for the success of the strategy (Nya *et al.*, 2023:1468). The communities have the right to play an active part in decision-making processes, but they can only do so if they are informed and empowered in this regard. A crucial part of IWRM is therefore community-centred education and engagement. The plan also stresses that "IWRM is not just for 'experts' and water professionals". Nya (2023) further notes that, to be effective, IWRM must be understood and supported by all water users, from the most basic to the most complex level of an IWRM system.

The plan presented in this research study holds as its basic element the collaboration of three spheres of government, business, and community toward the establishment of a cooperative environment for sustainable water resource management. This plan assumes that these collaborative elements can use cutting-edge technologies to conserve and treat water effectively and can, through means of environmental education and community awareness, transform the mined area of Rustenburg Local Municipality (RLM) into a sustainable water resources management model (Vushe, 2021:492). It then moves to discuss the plan's next steps, which concern the design and implementation of project infrastructure that is both economically and environmentally sustainable. Finally, the plan suggests the Monterey-style models of innovative financing as key components along the way to implementing collaborative water resource management

(Mvulirwenande & Wehn, 2021:168). Proposed are programmes geared toward schools, businesses, and community groups to make them aware, not just conscious, but truly aware of the reasons for conserving water and for sustainable practices. These programmes are designed not only to reach the members of the targeted entities but also to ensure that all community members can equally access this vital information. The community must have a solid foundation of resilience if it is to meet the water management challenges of the future.

6.7 Implementation strategies

A comprehensive and multi-faceted strategy is necessary for the successful implementation of an Environmental and Integrated Water Resources Management plan in Rustenburg Local Municipality (RLM). The first element of such a strategy is the establishment of a solid institutional framework that can support integrated water resources management. This framework must ensure ample participation by all relevant stakeholders, including government entities, communities, and the private sector (Biswas & Tortajada, 2018:3). A second element is the formation of an authority or dedicated committee that is charged with overseeing the plan's implementation. This entity, in close consultation with stakeholders, must develop a solid policy, conduct effective monitoring and evaluation, and ensure that the IWRM plan stays on track and remains relevant to the broader development imperatives of Rustenburg. Communication among stakeholders is a third crucial ingredient in the formula for success.

6.7.1 Short-term actions

Immediate actions should focus on the most pressing potable water and sanitation infrastructure management problems in Rustenburg Local Municipality (RLM). It is vital to improve the current systems and bring the new ones up to a basic level of service (Sishawu, 2023:21). Several steps must be taken nearly at once in the up-front phase and early in the foundation phase to keep the total costs down and minimise disruptions. These include a shift towards no-cost and low-cost measures that can be initiated very quickly, as well as with water-saving devices and practices that can be installed in residences and in the local businesses, with minimal inconvenience (Thiam *et al.*, 2021:174).

6.7.2 Long-term policies and actions

One of the primary findings of this study is how clearly disconnected municipal service providers are from the communities they serve, most notably school communities. Notwithstanding available policies that encourage a participatory approach toward governance, the implementation continues to be a largely alienating top-down affair, with local education stakeholders having little say in the matter. Therefore, in an attempt to close this gap, it is suggested that participatory monitoring structures be made official, where school governing bodies will engage parents as well as learner representatives to oversee potable water and sanitation infrastructure. These structures should be responsible not just for reporting infrastructure failures but also for consulting during the planning and implementation of municipal service delivery programs. This proposal is consistent with HRBA principles, which hold that a duty exists upon duty-bearers (municipal officials) to involve rights-holders (school communities) in planning, delivery, and evaluation of services. Such intervention will greatly help build the municipality's transparency, accountability, and responsiveness to service delivery needs expressed locally.

Assuredly, structured school-based infrastructure audits should be conducted, whereby each school will assess the status of its water and sanitation facilities every quarter for input into municipal planning processes. These audits should draw support from user-friendly GIS dashboards that catalogue infrastructure condition, timelines for repairs, and budget allocation per school zone. This will ensure that real-time data is made available to local officials and school communities, thereby allowing them both to have evidence-based dialogue and jointly make decisions. This recommendation further provides a contextualisation of what is otherwise an academic call for some kind of participation: a tangible, workable, technology-enabled strategy. Such avenues have evidentially empowered municipalities that implement similar participatory infrastructure-tracking systems in fast-tracking response time for maintenance cases and, in so doing, build trust with the communities. Therefore, the creation of a working agreement for active, measurable, and accountable collaboration between Rustenburg Local Municipality (RLM) and its school communities is vital to ensuring sustainable outcomes on water and sanitation service delivery.

The IPD of Rustenburg Local Municipality (RLM) emphasises strategic priorities such as augmenting the groundwater supply, upgrading sewer infrastructure, and undertaking water conservation and demand management initiatives. These processes are critical pathways to improved service delivery, reducing infrastructure backlogs, and ensuring sustainable development in line with national and international goals of development.

6.7.3 Monitoring and evaluation system

A well-established monitoring and evaluation (M&E) system is crucial for assessing the effectiveness of the IWRM plan and facilitating its continuous improvement. This system should employ clear metrics and indicators to track progress towards the plan's objectives (Skoulikaris & Zafirakou, 2019:14836). Regular evaluations are necessary to identify implementation challenges and bottlenecks, allowing for timely adjustments. Stakeholder involvement in the M&E process is important, ensuring that feedback from various sectors is incorporated. This participatory approach to M&E can improve accountability and adaptability of the IWRM plan, ensuring it remains attuned to the changing needs of Rustenburg Local Municipality (RLM).

6.8 Monitoring and evaluation framework

The Environmental and Integrated Water Resources Management (EIWRM) plan is a large and complex entity. To contain and protect its constitution is the notional principle of subsidiarity, that is, the right of the local level to local governance over water and related resources (Meissner *et al.*, 2019:2). Below, I provide a broad outline of how monitoring and evaluation (M&E) works within the EIWRM plan, and the variety of ways in which the impacts of the plan are being assessed. I do this to give readers an idea of the internal logic of the plan, but also to tell the story of inclusion, not only of stakeholders in the impacts of the plan, but also of readers to understand the plan. To assess the IWRM plan effectively, the M&E framework must align with the plan's goals. This means setting clear and quantifiable targets for each part of the plan, from the water quality improvements to expanded access to clean water to improved ecosystem health. It is essential to have baseline data to measure the progress and impact of these targets accurately. As part of the good practice of management, periodic evaluations of the "M" in M&E should be undertaken to determine the performance of the IWRM plan relative to

these targets. The framework should also allow for the identification and examination of any unintended effects or problems that crop up during implementation.

It is essential to choose the right metrics and indicators if the monitoring and evaluation framework of the IWRM plan is to serve its purpose. These should be SMART: specific, measurable, achievable, relevant, and time-bound (Essex *et al.*, 2020:3). Key indicators could cover a range of dimensions, including ecological, public health, and stakeholder satisfaction. E or CE key indicators could include measures related to water quality (e.g. pollutant levels), public health (e.g. incidences of water-borne diseases), and stakeholder satisfaction. Environmental indicators, condition of local water bodies and biodiversity are vital for assessing the IWRM of the IWRM plan (Thiam *et al.*, 2021:176).

The framework for monitoring and evaluation should remain flexible, changing as the integrated water resources management plan and Rustenburg's context change. It is vital to ensure that the M&E framework is effective and relevant, which necessitates regular revisions. These changes may affect the metrics and indicators, the methodologies with which data are collected, or the targets set within the plan. More than anything else, stakeholder feedback should inform the fundamental revisions of the M&E framework, since local knowledge is essential to effectively plan for and manage any decisional context. A responsive framework always remains in tune and integrates local experiences, allowing for a water resources management plan that works, both in terms of the emerging day-to-day challenges that we know can (and do) occur anywhere within a river basin, and in terms of challenges that occur as longer-term changes in context (Martinez-Cruz *et al.*, 2024:1).

6.9 Development of the framework

The proposed framework development includes encompassing participatory governance, demand-responsive methodologies, and sustainability protocols within educational institutions of Rustenburg Local Municipality (RLM). Through precise integration of stakeholder engagement mechanisms, including SGBs, the framework establishes accountability parameters in service provision (Matseke, 2020:93). Consonant with participatory action research methodologies, this approach necessitates active involvement of relevant actors in problem identification and solution generation processes (De Oliveira, 2023:287-288).

Demand-responsive protocols facilitate customisation of potable water and sanitation services according to institution-specific requirements through iterative assessment mechanisms. The theoretical underpinnings of integrated water resource management emphasise coordinated development strategies maximising socioeconomic welfare whilst maintaining ecosystem integrity (Biswas *et al.*, 2022:2). Such methodological approaches align with South Africa's National Water Resource Strategy, wherein equity and sustainability constitute fundamental pillars of effective resource management (DWS, 2014).

Environmental and operational sustainability measures manifest through diverse mechanisms, including conservation techniques, maintenance scheduling protocols, and infrastructure resilience enhancement strategies addressing climatic vulnerabilities (Mugambiwa & Chitongo, 2023:27). Extant literature demonstrates correlations between infrastructure maintenance and community health outcomes, particularly regarding sanitation-related disease burden reduction (Momberg *et al.*, 2020:835).

Systems-based methodologies bridge policy-practice differences through recognition of governance-level interdependencies, from municipal frameworks to institution-specific protocols. Dynamic feedback mechanisms facilitated adaptive management strategies, addressing emergent challenges within the system. Research indicates that fragmented interventions demonstrate limited efficacy, whereas integrated approaches enhance service delivery and access equity (Stockton *et al.*, 2021:1).

The framework incorporates internationally validated best practices, emphasising community engagement, procedural transparency, and accountability mechanisms. Case studies demonstrate the significance of collaborative planning processes, inclusive decision-making protocols, and educational initiatives promoting water conservation awareness (Nyahunda, 2021:122). These elements collectively contribute towards establishing an adaptive model addressing the unique requirements of Rustenburg's educational institutions, thereby bridging theoretical-practical implementation gaps.

6.9.1 Stakeholder involvement in the proposed framework for water and sanitation management in schools

Effective potable water and sanitation infrastructure management in schools requires a collaborative framework that actively involves a range of stakeholders. Each stakeholder plays a unique role in ensuring that sanitation facilities are functional, inclusive, and sustainable. The Department of Basic Education (DBE) is a key player, responsible for setting national standards and policies on infrastructure provision and hygiene education. Their involvement ensures alignment with national health and education goals, as outlined in the National School Hygiene and Sanitation Policy (Department of Basic Education, 2019). Provincial education departments also play a vital role in budgeting and monitoring implementation, helping to bridge national policy and local school-level action.

School management teams (SMTs), including principals and governing bodies, are central to day-to-day decision-making and maintenance of sanitation facilities. Their role includes managing funds, overseeing infrastructure upkeep, and ensuring that hygiene protocols are followed. The School Governing Body (SGB), which includes parents, ensures community representation in decisions regarding sanitation priorities and funding allocation. According to UNICEF (2018), engaging school management in sanitation planning leads to greater accountability and more responsive infrastructure improvements. Involving these internal stakeholders helps embed sanitation responsibilities into school culture, increasing the likelihood of sustained improvements.

School communities themselves are stakeholders in the proposed framework. Their input provides first-hand insight into the usability, safety, and privacy of school sanitation facilities. Engaging learners through health clubs, peer education programmes, or participatory research helps promote a sense of ownership and encourages behaviour change. Studies have shown that learner involvement can improve hygiene practices and reduce vandalism, especially when they feel their needs are being heard (Water Research Commission, 2019). Teachers also play a dual role, both as educators and supervisors of hygiene behaviour, highlighting the importance of training and support for their role in sanitation education.

Community members, non-governmental organisations (NGOs), and local municipalities round out the broader network of stakeholders. Municipalities are responsible for waste

removal and water supply, making their coordination essential for functional infrastructure. NGOs can provide technical support, health education, and advocacy, especially in under-resourced communities. Collaboration with community members builds trust and ensures that sanitation solutions are culturally appropriate and locally supported. According to the World Health Organisation (2015), multisectoral involvement is key to the long-term success of WASH (Water, Sanitation and Hygiene) initiatives in schools. Therefore, the proposed framework must be participatory, inclusive, and adaptable to local needs.

6.9.2 Improving participatory governance in water and sanitation infrastructure management in schools

Participatory governance can be enhanced in school water and sanitation infrastructure management by fostering inclusive decision-making and accountability mechanisms that involve all relevant stakeholders, including learners, educators, parents, local government, and civil society. According to the Water Research Commission (2019), active participation from SGBs and community stakeholders leads to more sustainable and contextually appropriate sanitation solutions. Establishing school-based sanitation committees, which include learners and community members, ensures that diverse voices are heard and considered in planning, implementation, and maintenance activities. These structures promote a sense of ownership, which is crucial for the long-term success of water and sanitation interventions.

Capacity building is also essential for strengthening participatory governance. Many school and community stakeholders may lack the technical or administrative skills needed to manage potable water and sanitation infrastructure effectively. As noted by UNICEF (2018), training in hygiene education, infrastructure monitoring, and basic financial management enables local actors to make informed decisions and advocate for improved services. Transparent communication channels such as participatory audits, regular stakeholder meetings, and learner feedback systems further support accountability and responsiveness. Collaborations with municipalities and NGOs can also provide technical support and help bridge the gap between policy and grassroots implementation (WHO, 2015). By empowering all stakeholders and fostering collaborative structures,

participatory governance becomes a transformative tool for improving school water and sanitation management.

6.9.3 The Need for byelaws in managing water and sanitation infrastructure in schools?

Yes, byelaws are essential for the better management of potable water and sanitation infrastructure in schools, as they provide a legal and regulatory framework that supports accountability, enforcement, and sustainability. Byelaws can set clear standards for hygiene, maintenance schedules, waste disposal practices, and the roles of various stakeholders. In many South African municipalities, local byelaws govern public health and sanitation, but these often do not extend specifically or sufficiently to school environments. Strengthening or adapting such byelaws to include school-specific provisions can help ensure that water and sanitation services are maintained at acceptable levels and that there are consequences for neglect or misuse (Department of Basic Education, 2019).

Moreover, byelaws can support participatory governance by formalising the roles of SGBs, principals, and local authorities in managing sanitation infrastructure. This can include mandatory reporting mechanisms, budgeting for infrastructure maintenance, and public health compliance requirements. According to the South African Human Rights Commission (2014), the absence of enforceable guidelines often leads to service delivery breakdowns and unsafe sanitation conditions, particularly in under-resourced schools. Byelaws aligned with the Constitution and relevant education and environmental health legislation (e.g., National Health Act 61 of 2003) would provide a more robust governance structure for schools. Therefore, the development and implementation of context-sensitive, enforceable byelaws are a critical step toward ensuring dignified, safe, and sustainable water and sanitation facilities in South African schools.

Republic of South Africa. (2003). National Health Act 61 of 2003. Pretoria: Government Printer.

Proposed Framework for Water and Sanitation Infrastructure Management in Schools

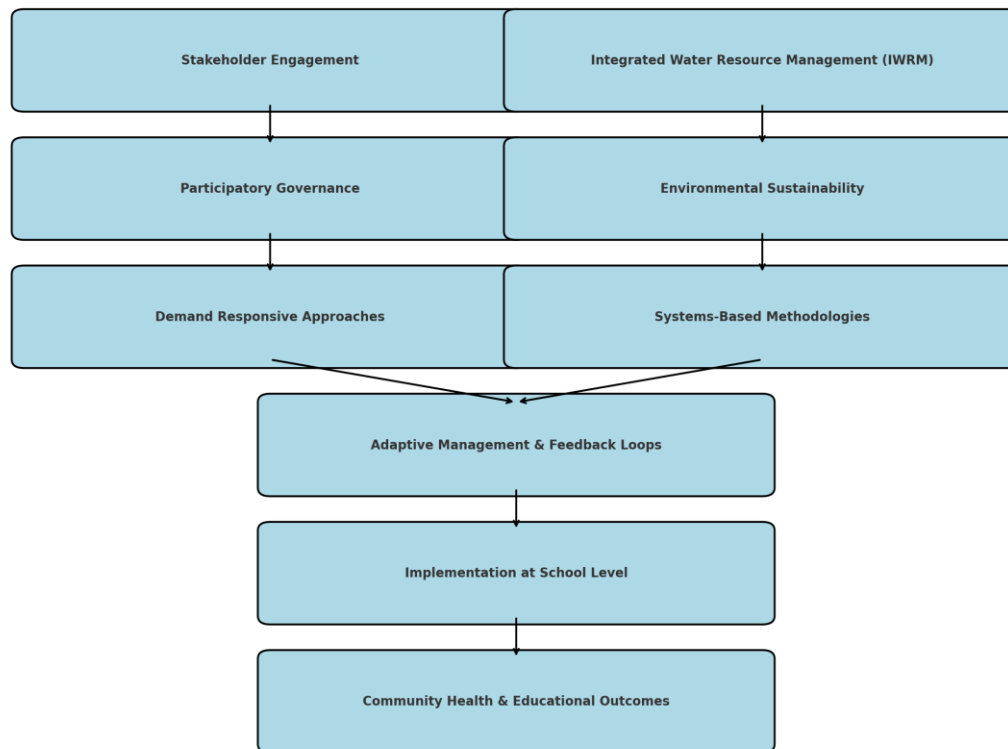


Figure 6.1: Proposed plan for Rustenburg Local Municipality (RLM) EIWRM

Source: author generated

The graphical delineation of the IWRM cycle embodies a continuous, adaptable process whereby various constituents synergistically engage to actualise sustainable hydro-management. The cyclic flow summarises crucial stages, issues, diagnoses, stakeholder deliberations, policy codification, infrastructural deployment, and iterative monitoring evaluation protocols. Each constituent phase transacts absolutely into the one succeeding, ensuring that data-driven feedback adjusts policy reformulations and resource distributions, thus engendering a receptive, and community-centric hydro governance paradigm. This methodological approach harmonises appropriately with participatory action research frameworks, inculcating inclusivity, adaptability, and

sustainability within resource stewardship practice (Mugambiwa & Chitongo, 2023:27; Nyahunda, 2021:122).

6.10 Chapter conclusion

The EIWRM plan proposed for the Rustenburg Local Municipality (RLM) is a decidedly detailed scheme to improve the water and sanitation situation in the area. It addresses the probable spectrum, from the protection of water sources through advanced treatment of wastewater, to reclaim as much water as possible. The focus is on both water pollution and the quality of water used. This includes the pre-water stage, where water is cleaned and purified before use - requiring less energy, making it safer and improving its suitability for later treatment. It also covers the post-water stage, where water is treated for safe reuse. Many people use large amounts of water without realising how much pre-treatment can improve its freshness and overall quality. The main reasons why the execution of the plan could fail are: insufficient resources (both financial and human); lack of goodwill and involvement by the most relevant stakeholders; and lack of leadership.

Rustenburg's water and sanitation infrastructure stands to benefit from an "integrated approach to water resource management" (Thiam *et al.*, 2021:175). The water management plan uses a variety of largely technologically driven strategies, from effective monitoring of water sources and pollution to the improved treatment of wastewater. Promoting water conservation and effective recycling of water, as well as keeping sources of drinking water safe from contamination, are also key components of the plan. Uniquely, the plan attributes much of Rustenburg's current problems of wastage and pollution to 19th-century practices followed in the use of clean water, and it seems bent on moving guaranteed access to water for all citizens, and an efficient system of removal and treatment of waste, into the 21st century.

Achieving universal access to sustainable water and sanitation management is the sixth Sustainable Development Goal, on clean water and sanitation. Since it highlights the significance of ensuring water security and the availability of water in adequate amounts, acceptable quality, and in a sustainable manner, this goal is crucial to the study (Monni *et al.*, 2018). But in South Africa, it has been discovered that delivering clean water presents several difficulties for local towns, districts, and metro areas (Zindi & Shava, 2022). Water services delivery has become inefficient due to issues including inadequate

financial management, which resulted from putting political interests ahead of the requirements of the local population (Eales, 2011; Munzhedzi, 2020).

In addition to the lack of transparency and community confidence about water availability, this has resulted in vandalism of the municipal water infrastructure as a result of irritation with the failure to provide water services (Majuru *et al.*, 2012; Sershen *et al.*, 2016).

SDG 6 provides guidance for resolving these issues so that communities can continue to receive water services. To provide clean, drinkable water, South Africa has water laws and sustainable development goals that are backed by the national Constitution. Because water facilitates both economic growth and sustainable development, achieving this goal is crucial. Furthermore, water supports the fundamental rights of health and food security. The plan's formulation and execution underscore the necessity of practising sustainable, integrated water management. This is not a simple undertaking. The Waterberg district is facing several immediate and two overarching long-term water-related problems, which tie directly to the vision's twin pillars. This approach not only tackles immediate concerns related to water but also aligns with broader sustainable development objectives. The plan's effectiveness in Rustenburg could serve as an example for other municipalities because it adopts strategies that are comprehensive and participatory. These are wonderful for practising water management, and they also portend good outcomes for maintaining water security. In the next chapter, a summary of the research, logical conclusions and recommendations are provided.

CHAPTER 7 CONCLUSION AND RECOMMENDATIONS: ENHANCEMENT MANAGEMENT OF POTABLE WATER AND SANITATION INFRASTRUCTURE IN THE SELECTED SCHOOLS OF RUSTENBURG LOCAL MUNICIPALITY (RLM)

7.1 Introduction

The main conclusions that resulted from the research objectives of this study are outlined in this chapter. The chapter concludes with suggestions on how the Rustenburg Local Municipality (RLM) could enhance management of potable water and sanitation infrastructure in selected schools. It draws together diverse threads of a comprehensive literature review, a well-organised conceptual framework, and primary data extracted from many varied key informants in the Rustenburg educational community. Additionally, it offers insights and observations to investigate people's life experiences. This study employed a participatory action research approach as study focus. I chose thirty respondents, using purposive sampling, a non-probability sampling technique.

The respondents were grouped based on the research questions, considering their backgrounds and potential contributions to the research study. An extensive informal discussion with each of the respondents was used to gather the data. Based on their expertise and experiences, municipal authorities' opinions on potable water and sanitation infrastructure management were sought.

A literature review, potable water and sanitation infrastructure management system observation, and a document review of the Rustenburg Local Municipality's (RLMs) IDP and management policy were also used to gather the data. The data was subsequently subjected to thematic analysis, which involved the development of codes and topics. Ethical considerations were applied throughout the entire data generation procedure. During this conclusion, it is necessary to reflect on the progression of the research study.

The research began by assessing the current state of potable water and sanitation infrastructure facilities in selected schools within Rustenburg Local Municipality (RLM). It then developed into how the conditions of these facilities affect education and health,

investigating the non-political reasons that keep essential services functioning poorly. The human and systems sciences provide the best guides for comprehending the dynamics involved and for a reasonable interpretation of their meanings. Their insights also make it possible to stake out a collective space for the right to water and sanitation in schools. There is no classification available for the kinds of school facilities that present such a serious and obvious problem to human rights. This chapter goes beyond a summary of research findings. It provides a way forward. The thoughts in this chapter are directed at educational decision-makers and local communities.

7.2 Summary of literature

The study of potable water and sanitation infrastructure in schools within the Rustenburg Local Municipality (RLM) is grounded in two key theoretical foundations: the Human Rights-Based Approach (HRBA) and the systems theory of service delivery. The HRBA is the key pillar of this research. It emphasises the vital relationship between human rights and access to essential services like drinking water and sanitation. The HRBA is especially suited to the South African context, where recognition and realisation of basic human rights such as access to clean water and sanitation are mandated by the Constitution (RSA, 1996). Yet, despite such constitutional imperatives and considerable research that documents how much both water and sanitation have changed for the worse over the past few decades, long-standing differences in basic service provision endure, especially in marginalised communities (and within the educational sphere) (Owor, 2022). And here is where the second theoretical framework comes into play. Systems theory, with the HRBA, allows us to interrogate the (non)provision of potable water and (adequate) sanitation in schools by examining both the "human" (e.g. rights, responsibilities, and resources of all parties) and the "mechanics" (interconnected components) of the public service delivery system.

The mining and urbanisation of the past few decades have brought massive, rapid population growth and a continuous influx of people to the Rustenburg area, resulting in huge strains and demands on the most basic public services. Education is among the most meaningful of these basic services for the long-term wellbeing of the children and communities directly affected, and by precepts of HRBA, all children in Rustenburg have an equal right to a quality education with healthy conditions for learning. However, the

following realities of educational facilities in the area comprise a not-so-hidden aspect of a long-term public health crisis: they are unsafe; they are unsound; and they are largely unserved when it comes to basic, reliable, and functionally healthy water and sanitation facilities.

In South Africa's transition to democracy after 1994, there was an integration of HRBA, which aligns with the nation's constitutional commitments to human rights. This includes the right to water (RSA, 1996). The legal structure for water governance established by the National Water Act (1998) is founded on human rights principles (Department of Water Affairs & Forestry, 1998). However, there are widespread problems of implementation and governance, which require a signal for better performance of water governance to be emitted from the human rights principles articulated in the Act (Nyahunda, 2021).

The principles of equality, accountability, and participation are vital in Rustenburg because there are marked differences in the access that schools have to water and sanitation services. Legal frameworks and policy instruments, such as the Water Services Act (1997), are key to the implementation of these principles. The problem is that there is a considerable difference between the intention of the policy and its actual practice. This study emphasises the important role that an HRBA plays in addressing this. It also emphasises the key role the principles of equality, accountability, and participation have in assessing which key parties should carry out their essential tasks to ensure that access to water and sanitation services is realised.

This study draws its theoretical perspective from the systems theory of service delivery. Systems theory originated with the pioneering work of Bertalanffy in 2007 and has become extensively used in the field of public administration for analysing the interconnectedness and interdependence found within public service delivery systems (Peters, 2019). In the case of Rustenburg, systems theory is drawing back the curtain on the administrative and operational problems that torment the delivery of potable water and sanitation to public schools. The theory is making it possible to examine the service delivery system as a whole, encompassing all aspects of policy development, execution, and the all-important feedback mechanisms that are critical in any environment, such as

Rustenburg's, that is characterised by rapid urbanisation and infrastructural stress due to mining (Phakedi *et al.*, 2021).

Applying systems theory to the Rustenburg context enables an in-depth exploration of the complex, interwoven factors influencing water and sanitation services in local schools. I took a close look at the policies that should dictate what happens, who should do it, and how they should do it if the services are to be delivered effectively and efficiently. I did not just look at whether the policies are being implemented or not (as they mostly are, in some form or another); I also assessed their efficacy and the feedback loops that modify the policies and, quite often, the actors who implement them (Bertalanffy, 1969; Ramos, Aguiar & Pequito, 2022).

In Rustenburg, schools use systems theory as a basis for managing potable water and sanitation services. It helps us to understand the multiple layers of governance, resource allocation, and community engagement involved in serving the schools, from the federal to the local level of government, including the schools themselves, as a vital part of the community. There are many people, and a lot of so-called "resources" engaged in this problem. Systems theory highlights the necessity for policy reform, community engagement, and infrastructure improvements. More importantly, it equips communities to establish mechanisms that enable governance partners to exchange candid feedback with one another, fostering a collaborative approach to addressing the problem.

System Theory stipulates a complete, or total, approach to remedying the potable water and sanitation problems in the schools of Rustenburg. It champions not just the physical problem of infrastructure but also looks at service delivery from the angles of governance and policy and community. It provides a comprehensive view of what must occur for any intervention to be efficient and sustainable in serving the sub-district's schools. This perspective is valuable, as the schools face similar issues and operate in contexts comparable to those found in the surrounding communities, towns, and sub-districts.

Summary of empirical data

Chapter 5 of the study on potable water and sanitation systems in schools within the Rustenburg Local Municipality (RLM) explores the perspectives of various stakeholders, including school administrators, educators, local government officials, and maintenance staff. A key theme is the "Problems with Water Supply and Sanitation Infrastructure,"

highlighting significant shortages in water and sanitation facilities, which adversely affect the health and educational outcomes of learners. Many schools resort to inadequate temporary solutions, such as bucket systems, which emphasise the urgent need for sustainable, long-term infrastructure improvements.

The chapter also discusses the “Impact on Education and Health,” illustrating how water supply issues and insufficient sanitation create public health risks and disrupt education, particularly in densely populated schools. This situation reflects broader systemic challenges related to governance and resource allocation. The study advocates for comprehensive, gender-sensitive solutions that address the interrelated issues of educational access, health, and water sanitation, while also considering environmental factors like drought.

Resource allocation and budget constraints are critical issues, with the study revealing systemic underfunding and poor planning for maintenance, leading to deteriorating infrastructure. Environmental conditions exacerbate water scarcity, particularly in schools with high populations. Education and awareness initiatives are essential for promoting water conservation and sanitation practices, with community engagement playing a crucial role in developing sustainable solutions.

The chapter concludes that effective governance and policy frameworks are necessary for delivering services in the potable water and sanitation sector. Mismanagement and corruption hinder local governance, necessitating active participation from schools, community members, and parents to foster accountability and responsive local authorities. Overall, the challenges related to water and sanitation infrastructure in schools require a systemic approach that integrates health, safety, and educational needs, advocating for a collaborative effort between relevant departments to ensure learner wellbeing.

7.3 Review of the research objectives

The research objectives enhance the quality of a literature review by providing a clear direction, ensuring relevance, and preventing unnecessary detours. This leads to a more comprehensive and focused review that effectively synthesises existing knowledge and

identifies gaps for the future research. The following research objectives are discussed as following:

7.3.1 Research Objective 1: Critically examine the current state of water and sanitation infrastructure in Rustenburg schools

The present research aimed to assess the potable water and sanitation infrastructure situation within the schools of Rustenburg Local Municipality (RLM). To this end, a thorough evaluation of the potable water and sanitation infrastructure in the targeted education facilities was conducted, employing the use of a mixed-method approach. Primary data were obtained through the use of personalised informal discussions with key stakeholders in the sampled schools, while an extensive document review served to supplement the main evaluation. The document review was able to shed light on several issues regarding the main water and sanitation infrastructure in the targeted education facilities.

7.3.2 Research Objective 2: Assess the perception's impact of water and sanitation infrastructure on education and health in Rustenburg schools

The second component of the research project concentrates on exploring how the Rustenburg potable water and sanitation infrastructure or lack thereof, affects the educational and health outcomes of learners in the requisite schools. The available literature is stark, even sobering. As McMichael (2019) directly asserts and argues, poor WASH (water, sanitation, and hygiene) resources lead decisively to poor health and, by extension, to poor educational outcomes for learners. The authors point to the following problems and their resulting "adverse effects": (1) health risks tied directly to an environment with insufficient sanitation, (2) basic hygiene deficiency (soaps and towels) that promotes a germ culture, (3) poor WASH resources (along with inadequate health education), leading to significant absenteeism, disruption, and (in some cases) fatal consequences for learners (and, as a corollary, significant disruption to the educational process itself). The next chapter, Conceptual Framework, lays out more clearly the link between water and sanitation infrastructure and education and health. It uses two theoretical lenses: the human rights-based approach and systems theory. Together, these frameworks provide a clear pathway from the right to water and sanitation, as

enshrined in many human rights treaties, to educational attainment and improved health, which directly fulfils the second objective of this study.

7.4.3 Research Objective 3: "Challenges in implementing effective water and sanitation management strategies in schools"

The third research objective focuses on uncovering the problems that make it difficult for effective water and sanitation management to happen in schools of Rustenburg Local Municipality (RLM). This literature review has already identified a number of people and systemic problems. There are inadequate finances, insufficient governance, and a lack of maintenance, to name just a few. The interplay of water supply, sanitation, and rights not only embodies the fundamental components of life but also represents the quintessential venue for exercising and enjoying rights. These components should work in concert; failing to do so puts an individual's health, educational opportunities, and potential for social and economic mobility, at risk. They protect life, which is a basic human right. This study operates within this rights framework because it is the World Bank's inestimable obligation to help impoverished countries achieve the vital components of this right and consequently carry out the mandate decreed by its founding articles.

7.3.3 Research Objective 4: "Explore, assess and recommend service delivery mechanism to improve potable water and sanitation infrastructure services in Rustenburg Local Municipality (RLM) schools"

The enhancement of water and sanitation services in schools in Rustenburg is the core concern of the fourth research objective. Proposals are put forward, using the literature review as a basis, to identify key areas in need of reform so as to effect successful change. The review draws attention to necessary reforms in governance, community engagement, and critical infrastructural investment, as key drivers of change to effect the necessary upgrades to this vital service in Rustenburg schools. This review, and the next chapter contain the most detailed and reasoned proposal of the four contained in this document. The Human Rights-Based Approach and systems theory in the Human Rights Framework lay the theoretical foundation for these strategies. They advocate not only focusing on infrastructure development but also concentrating on policy reform and community involvement. The design and the implementation of that integrated model

should address at least the following core areas: governance, community involvement, planning and maintenance, infrastructure, and a sustainable investment model. The variety of challenges in these core areas and the large number of educational institutions involved demand a simultaneous top-down and bottom-up response.

7.3.4 Research Objective 5: "Model framework development for water and sanitation management in schools"

The objective of Research Study 5 is to put together a framework for the effective management of water and sanitation in schools in the Rustenburg Local Municipality (RLM). This framework is informed by a literature review that provides the necessary underlying structure for the model and reveals important aspects of sound management. Those important aspects highlighted in the review are integrated approaches, effective stakeholder involvement, and, mainly, sustainable practices that ensure positive, lasting results. Informal discussions conducted with local stakeholders provided the study with essential primary data. These conversations revealed the most pressing issues in the Rustenburg schools and allowed me to dig deeper into problems already uncovered through reviewing existing literature. In the schools we visited, the stakeholders often referred to insufficient resources as the root cause of the many problems they face. By combining insights from the literature and theoretical principles with empirical data, the research reaches its goal. That is, it produces a detailed model framework that addresses the inherently complex nature of water and sanitation management in educational environments.

7.3.5 Research Objective 6: "Policy recommendations for water and sanitation management in schools"

The sixth goal of the research project involves proposing ways to improve the management of potable water and sanitation infrastructure in schools in the Rustenburg Local Municipality, as part of policy recommendations. This undertaking is necessary because, as the literature review shows, policy gaps exist that need to be closed to get the system working correctly. Insight from the literature review is complemented by information obtained through informal discussions with school administrators, educators, and local government representatives. They provided a clear, direct view of the obstacles that currently exist in management systems and what needs to be done to effect real

change. Finally, a conceptual framework that encompasses both a human rights and a systems view complements formulating these policy recommendations.

The proposed recommendations concentrate on ensuring that places of education have equal access to water and sanitation and that there is governance with meaningful participation. They also emphasise adaptive measures in the setting from which the authors have drawn their evidence for the recommendations. The authors call on persons at the helm of governance at the national and provincial levels to take heed and act on these recommendations. They seek to close the gap between policy and implementation so that all is done in the interests of the rights to water and sanitation, the right to a healthy learning environment, and the narrowly defined group that is the focus of their study - the learners in Rustenburg Local Municipality (RLM) schools.

7.4 Recommendations based on case study and empirical data

School Specific Recommendation: Development and Integration of Water and Sanitation Literacy Module in Life Orientation Curriculum

The schools in Rustenburg Local Municipality (RLM) should develop and approve an environmental policy that mandates the incorporation of a water and sanitation literacy module in the Life Orientation curriculum for all grades. This module should focus on practical hygiene behaviour(s) with respect to safe water use, hand washing, and toilet hygiene, as well as civic responsibilities related to water conservation and environmental respect. Activities within this content would be interactive, such as conducting learner-led water audits, sanitation inspection checklists, and peer-led awareness campaigns. The module should be contextualised according to each school's specific infrastructure so that learners can link their theoretical knowledge with lived experiences.

In support of implementation, schools must identify "Water and Sanitation Champions" among the educators, trained with the help of the local Department of Education and municipal environmental officers. These champions would be responsible for the implementation of the module and public awareness campaigns around key events (e.g. World Water Day) as well as updating municipal officials on infrastructure issues. By institutionalising this environmental policy into school governance (in instruments like School Improvement Plans and Codes of Conduct), schools will promote hygiene

practices for sustainability while developing a generation of learners who are informed and active in the defence of their right to a safe learning environment.

7.4.1 Recommendations based on the literature of potable water and sanitation infrastructure in schools.

Enhancement of Governance and Policy Frameworks: This study's literature review emphasises the critical role that governance plays in the efficient management of potable water and sanitation services in schools. It is drawn from the work of South African authors who are well acquainted with the realities of our context. They signal the urgent need for school authorities and local government to work together if we are to have any hope of serving the pupils. It is proposed that specific committees or task forces be set up, with members of schools, local government agencies, and the community. Their role would be to see that the policies made at top level get implemented, that the regulations and rules are followed, and that any problems that arise are solved quickly. They would do this primarily by making sure that the frameworks put in place work effectively and, if they do not, by modifying them until they do.

Investment in sustainable infrastructure and technology: The literature strongly recommends investing significantly in innovative technologies and sustainable infrastructure to make real the vision of safe and reliable water, sanitation, and hygiene for all schools. The recommended investment encompasses both (a) resilient infrastructure that can withstand the environmental challenges schools invariably face (even in many parts of the world where learners are relatively safe from natural disasters, droughts and floods, a surprisingly rainy season after months of drought, and other forms of extreme weather have proven that they can happen almost anywhere and at any time), and (b) sustainable technologies, such as solar-powered water systems, that offer the prospect of reliable, adequate, and safe water to all school populations in their increasingly normal and fully accessible school day.

7.4.2 Recommendations based on empirical data

Strengthening community engagement and participation: Information gleaned from informal discussions with educational administrators, teachers, and community members underscores the vital importance of community engagement in the realm of water and

sanitation facility management. This community engagement is rendered not just as a good idea for sustainable problem-solving but as a culturally resonant way to achieve desired outcomes. Schools are directed, along with local authorities, to create purposeful forums or committees involving parents and community leaders, to identify problems associated with facilities and water access, prioritise them, and work on achieving sustainable solutions to the identified problems. Community-led initiatives, such as local fundraising for potable water and sanitation infrastructure projects, and volunteer programmes for facility upkeep - represent the latest drive to complement government efforts in the water and sanitation sector. These currently operate in parallel to much of the systems reform proposed by the World Bank. In theory, they serve both to improve the immediate efficacy of water and sanitation services and to create a sense of community ownership of these services.

Enhanced training and capacity building for school staff: Staff informal discussions reveal a skills and knowledge gap that hinders effective management of the potable water and sanitation infrastructure in schools. To address the problem, we recommend the establishment of ongoing training and capacity-building programmes for school staff, particularly those who bear direct responsibility for the maintenance and management of these facilities. Proximity to the problem suggests that these initiatives should concentrate on the essential skills presumed in the maintenance of WASH facilities, the daily application of good sanitation and hygiene practices, and necessary and sufficient behaviours for the efficient, effective, and responsible use of water in school settings.

7.4.3 Recommendations based on proposed model and case study

Integration of a Human Rights-Based Approach in Policy and Practice: This study underscores the necessity of incorporating a Human Rights-Based Approach (HRBA) into the context of potable water and sanitation within educational institutions. The HRBA is founded on the premise that rights should be at the core of policy formulation and that these rights are the basis for service delivery, particularly when the right to water and sanitation is under threat. This approach must be applied consistently in all governmental policy spheres. I recommend Rustenburg's educational institutions to compel local authorities to implement the right to clean and safe potable water and the right to safe,

secure, and sanitation for all learners. Furthermore, the study insists on regular and reliable monitoring and reporting of these rights.

7.5 Implementation of systems theory in service delivery:

The conceptual framework advocates employing systems theory to improve the delivery of potable water and sanitation services in educational settings. This theory is useful for uncovering systemic inefficiencies within the current service delivery model. It is recommended that educational institutions and local government bodies apply a systems thinking approach to achieve a more comprehensive understanding of the elements impacting the service of potable water and sanitation to schools. This would involve an in-depth analysis of everything from the current infrastructure to the current assignment of roles to service stakeholders. The analysis should also consider what the service environment means to the current and future effectiveness of the water and sanitation service delivery model.

7.5.1 Development of sustainable and adaptive infrastructure:

According to inscribed insights from the conceptual framework, there is a clear need to build sustainable and adaptable infrastructure for water and sanitation in schools. This writing posits that the development of such infrastructure requires an investment in resilient systems that can stand up to environmental challenges and was able to accommodate a future learner body whose needs are not yet fully known. It is suggested that the exploration of innovative, "out-of-the-box" solutions such as rainwater harvesting systems and using solar power in water solutions, be a part of any discussion about infrastructure in WASH. From a gender perspective, the writing reminds readers to include all learners in such conversations and to pay particular attention to those with disabilities and to female learners, whose unique needs in the WASH area are often ignored in conversations about infrastructure. Finally, the piece urges communities to collaborate with NGOs, the private sector, and local community organisations in finding and employing infrastructure development expertise that is needed to establish those resilient and adaptable systems in schools.

7.6 Areas for future research

7.6.1 Future Research Area 1: Longitudinal impact assessment of improved water and sanitation infrastructure on educational outcomes

An area for future research is the performance of longitudinal studies that can evaluate the effect that improved potable water and sanitation infrastructure may have on educational outcomes in the schools of Rustenburg Local Municipality (RLM). This study and other literature have established a clear link between the presence of good potable water and sanitation facilities and learners' health and academic success. What this research study has not explored, however, is the endless area of long-term effects on the kinds of facility improvements that pay off in ways that are surely not immediately visible, much like the often-protracted payoff one sees for improvements made to school curricula. Future research could track changes in these educational results for a good while after the improved interventions. Such studies could provide valuable insight into the longevity of the benefits associated with investing in potable water and sanitation infrastructure within schools and the potential payoff for influencing policy and resource allocation. Longitudinal studies would thus serve to enhance the investment rationale for school-based water and sanitation facilities, considered not only as public health and human rights advancements but also as educational improvements.

7.6.2 Future Research Area 2: Effectiveness of community participation models in water and sanitation management

Future research could usefully address the effectiveness of community participation models in the management of potable water and sanitation infrastructure within schools. This research underscores the basic problem: not enough engagement of the educational community in the management of these systems. This study's investigation of these communities suggests that participatory management is not at all standard. This study could be replicated with any number of similar communities in any number of countries to determine how typical or atypical these cases are. It could also usefully include the examination of a couple of community-implemented water and sanitation management projects as counterparts to the projects we visited. The goal of these investigations is to determine how well these management models work in delivering educational services and empowering communities, and to see whether they serve to enhance the

maintenance of educational facilities. These probes will pay particular attention to how much or how little they involve the educational communities they are supposed to serve. That will contribute to a better understanding of community management of educational governance and put significance into the discourse on participatory governance and community-led development.

7.6.3 Future Research Area 3: Adaptive water and sanitation strategies in the context of climate change

Given the intensifying effect of climate change on global water supplies, it is becoming more urgent to develop and test adaptive strategies for potable water and sanitation in the kinds of institutional settings that were most vulnerable to the onset of climate impacts, like the rapidly changing, semi-arid environment of Rustenburg, in South Africa's North West Province. These studies could evaluate cutting-edge technologies and practices, such as rainwater harvesting, which could be employed to secure a potable water supply for the people of the region. The aim would be to establish not just systems that now serve the supply and demand level conditions asserted by the relevant authorities, but also ones that adjust dynamically to a future with an uncertain supply side problem, likely either too much or too little water.

7.7 The contribution of the research study to the body of knowledge

This Environmental Integrated Water Resource Management (EIWRM) framework is the main contribution of this study towards addressing potable water and sanitation challenges under the Rustenburg Local Municipality (RLM) in schools. The framework reflects participatory governance, demand-responsive service delivery, and environmental sustainability strategies, all of which are contextually adapted for education. Of course, the major structural model of infrastructure governance improvement will be the EIWRM plan. However, GIS will be a very important enabling tool for converting this framework into effective operation. GIS will allow its real-time spatial mapping, monitoring, and analysis of infrastructure conditions, water sources, and sanitation risks all across the municipality. The integration of GIS with the EIWRM framework would enhance data-driven planning and resource allocation, as well as earlier identification of service delivery gaps. So this synergy would enable response actions by municipal authorities and school managers to address up-and-coming issues, especially

when targeting high-risk or underserved areas. GIS, therefore, within this study, is not to be seen merely as a standalone solution; rather, it is placed within it as a vital support mechanism underpinning both operationalisation and adaptive management aspects of the EIWRM framework. Together, these components present a holistic, evidence-based approach to overcoming systemic failures in school water and sanitation service delivery.

Central to the present study is the proposed Environmental Integrated Water Resource Management (EIWRM) framework that aims to address potable water and sanitation challenges in schools within the Rustenburg Local Municipality (RLM). This framework incorporates participatory governance, demand-responsive service delivery, and environmental sustainability strategies specific to the educational context. While the EIWRM plan is the broadest model for improving the governance of infrastructure, Geographic Information Systems (GIS) work as an essential facilitative mechanism for the effective operationalisation of the framework. GIS offers real-time mapping, monitoring, and analysis of conditions existing within the infrastructure, water sources, and sanitation risk throughout the municipality. When adopted into the EIWRM framework, GIS adds to data-driven planning, resource allocation, and early detection of service delivery gaps. This will give the municipal authorities and school managers a proactive response to most challenges facing the municipalities in high-risk areas or underserved areas.

One of the solutions that is now highly visible in the empirical study is the introduction of a formalised, school-based maintenance-reporting protocol in which SGBs note the status of infrastructure and submit reports of their condition to municipal service departments each month. Such a participatory monitoring system not only allows for early leak detection within the system but also reinforces the sense of ownership and accountability within the school community. Supported by the evidence in literature (Momborg *et al.*, 2020:835), this finding suggests that sustainable infrastructure performance strongly correlates with the appropriate localised, routine maintenance and engagement with the community. Therefore, GIS does not offer itself as an isolated solution but as one of the most crucial support mechanisms within this study that would enhance operationalisation and adaptive management components of the EIWRM framework. When viewed together, these components provide an integrated, evidence-

based solution to address systemic failures in service delivery associated with school water and sanitation.

By coordinating the investigation of human rights and proper potable water and sanitation infrastructure management in the Rustenburg Local Municipality (RLM) with the United Nations (Agenda 2030): SDGs 6, 9, and 17 for the development of a central GIS for the management of potable water and sanitation infrastructure assets of the Rustenburg Local Municipality (RLM), the study also advances the perspective of urban geography. From a regional perspective, the study supports Africa Agenda 2063: The Africa We Want, which focuses on the introduction of ICT in Africa that led to the use of GIS for the management of infrastructure assets in Africa. From a national perspective, the study supports the Constitution of South Africa, 1996, which combats inequality by providing water as a constitutional right, and the National Development Plan Vision 2030, which aims to achieve sustainable and inclusive growth by 2030 by investing in a robust economic infrastructure that uses ICT to cover water resources.

7.8 Chapter conclusion

This chapter has summarised the research and offered an overview of the findings as closing remarks. The study recommendations and areas for additional research have been established with the help of the chapter's discussion. By identifying the strategies, technologies and governance of potable water and sanitation infrastructure management, the study adds to the body of knowledge in human (urban) geography regarding the promotion of GIS initiatives to monitor and service infrastructure. It also aligns with the National Development Plan Vision 2030, the South African Constitution, and the Sustainable Development Goals of the United Nations (Agenda 2030). Potable water and sanitation infrastructure assets are not managed by the Rustenburg Local Municipality's (RLMs)' unified integrated infrastructure asset management system, according to this report.

As a result, the municipality has an institutional setup for managing its potable water and sanitation infrastructure, with several departments having their management systems that have an impact on how potable water and sanitation infrastructure facilities are stored and managed. Municipal planning for the upkeep and repair of infrastructure equipment has been impacted by the institutional arrangements for managing potable water and

sanitation infrastructure equipment, which have led to departmental silos and the loss of information about municipal infrastructure assets. Additionally, this had an impact on the budget and expenses while figuring out how to increase revenue for infrastructure management.

Despite having municipal policies, such as the potable water and sanitation infrastructure management policy, the Rustenburg Local Municipality (RLM) finds it difficult to put them into practice. This is significant because, despite the Municipal Finance Management Act 56 of 2003 requirement that the municipality update its potable water and sanitation infrastructure register, it has not done so. Asset information begins to disappear when new infrastructure developments are put into place, and such infrastructure data is not kept up to date and recorded in a system. The study also discovered that there is a deficiency in political backing, stakeholder engagement, and citizenship participation, all of which might be utilized to enhance the management of potable water and sanitation infrastructure management through the exchange of ideas and opinions.

By creating a potable water and sanitation infrastructure framework and inclusive systems that work together off a centralised Geographic Information System (GIS), the study comes to a close. This creates an inclusive integrated water resource management system that combines all municipal data to encourage collaboration between municipal departments, sharing of potable water and sanitation infrastructure management data, and connecting data with infrastructure cost and billing. The system predicts plans for potable water and sanitation infrastructure, plans for maintenance and integrates relevant information.

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ANNEXURES A: TITLE APPROVAL LETTER



PO Box 1174, Vanderbijlpark
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Public Affairs
Tel: +27169103455

12 Aug 2022

DK MOSIME
12680524

Research title as approved by the scientific committee of the Afrocentric Governance of
Public Affairs Focus Area:

**HUMAN RIGHTS AND PROPER POTABLE WATER AND SANITATION INFRASTRUCTURE
MANAGEMENT AT SCHOOLS IN A RUSTENBURG SUB-DISTRICT**

Dear DK Mosime

This letter serves to confirm that your PhD research proposal has been approved by the
Humanities Research Management Committee.

The ethics application is referred to the:

* Research Ethics Committee- BaSSREC: X.

* Research Ethics Committee-HHREC: _____.

For the details on the procedure that you will have to follow to submit to the Ethics Committee
contact Ms Chantele Bloem at Chantele.Bloem@nwu.ac.za / 018 285 2583. When your ethics
application has been successfully completed and approved please inform her as the responsible
person.

Yours Truly,

A handwritten signature in black ink, appearing to read 'Costa Hofisi'.

Costa Hofisi
Research Director

ANNEXURES B: QUESTIONNAIRE

The following questionnaire are important and necessary for the purpose of statistics and gather all the opinions in the potable water and sanitation infrastructure management in the selected schools of Rustenburg Local Municipality (RLM).

Informal discussion questions for school Principal

I agree that the purpose of the study has been explained to me and that it is of my consent to participate. (Mark with X)

SECTION A: Demographics

1. Gender
2. How many educators and learners are there in your school:

SECTION B: The perceptions of Rustenburg sub-district residents and learners regarding management of potable water and sanitation infrastructure at local schools

1. What is your role in the school in terms of potable water and sanitation infrastructure asset management?
2. Do you access clean water at your school? Probe for any shortages.
3. Do you share potable water and sanitation facilities with the community?
4. Do you have water and sanitation committee among in your school?
5. Probe what does it do, activities etc., and does it interact with other committees?
6. Does the school support the activities of the committee? In what form?
7. What type of toilets does your school have?
8. How many are for pupils? And for teachers?
9. Does the school have a schedule for cleaning the toilets/latrines?
10. Who cleans the toilets?
11. Does your school offer education on hygiene to the pupils? In what way...?

SECTION C: The challenges that schools are faced with in the supply of potable water and sanitation by Rustenburg Local Municipality (RLM)

1. Do you experience any shortage of water? What was the cause?

2. The Constitution of South Africa Act 108 of 1996, section 27 (1) to provide water which is a basic need to everyone. What are the challenges that hinders the provision of potable water and sanitation to the school with regard to infrastructure?
3. Does Rustenburg Local Municipality (RLM) have an Institutional committees that caters communities and other stakeholders for the coordination of the water service delivery? If yes, how is it assisting the municipality to improve water service delivery?
4. Do you think your school has enough infrastructure for potable water and sanitation to deal with water challenges versus the total number of Teachers, Learners and personnel in your School?
5. From your experience, what framework approach do you think can be used to manage water infrastructure assets at your school?

SECTION D: Service delivery mechanisms that can be implemented to improve the state of potable water and sanitation infrastructure at local schools

1. From your experience, do you think having one integrated water infrastructure management system (interlining all different units systems into one system) can improve potable water service delivery at your school and community?
2. In your opinion what should be done to ensure that the present water provision system is sustainable practices? Explain?

Informal discussion questionnaire for Teachers

SECTION A: Demographics

1. Gender
2. Name the subject(s) you are teaching at your school?
3. How many Teachers are there at your department?

SECTION B: The perceptions of Rustenburg Local Municipality (RLM) Teachers regarding management of potable water and sanitation infrastructure at local schools

1. Do you access clean water at your school? Probe for any shortages
2. Do you share potable water and sanitation infrastructure facilities with the community?
3. Municipalities are obliged by the Constitution of South Africa Act 108 of

1996, section 27 (1) (b) to provide water which is a basic need to everyone.

What are the challenges that hinders the provision of water to the school based on water infrastructure assets?

4. Does the school support the activities of the committee? In what form?
5. What type of toilets does your school have?
6. How many are for Teachers? And for Learners?
7. How many of these facilities are not operational?
8. Does the school have a schedule for cleaning the toilets/latrines?
9. Who cleans the toilets?
10. Does your school offer education on hygiene and water management to the Learners? In what way...?

SECTION C: The challenges that schools are faced with in the supply of potable Water and sanitation by Rustenburg Local Municipality (RLM)

1. In your opinion what should be done to ensure that the present water provision system is sustainable practices? Explain
2. Do you think the Rustenburg Local Municipality (RLM) has enough infrastructure assets to deal with water challenges? Explain.
3. Any further water and sanitation challenges at your school?

SECTION D: Service delivery mechanisms that can be implemented to improve the state of potable water and sanitation infrastructure at local schools

4. What do you want to see done with regards to water and sanitation at the school?
5. Does your school have committees that work with the Municipality for the of the water service delivery? If yes, how is it assisting the municipality to improve water service delivery?

Informal discussion questionnaire for Rustenburg Local Municipality (RLM) officials

I agree that the purpose of the study has been explained to me and that it is of my consent to participate. (Mark with X)

SECTION A: The perceptions of Rustenburg sub-district residents and learners regarding management of potable water and sanitation infrastructure at local schools.

1. What is your duty in the RLM in terms of potable water and sanitation infrastructure management?
2. Does the school share potable water and sanitation infrastructure facilities with the communities in the RLM?
3. What type of toilets does the school have in the RLM?
4. Does the Municipality have road show to offer education on hygiene to the school and importance of saving water? If so how is that done?
5. Does the RLM have access clean water for the school?
6. Does the MRLM experience any shortage of water with time? What causes that?
7. Does Rustenburg Local Municipality (RLM) have an established committees that provides schools and other stakeholders for the coordination of the potable water and sanitation service delivery? If yes, how does it assist the municipality to improve water service delivery?
8. Do you think the RLM has enough potable water and sanitation infrastructure f to deal with water challenges versus the total number of Schools in it?
9. Briefly describe the relationship that RLM has with the Department of Education.
10. What are the challenges that affects the provision of potable water and sanitation water infrastructure to the schools?
11. Do you think RLM has enough potable water and sanitation infrastructure to deal with challenges in schools? Explain
12. Does Eskom load-shedding affect the functioning of potable water and sanitation infrastructure? If Yes, how so?
13. Do you see any Water shedding in the near future? What can be done?
14. The country is undergoing of 4th industrial revolution as described by the President,
15. Could there be potable water and sanitation management technologies that be utilised by the Rustenburg Municipality in-order to improve service delivery in schools?
16. What should be done to ensure that the present potable water and sanitation provision system is sustainable even for the future generation?

Informal discussion questions for Public works officials

1. What is your role in the department in terms of water infrastructure asset management?
2. Explain the relationship between Department of Public Works and Education.

3. What are the challenges that hinders the provision of water to the schools based on water infrastructure assets?
4. Based on the challenges mentioned above, what best strategies as a solution can Bojanala Public Works use to manage its water infrastructure assets in the schools they are servicing?
5. If water infrastructure assets of schools are managed properly, can it improve the turn-around time in terms of water service delivery in schools? Explain
6. In your opinion what should be done to ensure that the present water provision system is sustainable and managed efficiently in schools as you assist them?
7. Do you think Public Works has enough infrastructure assets to deal with potable water and sanitation challenges in schools? Explain
8. Does Department of Public Works have an institutional committees that caters schools and other stakeholders for the coordination of the water service delivery? If yes, how is it assisting to improve water service delivery?
9. From your experience in the Department, what framework approach do you think can be used to manage water infrastructure assets?
10. With the current load-shedding happening, how does it affect the functioning and conditions of the asset management and water management?
11. From your knowledge of 4th industrial revolution, how can smart water management technologies be used to improve asset management and service delivery in municipality?

ANNEXURES C: PROOF OF LANGUAGE EDITING

Olivier Language Practitioner

Editing and Translation Service Certificate

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Author: Mr D K Mosime

Student number: 12680524

Editor: Willemien Olivier

This paper was proofread by a proof reader

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This is to confirm that the paper with the provisional title, *Human rights and proper potable water and sanitation infrastructure management at schools in a Rustenburg sub-district*, to be submitted by D K Mosime of North-West University, has been edited for language by Olivier Language Practitioner, Willemien Olivier. The document needed only a few amendments. Neither the research content nor the author's intentions were altered in any way during the editing process.

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