WATER USE EFFICIENCY AND SAFETY IN BUILDINGS

Volume 1: Technical Support Document for Water Use Efficiency and Water Safety in Buildings

Report to the
Water Research Commission

by

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The publication of this report emanates from a project entitled: *Supporting the Development of Standards for Water Use Efficiency and Water Safety in Buildings* (WRC Project No. C2020/2021-00441).

This report forms part of a set of two reports. The other report is *Water Use Efficiency and Water Safety in Buildings. Volume 2: Guidelines for development of a Water Safety and Security Plan for Buildings.* (WRC Report No. TT 917/23)

EXECUTIVE SUMMARY

BACKGROUND

Worldwide, as in South Africa, national legislation is in place for provision of water services to the public by Government or public Water Services Providers. Once the water enters a private dwelling, the onus is on the property owner to effectively utilise the water, to ensure there is no additional contamination from external sources, and to safety dispose of any wastewater that cannot be disposed into municipal system. While regulatory authorities provide oversight of public water supplies with regards to water use efficiency and water safety, this is more challenging with thousands of independently owned buildings who are responsible for their internal water services and are not subject to regulations.

AIMS

The project aims were:

1. To identify gaps in the current legislative framework governing water use efficiency, water supply and water safety in various building types.
2. To assess water use efficiency, water supply and water safety in various building types throughout South Africa.
3. To generate data sets, benchmarks and guidelines that will lead to subsequent development of national standards for water use efficiency and water safety in buildings.

METHODOLOGY

The first activity was Stakeholder mapping and engagements. Stakeholder mapping allows for identification of stakeholders, their roles and responsibilities and subsequent categorisation based on level of influence and interest.

NRCS together with DWS were identified as key stakeholders (Promoters with High Power/High Interest) as they were responsible for adopting, publishing, implementing and enforcing the standards which would be developed in future:

As buildings are privately owned, there are a number of stakeholders with low power but have high interest (Defender Stakeholders) such as Green Building Council, IOPSA, SAPOA, SALGA and Green Cape. These Defender Stakeholders can provide valuable input on user requirement and be effective promoters of the project and help ensure adoption of standards and guidelines.

Sector Feedback sessions with stakeholder were critical to share progress, improve understanding of current challenge and obtain buy-in for guidelines which were developed.

To achieve aim 2, a baseline assessment was conducted of all building categories as per NBR in all provinces though an Online survey using Google platforms. The online survey comprised 30 questions divided into 5 sections: building information, water supply, water storage, water use efficiency, and water safety. Despite extensive communication of the survey with various stakeholder, only 67 respondents completed the survey. The results of the survey were subject to data analysis using Python software and findings contributed towards status quo assessment of water services in buildings.

A detailed literature review was the final activity to achieve aims 1 and 2.

RESULTS AND DISCUSSION

The results of the online survey are summarised as follows:

- Most respondents were from Gauteng, and the majority of respondents (50%) were from domestic residences (H3) and dwellings (H4) – not a true reflection of water services in all building types. Future studies should target the building categories which house large number of people and service members of the public such as commercial, industrial, and institutional buildings.
- 90% of respondents use water for domestic use, 92.5% use municipal water as their main water source, most of plumbing work is conducted by external maintenance personnel such as plumber and contractors. This highlights the importance of using registered plumbers who are subject to ongoing training and amendment of by-laws to stipulate use of registered plumbers by building owners.
- Although 52% of respondents experience water shortages, only 63% of these respondents have on-site water storage tanks. As water interruptions increase due to various reasons, including load-shedding, the percentage of buildings with on-site storage is likely to increase and this highlights the need to develop standards for water storage and alternative water sources.
- The low number of respondents with water saving measures indicates most households are not concerned about water savings. The results are the same for water quality monitoring with only 15% monitoring water quality and only 6% monitoring for Legionella. These highlight need for public awareness campaigns on water scarcity and water quality.

Scenario analysis between various parameters found no meaningful correlations. This may be attributed to the low number of responses, responses largely from private houses or may reflect the actual situation. Main findings of scenario analysis are:

  - There is no relationship between building type/amount of on-site storage and water quality monitoring: Building owners are not aware of potential water quality risks (including Legionella) associated with large internal network or supplying water to large number of people/members of the public.
  - Building owners who participate in certification programs are more likely to monitor water quality. This group is therefore more likely to adopt proposed water quality monitoring guidelines and certification programs are ideally suited to pilot such guidelines.
  - There is no clear indication that buildings which experience water shortages will have on-site storage or implement water savings initiatives. Consumers are likely to implement standards related to water use efficiency if there is a direct cost-benefit to them.

While the supply of safe water to buildings is delegated to Water Services Institutions, the NBR and BS Act, together with associated norms and standards, forms the legislative framework for water services within buildings. The NRCS is the entity responsible for implementation of the NBR and BS Act and this occurs at municipal level by appointment of Building Control Officers who are responsible for ensuring all new buildings comply with the act and compulsory standard SANS 10400. However, their jurisdiction only applies to new buildings, and does not apply to internal networks of new and existing buildings which is covered by voluntary standards (SANS 10251). Proposed revision to the NBR and BS Act will incorporate voluntary SANS 3088:2019 which addresses Water efficiency in building. However, Building Control Officers will only ensure compliance of fixtures/fittings during construction and are not responsible for monitoring water usage in buildings after the construction of the building has been completed.

The NBR and BS Act does not cover aspects related to water quality and supply and recommends standards related to water quality and supply in buildings, which should rather be included in local by-laws as Water Services Institution have the required knowledge and skills to enforce these regulations.

As per the NWA, the WSI is responsible for provision of safe drinking water which complies with the National drinking quality standard SANS 241. However the SANS 241 standard is only applicable to municipal supply systems and does not extend to buildings.

Currently the only other legislation that covers water quality in buildings is the SANS 893-1 (Risk Management) and SANS 892-3 (Control) which outlines requirement for monitoring of Legionella under the Occupational Health and Safety Act. As this is a voluntary standard, there is no regulation of this standard and no information on Legionella monitoring and control in South African Buildings.

The DWS (2022) Blue Drop Progress report states that only 40% of municipal supply systems comply with microbiological parameters and only 23% comply with chemical parameters outlined in the SANS 241 (2015) standard. Building owners therefore can no longer assume municipal water entering their buildings is safe for human consumption and must implement systems to monitor and manage water quality risks in their reticulation networks.

Ideally drinking water quality should be extended to buildings, which, however, is challenging due to several reasons: (1) Large number of buildings require extensive resources to monitor, (2) Maintenance personnel in buildings lack understanding of water quality and associated risks.

The World Health Organisation's Water Safety Planning (WSP) methodology offers a holistic approach to manage risks in buildings and places the responsibility of risk management on the building owner. The systematic approach of the WSP can be modified to cover all aspects of water services and can be extended to water scarcity while the cycle of continuous risk management will ensure that new and emerging risks are constantly identified and managed.

Due to the lack of water quality regulations in building, adoption of WSP in buildings may result in self-regulation by building owners through awareness of potential risks, and this may prove to be an effective mechanism to improve water use efficiency and water safety in buildings.

With regards to water use efficiency, DWS provides policies related to water use efficiency and implementation of national programs. However, the onus is on WSI to reduce water losses as DWS' role is purely advisory, does not set targets or enforce policies/programs related to water use efficiency.

There are several industry-specific water use efficiency guidelines, benchmarks and tools which are valuable resources to ensure water use efficiency in various industries. However, they remain voluntary guidelines and therefore cannot be monitored or enforced unless they are incorporated into legislation.

Installation of water-efficient fittings in buildings presents an opportunity to reduce water demand in buildings and address risk of scalding. The current initiatives by SANEDI under the ongoing South African Appliance Standards and Labelling Programme (S&L Programme) and the Collaborative Labelling and Appliance Standards Program (CLASP) are addressing the process of developing and improving standards for taps and showerheads, including thermoregulator mixers to control water temperature at taps. Once this labelling program is completed, it will be adopted into the NBR and BS Act to form part of compulsory national standards to ensure water use efficiency fittings are installed in all buildings and will address the risk of scalding.

Water use efficiency in buildings can be improved if local by-laws include water efficiency measures such as installation of water-efficient fittings, sliding-scale tariffs, penalties for high water use and fines for wastage of water. The challenge remains the lack of updated by-laws, lack of enforcement of by-laws due to

insufficient capacity and skills, and perhaps a lack of political will to include and enforce water use efficiency at municipal level.

RECOMMENDATIONS

- Future study to expand on baseline assessment of water services in building to improve understanding of water services in all building classes.
- DWS to set national, regional targets to reduce non-revenue water and improve water use efficiency at municipal level. The use of Incentive-based Regulation such as No Drop Certification provides a tool to monitor implementation of targets and this should be coupled with some form of punitive measures (reduced funding) to drive water use efficiency.
- DWS to enforce regulations that will ensure delivery of safe drinking water to all consumers. Adherence to Norms and Standards and Incentive-based regulations (Blue Drop Certification) should be coupled with Punitive regulation (Enforcement) to ensure consumers receive safe water which does not present a health risk.
- NRCS to finalise revision of the NBR and BS Act to promote water use efficiency by the incorporation of voluntary SANS 3088:2019 (Water efficiency in building) into compulsory standard SANS 10400.
- Implementation of CLASP report to ensure standardised labelling for taps, showerheads, and thermoregulator mixers with subsequent development of compulsory standards for all plumbing fixtures to promote water use efficiency and water safety in buildings. These standards must be incorporated into the NBR and BS Act as requirement for all new buildings.
- As WSI is the authority for water services provision, local municipalities must ensure current by-laws are updated to address issues of water safety and water use efficiency whilst also ensuring sufficient skills and resources are provided to enforce these by-laws.
- Public awareness campaigns to emphasise water scarcity, promote water use efficiency, sensitise consumers on potential health risks associated with their municipal supply and internal networks should aggressively be increased.
- Adoption of WSP by building owners as a means for self-regulation of internal water services by buildings owners. An Incentive-based program promoting WSP may provide the ideal platform for such an initiative. This can also form part of green building certification programs to ensure health and safety of occupants.

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Plumbing Industry Regulations Board (PIRB)
Green Building Council of SA (GBCSA)
South African Property Owners Association (SAPOA)
Institute of Plumbing South Africa (IOPSA)
IOPSA magazine – Plumbing Africa

Finally, to my co-author, Matthew Damons and students, Phumudzo Budeli and Michela Masango: thank you for your enthusiasm and hard work to complete this project.

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CDC	Centre for Disease Control
CLASP	Collaborative Labelling and Appliance Standards Program
COC	Certification of Compliance
DPW	Department of Public Works
DWS	Department of Water and Sanitation
EO	Executive Order
GBCSA	Green Buildings Council of South Africa
IOPSA	South African Institute of Plumbers
IRIS	Integrated Regulatory Information System
IWA	International Water Association
NBR and BS Act	National Building Regulations and Building Standards Act
NIOH	National Institute of Health
NRCS	National Regulator for Compulsory Specifications
NWA	National Water Act
NWRS2	National Water Resources Strategy 2
PIRB	Plumbing Industry Regulation Board
POE	Point of Entry
POU	Point of Use
SA	South Africa
SABS	South African Bureau of Standards
SALGA	South African Local Government Association
SANEDI	South African National Energy Development Institute
SANS	South African Nation Standards
SAPOA	South African Property Owners Association
SDG	Sustainable Development Goals
SWPN	Strategic Water Partnership Network
US EPA	United States Environmental Protection Agency
VIPs	Ventilated Improved Pits
WHO	World Health Organization
WRC	Water Research Commission
WSI	Water Services Institutions
WSPs	Water Safety Plans

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BACKGROUND

INTRODUCTION

Water is our most precious resource without which we cannot survive. While a constant supply of clean water is required for daily consumption, maintaining hygiene and cooking; water is essential for providing food and maintaining industries. The efficient use and the safety of this precious resource is therefore critical to human existence. Today, nearly two billion people live in areas at risk from severe water scarcity, while water crises are one of the greatest risks to the global economy (WWF, 2020). This can be attributed to several reasons, including increased demand due to population growth, climate changing leading to unreliable water supply (droughts and floods), and pollution of fresh water sources from industries and agricultural activities.

Currently 56.2% of the global population lives in cities and rely on piped water supply systems for potable, industrial and to some extent, agricultural water source (Buchholz, 2020). The residents are dependent on the local Water Services Provider in their area to ensure constant supply of clean water. As most large cities in the world have extensive, ageing water networks supplied by single water source, the water services authorities must ensure water treatment plants are optimised to deliver safe drinking water and networks are subject to routine maintenance to maintain the integrity of the supply system. Worldwide, as in South Africa, national legislation is in place for provision of water services to the public by Government or public Water Services Providers. Once the water enters a private dwelling, the onus is on the property owner to effectively utilise the water, ensure there is no additional contamination from external sources, and safety dispose of any wastewater that cannot be disposed into municipal system

PROBLEM STATEMENT

While regulatory authorities provide oversight of public water supplies with regards to water use efficiency and water safety, this is more challenging with thousands of independently owned buildings who are responsible for their internal water services. Water scarcity faces most urban cities in the world today due to ageing water infrastructure, increased demand from growing urban populations, and effect of climate change which reduce reliability and quantity of water resources. South African consumers in general have little regard for the scarcity of our water resource as is evident by 2012 Water Research Commission (WRC) publication (Mckenzie *et al.*, 2012), which found South Africans use between 182 and 233 litres/person/day compared to a world average of 173 litres/person/day. As much as 30% of water in South Africa is for urban and rural use, including domestic use with large commercial building, which consume huge quantities of water for potable and industrial use.

In urban areas, consumers can take responsibility for using water efficiently where supply is unreliable or insufficient. During the drought in Cape Town, from 2015 to 2018 the City of Cape Town reduced water usage by more than 50% with average combined usage of 500 million litres per day. This was achieved through severe water restrictions, increased tariffs for high water usage, punitive measures for wasting water, and public awareness campaigns. However, since the drought has ended, average combined usage has steadily increased to > 700 million litres per day from 2020 (WHO & International Water Association, 2011)

To address issues of water scarcity, government and private organisations have published water use efficiency guidelines for various industries such as health care and tourism and there are several building certifications programs which provide water use efficiency guidelines and benchmarks. However, these are

only guidelines which are not subject to regulation and implementation is at the discretion of the property owner or industry.

According to the World Health Organization “While public water supplies are generally maintained by water utilities or agencies with particular expertise, this is often not the case with water supplies within buildings. A general perception can be that water systems in buildings connected to public supplies are safe, ignoring the potential for contamination (both chemical and microbial) and growth of waterborne opportunistic pathogens within the building water systems.”.

Within buildings, there is little or no actions from private home/property owners to check and maintain safety of water within their internal reticulation network. The general perception is that piped water is safe to drink and there are no additional risks within internal reticulation networks. This is in part due to building water systems often managed by general maintenance staff that focus on water supply instead of water quality as they have little training or expertise in managing water quality.

The Department of Water and Sanitation (DWS) (2022) Blue Drop Progress report, which was released by the Minister of Water and Sanitation, Mr Senzo Mchunu in May 2022, states 60% of water supply systems in the country do not comply with microbiological determinants and 77% of water supply systems do not comply with chemical determinants. In addition, 66% have insufficient number of samples to verify microbiological quality and 77% have insufficient number of samples to verify chemical water quality as per the SANS 241 requirements. The poor performance of most supply systems indicates serious health risk to consumers of municipal water supply due to water quality failures or insufficient information to verify the safety of municipal water supply. Building owners therefore can no longer assume municipal water entering their buildings is safe for human consumption and must implement systems to identify and manage water quality risks.

At present, there are no legal requirements for water quality monitoring in buildings in South Africa except for the voluntary Standard for monitoring of Legionella, SANS 893 under the Occupational Health and Safety Act (No 85 of 1993). As this is a voluntary standard, there is no regulatory authority to ensure Legionella monitoring and control is taking place and this remains at the discretion of the building owner. The COVID-19 pandemic has highlighted the issue of water safety for all consumers, especially within buildings. After prolonged periods of shutdown or reduced occupancy levels, stagnant water in buildings have insufficient/no disinfection residuals which can lead to growth of pathogenic organisms in the water network as well as increased potential for growth of Legionella bacteria in hot water systems. During the lockdown, incidents of Legionella infections have increased worldwide due to the shutting of commercial building for long periods to deal with COVID-19 pandemic. For the first time, building owners have had to take responsibility for ensuring the safety of water within their facilities and this has highlighted the lack of legislation and information to ensure water safety in buildings.

In summary, there are challenges with regards to implementing water use efficiency measures and ensuring water safety in buildings:

- Lack of baseline information on status of water supply, water use and water safety in South African buildings.
- Lack of regulations addressing water use efficiency and water quality in buildings.
- Lack of regulations/standards for water quality monitoring within the buildings.
- Lack of compulsory standards from Legionella monitoring.
- Lack of roles and responsibilities for enforcing water services regulations within buildings.
- Lack of guidelines for re-opening all types of buildings after extended periods of closure/low activity, e.g. lockdown, after vacations, low season, etc.

To address these challenges, appropriate national standards must be developed, adopted and enforced to ensure buildings always provide a reliable supply of clean, safe water.

AIMS OF THE PROJECT

This WRC project aims are listed below, with outcomes and expected impact as per Figure 1.1.

1. To identify gaps in the current legislative framework governing water use efficiency, water supply and water safety in various building types.
2. To assess water use efficiency, water supply and water safety in various building types throughout South Africa.
3. To generate data sets, benchmarks, and guidelines that will lead to subsequent development of national standards for water use efficiency and water safety in buildings.

SCOPE OF WORK AND LIMITATIONS

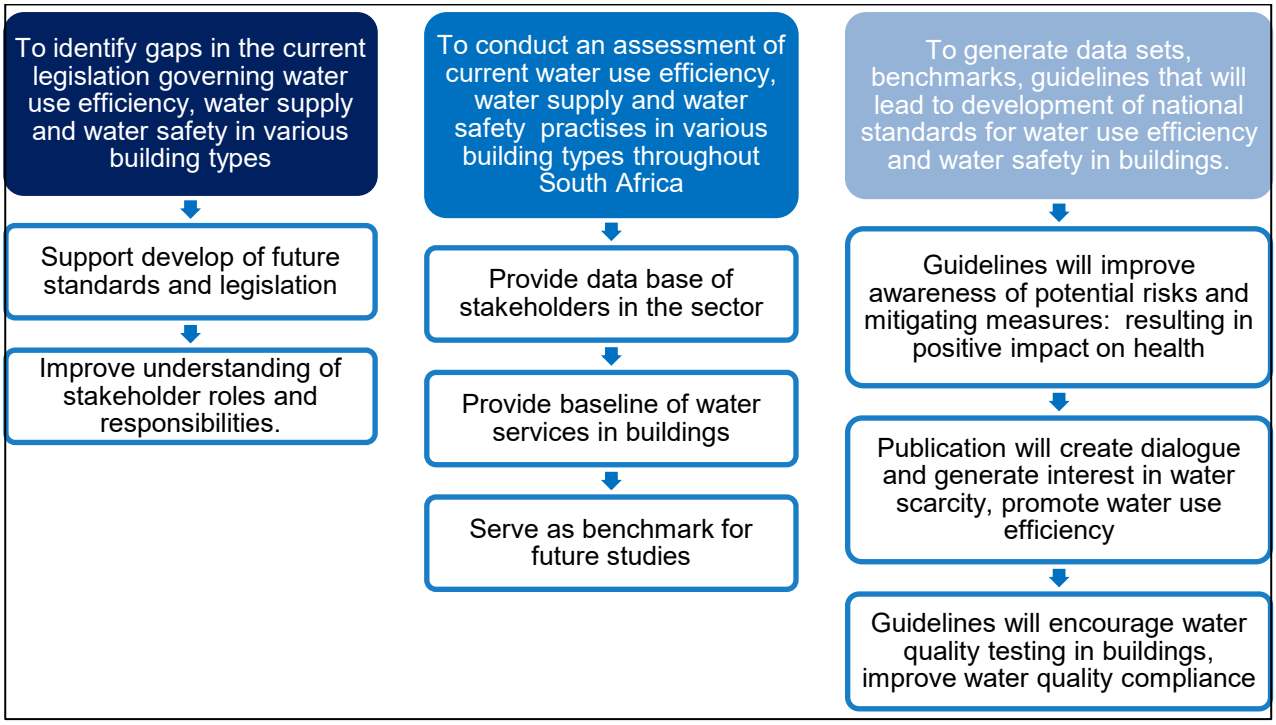

FIGURE 1.1: PROJECT AIMS, OUTCOMES AND EXPECTED IMPACTS

GENERAL STUDY APPROACH AND OUTCOMES

There were five phases in this project, each with specific actions and outcomes outlined in Figure 1.2 below.

- **Inception Phase**: sets the scene with detailed literature review of water supply, water use efficiency and water safety in buildings. This information guided the project team to develop the online survey.
- **Investigation Phase**: there were two activities for this phase:
    - Stakeholder engagement: The Stakeholder mapping and engagements were critical to understand the roles and responsibilities of the various stakeholders and their contribution in using, sharing and/or regulating guidelines and standards that are/will be developed.
    - Online survey: The online survey served as baseline of water services in buildings and to understand the general perception of buildings owners towards water security and water safety.

- **Data Analysis phase**: Date collation and scenario analysis provided clarity on the status of water services in buildings. The Stakeholder Feedback session provided an opportunity to engage stakeholders on the critical challenges, share information gathered, and obtain inputs on proposed tools. All information gathered during preceding phases were consolidated to provide comprehensive overview of water use efficiency and water safety in buildings and to identify areas where guidelines are required to improve water safety and security.
- **Development of guidelines**: Four guidelines have been developed to improve water safety in buildings as well as an excel-based risk assessment tool to identify and manage water services risks in buildings.
- **Outcome Phase:** The key outcome is the final report with guidelines as stand-alone appendices which can be used by building owners for easy reference. Knowledge dissemination includes both Stakeholder and Sector engagements to promote sharing of guidelines with building owners, plumbers, and facility managers.

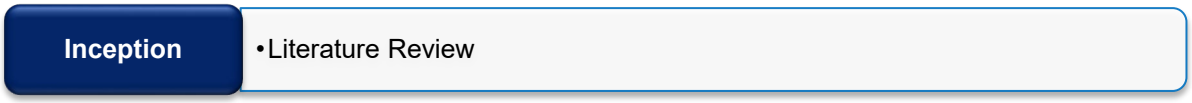

FIGURE 1.2: PROJECT PHASES AND DELIVERABLE

LEGISLATIVE FRAMEWORK ON WATER SERVICES IN SOUTH AFRICA

INTRODUCTION

As per the Constitution of South Africa (The Constitution of the Republic of South Africa, 1996), there is a legal obligation on the government to realise people's right to a reliable, sustainable, and sufficient supply of clean and safe water. The legislative requirements for water use and water quality are contained in various pieces of legislation at national and regional level. The overarching legislation is the National Water Act (NWA) (No 36 of 1998) which states the DWS is the custodian of all water resources in the country and responsible for its sustainable use and management. Any use of water must be approved by DWS and this includes abstraction, purification, storage, and discharge as per Section 21 of NWA.

According to the Reddick and Kruger (2019), South Africa is dependent on surface water resources for 68% of its supply needs, 26% of water supply needs comes from return flows and groundwater sources, and the remaining 6% is recovered through the desalination of seawater / brackish water) (Figure 2.1A). South Africa is ranked as the 30th driest country in the world with the average rainfall of 450 mm per year which is well below the world average of about 860 mm per year. It is a highly water-stressed country, with extreme climate and rainfall fluctuations, high evaporation levels and high runoff. The natural availability of water across the country is highly uneven with more than 60% of the river flow arising from only 20% of the land and four of South Africa's main rivers are shared with other countries. Most urban and industrial development takes place in locations far away from large watercourses, dictated either by the occurrence of mineral riches or influenced by the political dispensation of the past. As a result, in several river basins the requirement for water far exceeds its natural availability resulting in widely spread, large-scale water transfer schemes across catchment. The largest transfer scheme is the Lesotho Highlands Water Transfer Scheme which supplies South Africa with nearly 800 million cubic metres annually and provides revenue and hydroelectric power to Lesotho.

As per Figure 2.1B, agriculture is the largest water use sector (62%) in the country, followed by municipalities (27%), which include residential, commercial, and industrial users supplied by municipalities. Of the 62% used for agriculture, 35% is lost in the river and canal conveyance systems. In 2018, of an estimated 16.7 million households, 89% had access water, 46.3% had access to piped water inside the dwellings, 28.5% accessed piped water on site and 14.2% relied on communal or neighbour's taps (CLASP, 2021).

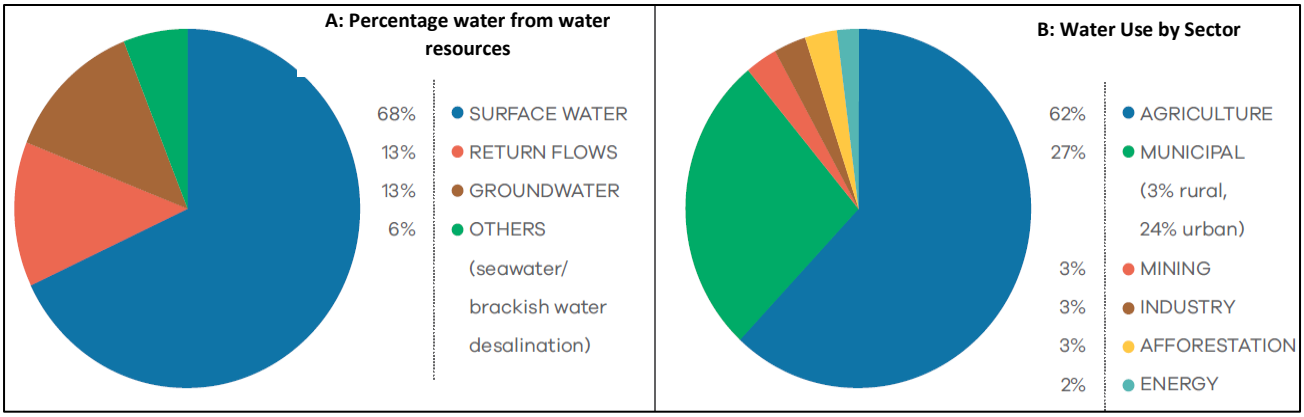

FIGURE 2.1: A) PERCENTAGE WATER REQUIREMENTS FROM VARIOUS WATER RESOURCES, B) WATER USE BY SECTORS IN SOUTH AFRICA, 2017 (WATER: MARKET INTELLIGENCE REPORT 2019, GREEN CAPE)

Based on South Africa's growing population, economic growth projections, and current efficiency levels, the country could have a water deficit of up to 3.8 billion m^3 by 2030 – a 17% gap between water supply and demand. Not all areas will be equally affected, with severe shortages expected in key industrial areas, e.g. Gauteng, Mpumalanga, KwaZulu-Natal, and the Western Cape (Reddick and Kruger, 2019).

South Africa faces several challenges with regard to water resources quality.

- Eutrophication is a major and widely recognised threat to water quality in the country and is a consequence of nutrient enrichment that leads to ecological changes, mostly notably blooms of algae or macrophytes that affect water quality.
- Acid mine drainage (AMD) results largely from the oxidation of sulphide minerals (often pyrites) leading to lowered pH levels, increased salinity (often as sulphates), and mobilisation of a number of toxic metals, many of which are toxic. AMD is associated with gold and coal mining and is a major environmental problem in South Africa affecting both surface and groundwater in the areas that it occurs (Gauteng and Mpumalanga).
- Contamination of water by poorly managed sewage effluents may lead to high nutrient and salt levels, decreased oxygen levels, and an increase in the number of pathogens present in the water body. The 2021 Green Drop Report states that only 2,5% of municipal wastewater systems achieved Green Drop certification and 334 out of 850 systems are in a critical state.

MUNICIPAL WATER SERVICES PROVISION IN SOUTH AFRICA

As per the Water Services Act (Act 108 of 1997), local government is the Water Services Institution (WSI) responsible for the provision of water services, i.e. water treatment and supply, wastewater collection and treatment. The Water Services Act allocates oversight and performance monitoring duties to DWS, including the function of Regulator. Section 9 of the Act makes provision for development of compulsory norms and standards by DWS for the purpose of regulating all aspects of water services while Section 62 states that DWS must monitor performance/compliance against national standards.

WATER USE EFFICIENCY

Water Use efficiency is addressed under sections 9(1) and 73(1)(j) of the Water Services Act which makes provision for regulations relating to compulsory national standards and measures to conserve water (GNR.509 of 8 June 2001). The regulation makes provision for an annual water services audit as component of a Water Services Development plan that reports on water conservation and demand management activities such as the results of the water balance, the total quantity of water unaccounted for, the demand management activities undertaken; and the progress made in the installation of water-efficient devices. In addition, the regulation states a WSI must take steps to reduce the quantity of water unaccounted for and keep record of the quantities of water measured and of the calculations made. The draft Water and Sanitation Master Plan by the DWS (2018) also advocates for 'reducing water demand and increasing supply'. The plans states: "As a target, average domestic consumption must be reduced to 175 litres per person per day by 2025", and one of the key actions is to "Reduce Non-Revenue Water (NRW) and water losses in all municipalities to 15% below the business as usual (1.1.1)".

The DWS (2013) National Water Resource Strategy (NWRS) states that South Africa is a water-stressed country, facing water challenges, such as security of supply and the inefficient use of water and aims to ensure that water is sustainably, efficiently and effectively managed through water conservation and demand management. Core Strategy 6 of the NWRS2 spells out that "Implementing water use efficiency, conservation and water demand management" is a non-negotiable principle. The strategy highlights the need to reduce water losses, increase water use efficiency; promote water saving through incentive-based programmes, including smart technology and rebates for water savings, and fast-track the implementation of WC/WDM in consideration of the elevated status in the National Government's Plan of Action (Outcome 10), which has set a target of 15% in 2014 for the reduction of water losses in distribution systems. Once again, these targets are not part of policy and cannot be enforced.

DWS (2022) has several water conservation initiatives such as:

- Labelling Program with SABS and SANEDI (see 2.3.3): development of standard for water use-efficient fittings aligned with ISO requirements. Once completed, DWS will advocate for removal of non-water use-efficient fixtures.
- Regulation 509 under Water services Act is part of National Building Regulation and stipulates that WSI must aim to reduce water losses within 48 hrs. However, there is no enforcement protocol or capacity to ensure this is achieved and DWS can only advise WSI to reduce water losses.
- JICA assisted project to create a Training facility for municipal staff to address water losses. This facility offers 6 weeks training which includes theoretical and workplace training, The facility trains around 60 people per year.
- DWS "War on Leaks" project: Historical project to address water losses in network and in households by training plumbers, water engineers, etc. to address water leaks. However, uptake of participants into municipalities was slow and program has stopped. Program recently linked to allegation of corruption and 'state capture".

Currently, the onus is on the WSI to reduce water losses as DWS acts only in an advisory role due to lack of targets for water losses for WSI and lack of enforcement policies related to water use efficiency.

WATER SAFETY

With regards to **water safety**, Government Notice No. 509 states that a WSI must ensure the delivery of safe drinking water by development of a detailed monitoring programme with comparison of the results against the National standard. As per the Section 9 requirement of the Water Services Act for compulsory norms and standards, DWS has developed the SANS 241 (2015) which is the National Drinking Water Quality Standard for potable water in South Africa. The latest version of the standard, SANS 241: 2015 lists the acceptable limit of water quality determinants for safe drinking water, provides details of sampling programs, risk assessment, incident management, and calculation of water quality compliance to ensure delivery of safe drinking water.

As per the Section 62 requirement of the Water Services Act, all water quality compliance results must be provided to DWS monthly to verify the quality of water provided. Currently, this is taking place via the electronic web-enabled Integrated Regulatory Information System (IRIS) of DWS (2021) which allows WSI to upload water quality data monthly thereby providing a broad overview of current water quality per water supply system. The IRIS system reports on water quality compliance of final water and at various point in the reticulation network for each risk category as outlined in SANS 241:2015: Acute Health, Chronic Health,

Operational, and Aesthetic The water quality compliance data on IRIS provides DWS with the required information to regulate and manage the WSI while providing the public with credible information to verify the quality and safety of water in their area. The SANS 241:2015 applies to municipal water supply up to the point of delivery into private property and homes and does not extend to network within buildings.

The Draft SANS 241ED7 has been issued by the SABS Committee TC147 for public comment (comments closed 29th June 2022). An addition to this draft SANS is Section 7.4: Monitoring of Static Tanks. This section requirements for monitoring of tanks by responsible person and the frequency of monitoring is dependent on the number of tanks. The "responsible person" is described as the "entity or person that has the overall legal responsibility for providing of wanting to provide drinking water for a given geographic area". This may have implications for building owners as they have the legal responsibility over water tanks on their premises. If this is included in the revised SANS 241 (2015), building owners may be required to monitor their water tanks and provide this information to the relevant WSI. The revised SANS 241(2015) standard may therefore have implication for building owners and development of future standards for water quality monitoring in buildings.

Local Municipal By-laws

Local Municipal By-laws outline the legal requirements for provision of water services within the designated municipality and vary from one municipality to the next. Municipal by-laws are laws passed by the Executive Council of a municipality to regulate the affairs and the services it provides within its area of jurisdiction, including water services. A municipality derives the powers to pass a by-law from the Constitution of the Republic of South Africa, which gives certain specified powers and competencies to local government as set out in Part B of Schedules 4 and Part B of 5 to the Constitution. The water services by-laws cover a variety of areas relating to water supply and wastewater collection, including water connections, metering, billing, effluent discharge standards, industrial effluent, water restrictions, drilling of boreholes and use of alternative water supply/wastewater treatment.

Draft water services by-laws are provided by DWS to local municipalities for further development and implementation. The onus remains on the municipality to expand their local by-laws to address issues related to water services within building with possible inclusion of new standards into by-laws. Currently most by-laws address issues of supply but do not cover water services within the actual building. In addition, many municipal by-laws are outdated (older than 5 years) and enforcement of by-laws is poor due to lack of resources and skills at local municipal level.

The City of Cape Town (CoCT) is one of the few municipalities that have comprehensive water services by-laws which address various aspects related to water services in buildings: some of these requirements are listed below as outlined in CoCT by-laws.

- **Water Services Intermediary (WSIs) Contracts** with individual who supply their own water services within buildings. The WSI contract stipulates the quality and quantity of water/effluent that can be used/discharged and details of connections to the municipal sewer (valves, pipe materials, flow meters, etc). In addition, the WSI Contract outlines monthly recording and monitoring of various activities, including volume of sewage discharged to network/volume of water used, quality of raw and final water/sewage and record of incidents.
- **Alternative water supply**: CoCT promotes the responsible use of alternative water sources to help minimise the quantity of water drawn from current water resources, especially in times of drought. The alternative water sources are rainwater, groundwater, basement water, surface water, grey water and treated effluent. CoCT has published detailed guidelines for installation of alternative water systems with clearly defined definitions, required authorisations, designs, use, storage,

monitoring of alternative water systems. These guidelines reflect the SANS 1732:2019. *Greywater reuse systems*.
While the guidelines are not compulsory, all installation are subject to approval by COCT which will evaluate installation against the guideline.

- **Installation of backflow protector for alternative system**: this is aligned with SANS 5171: 2014, *Protection against pollution of potable water in water installations and general requirements of devices to prevent pollution by backflow.*
- **Use of professional registered plumber for installation**

The City of Johannesburg (CoJ) is the WSI responsible for policy development and monitoring and is the custodiam of the by-laws. Key observations relating to the water services by-laws of CoJ are summarized below (City of Johannesburg, 2021):

- Although CoJ is the custodian of by-laws, they are not responsible for implementation of water services by-laws due to lack of capacity.
- JHB Water (Water Services Provider within CoJ) is responsible for connection of water and sanitation to supply and are also responsible for enforcement of by-laws related to municipal water supply. JHB Water is assisted by Johannesburg Metro Police Department (JMPD) and CoJ legal department assist with transgressions (fines, disconnections).
- There is no enforcement of other by-laws; borehole registration, storage of water, grey-water reuse, etc.
- Current By-laws are outdated (promulgated in 2004), draft by-laws awaiting approval since 2018/2019. This process has been delayed due to organizational challenges: promulgation has been slow due to it being driven by Speaker's office, by-law must stand for a year from date of public participation to gazetting of by-laws – but if date has passed, then you need to start process again, Issues with procurement of service providers for activities related to promulgation of by-laws.
- Draft by-laws do not address water use efficiency, alternative water supply is restricted to 20% of total use, no alternative water supply for potable use.
- Environmental Health Practitioners in CoJ are responsible for inspecting water tanks. However, they work independently of JHB Water to monitor on-site storage – no information on levels of monitoring programs, levels of compliance or incident management.

The challenges associated with water services by-laws is summarised below:

- Lack of updated by-laws at municipalities due to various reasons: long process to obtain approval for amendments and procurement issues.
- Inclusion of voluntary standards into local by-laws: subject to approval by Council, varies from one municipality to another depending on political parties.
- Enforcement of by-laws due to lack of resources.
- Enforcement of by-laws related to private buildings: authorisation to enter buildings, security issues, rights of private homeowners

WATER SERVICES PROVISION IN BUILDINGS IN SOUTH AFRICA

A constant supply of clean water is required in buildings to maintain health and hygiene as well as for other uses such as irrigation, cooling, heating and other industrial applications. A reliable source of clean water is therefore critical to ensure constant supply to buildings while the efficient use of water within the building will ensure sustainable use of this precious resource.

NATIONAL BUILDING REGULATIONS AND BUILDING STANDARDS ACT (ACT NO. 103 OF 1977)

The NBR and BS Act together with associated norms and standards forms the legislative framework for water services within buildings. The Act is responsible "To provide for the promotion of uniformity in the law relating to the erection of buildings in the areas of jurisdiction of local authorities; for the prescribing of building standards; and for matters connected therewith".

The NBR and BS Act ensures that all buildings comply with the water services requirements outlined in the Act before commencement of construction. The Act states that a suitably qualified Building Control Officer is appointed at each municipality as an agent of the Minister to DTI to ensure compliance with the NBR and BS Act. Implementation of act depends on competency of Building Control officer and his ability to implement corrective measures. The primary duty of building control officer is to inspect building works to ensure that they meet the minimum standards as set out in the legislation. However, their area of jurisdiction does not extend to the internal water network.

Where building developer/owner is not in agreement with a decision made by the local authority regarding permission to build, they have the option to approach the NRCS who will then appoint an appeals board to review the decision. In the past, the Court had the power to intervene if local authority does not adhere to findings of appeal board. However, this was found to be unconstitutional and therefore the NRCS does not have power to implement findings. The building owner can approach the court directly to intervene but this is a costly and lengthy process

The National Building Regulation is supported by a large number of compulsory standards governing the design, construction and management of buildings. The SABS standards SANS 10400 – 2010, *the Code of Practise for the application of the National Building Regulations*, is a mirror-image of the NBR and AS Act with sections A to X covering the legal requirements to ensure that buildings will be designed and built in such a way that persons can live and work in a healthy and safe environment. The SANS 10400 is therefore a compulsory standard as the standard is referenced in the NBR and BS Act and can be enforced by the Building Control Officer.

The National Regulator for Compulsory Specifications (NRCS) is an entity of the Department of Trade, Industry, and Competition (DTIC); established to administer compulsory specifications and other technical regulations with the view to protect human health, safety, the environment and ensure fair trade in accordance with government policies and guidelines. The legislative framework under which the NRCS performs its tasks on behalf of the DTIC are as follows:

- The National Regulator for Compulsory Specifications Act (Act No. 5 of 2008)
- Legal Metrology Act (Act No.9 of 2014)
- National Building Regulations and Building Standards Act (Act No. 103 of 1977) (NBR and BS Act)

The National Building Regulation Unit of the NRCS is responsible for ensuring uniform understanding and implementation of the NBR & BS Act. The strategic roles of the NBR are:

- Providing technical advice and interpretation of the (NBR and BS Act) to the built environment practitioners and other interested parties, such as homeowners, local authorities, government departments, and the public
- Performing building defects investigations that can be described as forensic architectural investigations.
- These investigations are performed to determine why and how building failures occurred

- Evaluation of the qualifications of Building Control Officers who do not satisfy the required minimum qualifications as prescribed by legislation
- Providing technical support and guidance to the SABS technical committees responsible for providing solutions to satisfy the legislative requirements in terms of developing the SANS 10400 range of documents
- To inform the building industry's stakeholders of the role and function of the NBR

Under the NBR and BS Act, there are currently no compulsory standard which refer to water use efficiency. There are a number of voluntary standards which refer to water-efficient fittings but these need to be reviewed due to the following reasons:

- The standards for taps in South Africa are outdated and ambiguous; providing a minimum required flow rate, but do not specify the maximum flowrate for water use efficiency.
- The regulation around the design specifications and sale of water-efficient fitting are not aligned, e.g. a SABS approved showerhead with a flowrate of 48 L/min can be sold to a consumer, even though it cannot be installed into a building.
- Implementation of water fixtures in buildings typically lie with the consumers/owners with limited knowledge of water efficiency; this often results in the installation of cheaper fixtures that are not water-efficient as their decision is cost-based.

In 2020 the NRCS commenced with development of new water regulations which will cover all technical aspects related to water services infrastructure and water supply installations, including SANS 3088:2019 *Water efficiency in building*. This standard will form part of SANS 10400 – XB (environmental legislation) and provides minimum requirements for plumbing fixtures and fittings and for water usage in buildings. These new regulations are subject to promulgated before they can be implemented at local municipal level by Building Control Officers. There is a clear need for clarification and alignment of regulations and standards on water-efficient fittings.

With regards to water safety in buildings, the stakeholder engagement conducted with NRCS revealed that non-technical aspects related to water quality and alternative water sources were not included in the proposed new water regulations for the following reasons:

- The NRCS does not view water as risk to inhabitants of building as water has never killed anyone in building. Health risks are minimal: dripping tap or burst pipes do not pose health risk.
- The NRCS assumes water entering the building is safe; municipality is responsible for water quality as per Water Services Act.
- Alternative water sources are the responsibility of the local municipality as it varies from one area to the next.
- Water quality and water supply is covered by other regulations under DWS: National Water Act and Water Services Act. Inclusion in the NBR and BS Act would be duplication of legislation and overlap of roles.
- The NBR and BS Act and associated standards directed at technical staff who do not have water quality expertise: engineers, architects, plumbers and Building Control Officers. Water quality competency is however available at local municipal level where it can be monitored and regulated.

For these reasons, the NRCS advocates for the inclusion of aspects related to water quality and alternative water sources under local municipal by-laws.

NATIONAL STANDARDS ON WATER SUPPLY AND DRAINAGE IN BUILDINGS

South African Bureau of Standards (SABS) is the statutory body that was established in terms of the Standards Act, 2008 (Act No. 8 of 2008) as the national standardisation institution in South Africa mandated

to develop, promote and maintain South African National Standards (SANS). SABS is the custodian of all national standards in the country. Standards are voluntary and can only become compulsory standards once they are incorporated in regulation.

The TC60 Technical committee of SABS is responsible for standards related to the NBR and BS Act (SANS 10400) which are currently in process of review. The SABS has developed the following new standards which apply to this study namely: SANS 3088: water use efficiency standard, and SANS 1732: Grey water use standard. These are voluntary standards, and not mandatory as they have not yet been not included in 10400 which is referenced in the NBR and BS Act.

SANS 10252

The SANS 10252 is a voluntary standard, used by engineers and plumber to design water services in buildings. The SANS 10252 covers various water sources (potable, fire water, hot water systems, water fountains, stormwater) and variety of aspects related to water supply, including design, installation, system components, material specifications, storage, plumbing, disinfection, quality, and qualifications of service providers. Of particular importance are the following sections of the SANS 10252 which refer to water quality:

- SANS 10252-1: 2018. Edition 3.1. Section 7.1.2 Water supply quality — Human consumption. These addresses recommended conditions for water which will prevent development of bacterium Legionella pneumophila.
- SANS 10252-1:2012 Edition 3. Section 7.1.3 Water supply quality — Plumbing considerations. This section deals with protection of plumbing in hot water systems due to the following water quality issues: scale formation, corrosion, biological growth, suspended solid matter or any combination of these
- SANS 10252-1:2012 Edition 3. Section 9.3 Disinfection. This standard outline procedure to disinfect and flush new and existing systems, including storage tanks.

Although the SANS 10252 is not part of the NBR and BS Act, it is referenced in the SANS 10400, Part A (*water supply Installation*) and Part B (*Drainage)* – every consumer installation must comply with SANS 10252, water supply and drainage for buildings and SANS 10254 – installation, maintenance, replacement and repair of fixed water heating systems. As the SANS 10252 is not duplicated in the NBR and BS Act, it is not subject to approval by the Building Control Officer.

Rudolph Opperman from the NRCS states that as the SANS 10252 is a compulsory standard as per the Water Services Act, DWS is responsible for enforcement: 'he who makes the law, must implement it" (NRCS, 2021). However, the Water Services Act is only applicable to the WSI (municipality) and does not extend to private building. Therefore, the SANS 10252 cannot be enforced by DWS under Water Services Act. Standards are called up in legislation, but if there not referenced in the applicable law, the standards cannot be enforced.

OTHER STANDARDS

There are several other voluntary standards which apply to water services in buildings such as:

- SANS 5171: 2014. Protection against pollution of potable water in water installations and general requirements of devices to prevent pollution by backflow
- SANS 10254: 2017.The installation, maintenance, replacement and repair of fixed electric storage water heating systems

- SANS 1808: 2017. Water supply and distribution system components, 66 volumes for various components of water supply network
- SANS 10306: 2010. Management of Potable Water In distribution systems.
- SANS 52566: 2010. Small wastewater systems (Design, installation), 4 volumes.

Under the National Water Act, allocation is made for additional regulations outlined in local by-laws which address issues of water services within the municipality. Voluntary standards which apply to buildings may be adopted into local by-laws thereby converting them to compulsory standards which can be enforced at local municipal level.

WATER EFFICIENCY LABELLING

The South African Water and Sanitation Master Plan 10.1, published by the DWS, indicates that a water efficiency labelling scheme will be established by 2025. In response to this goal, the SABS Special Committee, TC0138/SC02, participated in the International Standards Organization project (ISO/PC 316) to develop an ISO standard for water labelling systems. The SABS considers the ISO standard, once published, to be applied to establish a water efficiency labelling program in South Africa. To establish such a water efficiency labelling program, there must be uniformity between the requirements of all related SANS standards and international tap standards

The Energy Efficiency Programme at South African National Energy Development Institute (SANEDI) has recently been mandated to administer the implementation of the South African Appliance Standards and Labelling Programme (S&L Programme); The programme is also supported by the Collaborative Labelling and Appliance Standards Program (CLASP NGO), to improve policy and awareness creation of energy-efficient household appliances, lighting and water dispensing products in South Africa. CLASP has recently completed the "South African Tap and Flow Rate Gap Analysis Report" (CLASP, 2022) to inform the process of developing and improving standards for taps and showerheads. The main findings of this report are summarised below:

- Gap analysis conducted of the various SANS standards indicate several misalignments between SANS and international standards.
- Misalignments could be addressed effectively through amendments of the selected requirements of the SANS standards.
- Provides recommendations on how flow rates should be evaluated to determine appropriate flow rate requirements. A maximum flow rate is recommended for each type of tap to align with similar international requirements.
- Target water-saving flow rates are recommended for future implementation to improve water efficiency thereby aiding South Africa to improve sustainable use of our water resources.

Once this labelling program is completed, it will be adopted into the National Building Regulations and Building Standards Act (NBR and BS Act) to form part of compulsory national standards to ensure water use efficiency fittings are installed in all buildings.

THE PLUMBING INDUSTRY REGISTRATION BOARD (PIRB)

The PIRB is non-statutory board for registration of professional member. They promote better plumbing practices by ensuring their members comply with both compulsory and voluntary standards.

The CoC (certificate of compliance) is a system and process whereby a licensed plumbing practitioner will self-certify their plumbing work by issuing of a plumbing certificate of compliance to the relevant owner, municipality, local authority and/or insurance company. Through this process the licensed plumber shall

take ownership for their plumbing work and be held accountable for the said work. All PIRB Registered practitioners shall have in their possession the current compulsory SANS Codes of Practice, Building Regulations and Local Water By-laws documentation for ease of reference. The key standards for ensuring compliance are SANS 10400, SANS 10252: *Water supply and drainage for buildings*, SANS 10254: *electric water heating systems.*

As mentioned, some local by-laws (City of Cape Town) stipulate the use of professional plumbers to ensure compliance with standards. However, in areas where by-laws do not address these requirements, the appointment of plumbers is at the discretion of the building owner who in many cases will use unqualified plumbers to save cost.

The PIRB constantly updates members on new requirements and are key to sharing guidelines and standards for water use efficiency and water safety in buildings.

SUMMARY OF LEGISLATIVE CHALLENGES FOR WATER SERVICES IN BUILDINGS

FIGURE 2.2: SUMMARY OF LEGISLATIVE CHALLENGES FOR WATER SERVICES IN BUILDINGS

STAKEHOLDER MAPPING AND ENGAGEMENT

INTRODUCTION

A stakeholder is any individual, group, or party that has an interest in a project and can be affected by the outcomes of the project, i.e. anyone who has a stake in the project. In this project, the outcomes of the project are guidelines to improve water use efficiency, water supply and water safety in buildings. Future outcomes are development of national standards for buildings to ensure that, there is always a reliable supply of safe water while ensuring water is used effectively to reduce wastage. Stakeholder mapping outlines roles and responsibilities of stakeholders and this is critical to identify stakeholder who will be responsible for adoption and regulation of national standards. Stakeholder mapping is based on level of influence and interest: stakeholder with high levels of influence will assist in sharing guidelines with building owners and promoting awareness on water use efficiency and water safety in buildings in the sector. The stakeholder mapping procedures provide guidelines on frequency of communication and management of stakeholder for the duration of project depending on their position in the map. Therefore, the benefit of the stakeholder maps is that it allows for prioritisation of stakeholders which is critical to reduce time and effort. To identify the key stakeholders in this project, stakeholder mapping was conducted by the research team using four steps used in stakeholder management principles: Identifying, Analysing, Mapping, and Prioritising.

IDENTIFYING AND ANALYSING STAKEHOLDERS

The first part of stakeholder management is to identity all relevant stakeholders who are invested, affected by the outcomes of the project. The outcome of this stakeholder identification and analysis are presented in Table 3.1 below. The stakeholders were categorised into four groups as guided by Harrin (2010). The four different categories are briefly described below.

USERS OF THE GUIDELINES AND STANDARDS

Users are stakeholders who will use the guidelines and subsequent standards to ensure there is a reliable safe supply of water at all times while using water in the most cost-efficient manner without compromising supply. These are the actual owners of buildings and property management companies who will consult these guidelines for their own assurance and will use vendors to execute activities to ensure compliance. Users will be key to completing the survey and contributing to database of water supply in buildings.

PROVIDERS, SUPPLIERS OR VENDORS

Providers are suppliers or vendors of goods, services, and support. This group includes plumbers who are responsible for construction of infrastructure, suppliers of materials/goods/software, and specialists who offer advice and services for specific applications. We have also placed the SABS in this category as they are provider of the actual standards – they develop and sell standards.

INFLUENCERS

This group has the power to influence decisions and the ability to change the direction of a certain project or program. In this project, influencers are private and government organisations which have large membership bases and can therefore exert influence by advocating for the uptake and implementation of guidelines and standards SALGA has been included in this group as their members (Municipalities) are responsible for adoption and implementation of water by-laws which may include guidelines and national standards that are not currently part of legislation.

TABLE 3.1: STAKEHOLDER IDENTIFICATION AND ANALYSIS

Category	#	Stakeholder	Interests	Contribution to project				
				Complete survey	Provide insight	Use guidelines/ standards	Publish/ adopt/ share	Regulate
Users	1.1	**Private building owners**	• To have a reliable, safe supply of water at all times • To use water in the most cost-efficient manner without compromising supply	X		X		
	1.2	**Private Owners of number of buildings, Property Management Company, Property Funds, Real estate agencies**	• To have a reliable, safe supply of water always • To use water in the most cost-efficient manner without compromising supply	X	X	X		
Providers	2.1	**Plumbers**	To understand and implement all guidelines/standards			X		
	2.2	**Suppliers:** • Materials: pipes, storage tanks, valves, meters, etc. • Soft water: leak detection, water management, system, online monitors, etc. • Other: laboratory testing, corrosion control, etc.	To provide the required materials/services to implement guidelines/standards.			X		
	2.3	**Specialists:** Water treatment, water conservation and demand management, water reuse, industrial water	To provide the required specialist support to implement guidelines/standards			X		
	2.4	• South African Bureau of Standards (SABS): statutory body that was established in terms of the Standards Act, 2008 (Act No. 8 of 2008) as the national standardisation institution in South Africa, mandated to: • Develop, promote, and maintain South African National Standards (SANS) • Promote quality in connection with commodities, products, and services. • Render conformity assessment services and assist in matters connected therewith.	To develop and publish relevant standards that will ensure provision of reliable, safe water services to all buildings.		X	X	X	

Category	#	Stakeholder	Interests	Contribution to project				
				Complete survey	Provide insight	Use guidelines/ standards	Publish/ adopt/ share	Regulate
Influencers	3.1	**South African Property Owners Association (SAPOA):** Representative body and official voice of the commercial and industrial property sector in South Africa	• To ensure there is a reliable, safe supply of water at all times, to use water in the most cost-efficient manner. • To understand the guidelines/standards and disseminate the information to members	X	X	X		
	3.1	**National Home Builders Regulation Council (NHBRC):** established in terms of the Housing Consumers Protection Measures Act, 1998 to regulate the building industry and protect home buyers against shoddy workmanship.	To understand the guidelines/standards and disseminate the information to homeowners and builders.	X	X	X	X	
	3.2	**Green building Council of SA (GBCSA):** One of 75 members of the World Green Building Council that work in collaboration with industry bodies, leaders, government departments and professionals to develop market-based green building solutions for the transformation of the South African property industry.	To understand the guidelines/standards and disseminate the information to members	X	X	X	X	
	3.3	**South African Institute of Plumbers (IOPSA):** Provides a platform to advise on the practice and principles of the plumbing industry and consults stakeholders on matters affecting the plumbing industry.	To understand the guidelines/standards and disseminate the information to members		X	X	X	
	3.4	**South African Local Government Association (SALGA)**: autonomous association of all 257 South African local governments, comprising of a national association. Its role to represent, promote and protect the interests of local governments and to raise the profile of local government, amongst other objectives.	• To ensure all Water Services Authorities provide adequate water services provision to all citizens. • Share guidelines with Water Service Authorities for inclusion in local by-laws		X		X	
Governance	4.1	**National Regulator for Compulsory Specifications (NRCS):** an entity of the Department of Trade, Industry, and Competition (DTIC) established to administer compulsory specifications and other technical regulations with the view to protect human health, safety, the environment and ensure fair trade in accordance with government policies and guidelines.	• To develop, maintain and administer compulsory specifications and technical regulations related to buildings. • To maximize compliance with all specifications and technical regulations		X	X	X	X
	4.2	**Department of Public Works (DPW):** responsible for providing accommodation and property management services to all the other ministries of the South African government	To ensure all government buildings comply with national standards and best practise	X	X	X	X	

Category	#	Stakeholder	Interests	Contribution to project				
				Complete survey	Provide insight	Use guidelines/ standards	Publish/ adopt/ share	Regulate
	4.4	**Department of Water and Sanitation (DWS)**: custodian of South Africa's water resources. It is primarily responsible for the formulation and implementation of policy governing this sector.	• To ensure all Water Services Authorities provide a reliable supply of safe water to all citizens. • To develop, implement and enforce regulations related to water services provision. • To provide oversight of water services within local municipalities: inclusion of standards into draft by-laws		X		X	X

GOVERNANCE

This group refers to regulators, government departments, auditors, etc. The key regulator in buildings is the NRCS: an entity of the Department of Trade, Industry, and Competition (DTIC) established to administer compulsory specifications and other technical regulations. Water Quality is the responsibility of the local municipality as per the National Water Act with DWS acting as the regulator to ensure delivery of safe drinking water to all consumers. Therefore, DWS is also part of this group responsible for regulating water quality into buildings. Department of Public Works has been added as Regulator as it is the custodian and manager of all national governments' fixed assets, including buildings.

MAPPING AND PRIORITISING

A stakeholder map is a visual, four-quadrant influence-interest matrix used to identify stakeholders and categorize them in terms of their influence and interest in the project. The y-axis determines the level of influence, from highest on the top to lowest on the bottom—meaning how much can the stakeholder impact the project. The x-axis of the grid measures the stakeholder's level of interest, how much the stakeholders are impacted by the outcome of the project, from low (left side) to high (right side). Stakeholders are then plotted on this map depending on how they fall on those two metrices (Lopez, 2021). This methodology was used to create a stakeholder map for this project with 4 categories of stakeholders. Below is a description of each stakeholder category and rationale for categorisation of stakeholders.

AUDIENCE: LOW POWER / LOW INTEREST STAKEHOLDERS

This group does not have much power and have little interest in the project. These stakeholders can sometimes have valuable information from a requirements perspective, but their lack of interest can make it difficult to identify the knowledge or appropriate stakeholder to engage with.

Individual building owners and suppliers have been placed in this category. The NHBRC has also been added to this category as it serves individual homeowners.

LATENTS: HIGH POWER / LOW INTEREST STAKEHOLDERS:

They have the power to cause significant disruptions to the project, but they lack significant interest. This means that their expectations and needs must be understood and managed, but not to the degree of the high-interest stakeholders.

Property Management companies and Property Groups have been added to this group as they represent large number of building owners. However, they have little interest as they focus on buildings as a whole, not only on aspects related to water. The same applies to plumbers: large number of individuals who focus on plumbing issues in general. Department of public works has been added to this group as they have high level to power to implement standards in government buildings but expressed low/no interest.

PROMOTERS: HIGH POWER / HIGH INTEREST STAKEHOLDERS

They are usually responsible for regulation/governance. Because they have both the power and interest, their expectations must be managed carefully and effort made to keep them satisfied with the project progress and results. The Promoters in this project will be responsible for adopting, publishing, implementing and enforcing the standards which will be developed in the future. NRCS and DWS are responsible for regulation and therefore are promoters. While SABS is not a regulator, the organisation identifies, develops and publishes standards for the buildings and their participation is critical in implementing the findings of this project.

DEFENDERS: LOW POWER / HIGH INTEREST STAKEHOLDERS

This group usually needs to be kept informed and provided the opportunity to have some input, even if their input is not always implemented. These stakeholders can provide a great deal of background information, user requirements, and non-functional requirements. However, if carefully managed they can

be effective promoters of the project solution and built interest and help ensure adoption (Olson, 2013). Green Building Council, IOPSA, SAPOA, SALGA and Green Cape are all placed in this category as they have high interest in the project as demonstrated by the positive feedback after initial engagements. Figure 3.1 below shows the stakeholder map for this project.

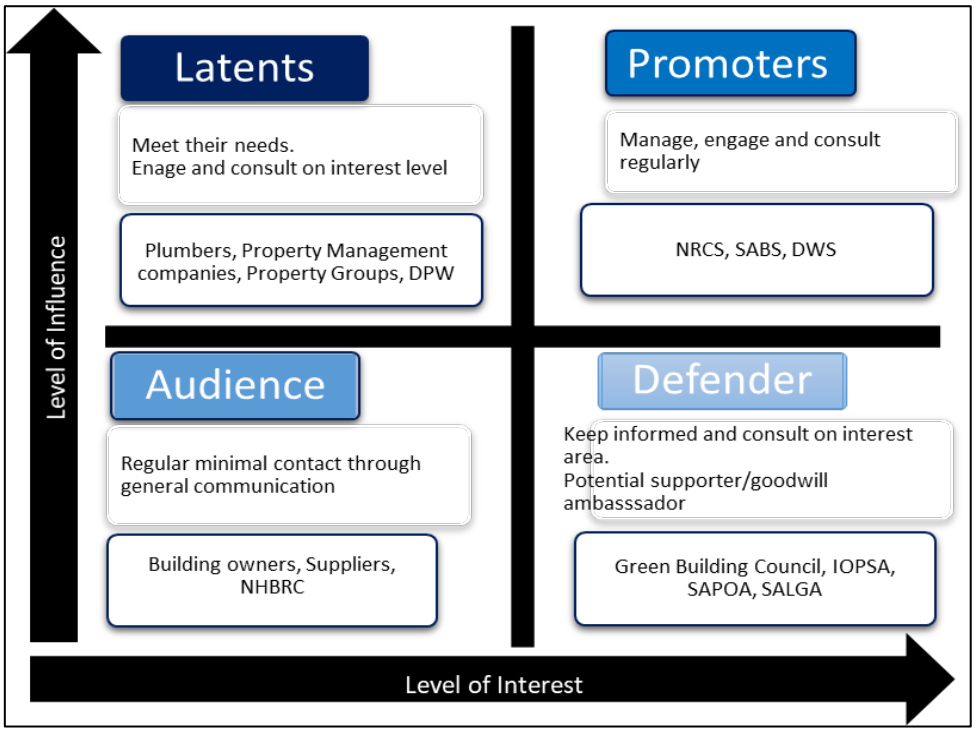

FIGURE 3.1: STAKEHOLDER MAP

STAKEHOLDER ENGAGEMENT

STAKEHOLDER ENGAGEMENT PROCESS

The stakeholder mapping process assisted in identifying key stakeholders who are critical to the success of the project, i.e. to obtain buy-in, gather information, and gain strategic insight that will improve the development of guidelines and subsequent standards. The project team embarked on stakeholder engagement sessions with the key stakeholders. Each stakeholder engagement session was conducted online with a detailed agenda, recording of online session and summary report of key outcomes for each session. However, setting up stakeholder engagement sessions was challenging due several reasons:

- Cold calls are not successful: no answer, reception do not know who the relevant person is in the organisation that can assist.
- Person who is contacted is junior and does not have required authority to engage.
- Senior person is very busy, difficult to secure meetings.
- Very large organisation and no clarity on roles/responsibility of each department – in particular Government Departments.
- Due to Covid-19, many organisations have only recently returned to 'normal business' (back in office): staff were busy dealing with backlogs and unavailable to meet.

Using personal contacts, e-introductions via networks and online meetings, the team was able to successfully conduct seven stakeholder engagement sessions.

The Stakeholder Feedback session provided an opportunity to engage stakeholders on the critical challenges, share information gathered, and obtain inputs on proposed tools. The first feedback session was held online on the 1st of July 2022 and focused on three activities:

- Feedback on data collection: Summary of key challenges from stakeholder engagement sessions and literature review, outcomes of online survey.
- Presentation of draft "Risk Assessment Tool" for use by building owners to identify and manage risks associated with water safety in buildings.
- Q&A session

MAIN INSIGHTS FROM THE STAKEHOLDER ENGAGEMENT SESSIONS

Table 3.2 below summarises these stakeholder engagement sessions and key outcomes for each session.

In summary;

- Attended by eight stakeholders: COJ, DWS, GBCSA, IOPSA, NRCS, Plumbing Africa, SABS.
- Valuable contributions by all attendees with consent on importance of this project to address issues of water safety in buildings.
- Key challenge was lack of regulations and lack of enforcement due to various reasons (lack of resources, lack of skills, overlapping mandates)
- General lack of understanding on regulatory framework for water services in buildings, how compulsory and voluntary standards are implemented and understood.
- By-laws are unique to each municipality; challenges with promulgation of new by-laws and enforcement of existing by-laws due to lack of resources.
- Draft SANS 241 addresses monitoring of onsite reservoirs in private buildings: SABS urged stakeholder to submit comments to ensure revised SANS 241 addresses some of these issues by allocating responsibility of inspections to municipalities.
- Increase in decentralised systems and alternative sources coupled with poor municipal water quality increases risk associated with water quality in buildings.
- Water Safety Planning tool was welcomed by stakeholders; concerns raised as to how building owners can be sensitised to water quality risk and encouraged to implement risk management procedures to mitigate water services risks in their buildings. Proposal is to develop communication strategy for building owners.

TABLE 3.2: STAKEHOLDER ENGAGEMENT FEEDBACK

Organisation	Overview of organisation	Stakeholder engagement session
Defender Stakeholders		
City of Johannesburg (COJ)	COJ is the Water Services Authority within City of Johannesburg Metropolitan Municipality. JHB Water is a separate entity operating as Water Services Provider to the COJ.	• COJ has issues with approval for new by-laws, currently using outdated by-laws which do not cover water use efficiency or alternative water sources. Draft by-laws only allow 20% of alternative water sources and do not approve of external Water Services Intermediaries. • Environmental Health Practitioners work independently of JHB Water to monitor on-site storage-fragmented approach to water quality monitoring. • Lack of enforcement of by-laws due to large, complex organizational structure with no clear section dedicated to water services in the network.
Green Building Council of South Africa (GBCSA)	Part of Green Building Council to develop market-based green building solutions	• Water use efficiency tool for new buildings predicts water usage of a building after its construction, existing building tool uses actual performance data of a 12-month period • With regards to water safety: assumption that all standards and health and safety regulations are adhered to and water entering buildings is safe • 'New build' tool does make provision for Legionella monitoring. • Key drivers for certification are cost-savings, resource conservation, reduced footprint, access to green funding.
Institute of Plumbing South Africa (IOPSA) and the Plumbing Industry Registration Board (PIRB)	IOPSA provides a platform to advise on the practice and principles of the plumbing industry, and PIRB is non-statutory board for registration of professional members.	• Enforcement of standards and regulations are non-existent – lack of standards included in by-laws lack of capacity at municipal level to enforce by-laws, • International guidelines for water use-efficient fittings different to South African guidelines. Technical committee at PIRB working with SABS to update standards • Internal water network not covered under the NBR and BS Act. Currently large number of unsafe installations due to use of unqualified plumbers. • Increased risk of scalding, increase health risk due to greywater use and water reuse in buildings.
Promoter Stakeholders		
Department of Water and Sanitation (DWS)	National department represented by Water Use efficiency Division: responsible for policies related to water use efficiency and implementation of national programs	• DWS provides policies related to water use efficiency and implementation of national programs. However, onus is on WSA to reduce water losses as DWS role is purely advisory, does not set targets or enforce policies/programs related to water use efficiency. • Project in place with SABS and SANEDI to bring water saving devices to the market. Development of National standard with labelling systems for water use-efficient systems, will form basis of the South African standard for water use-efficient fittings, aligned with ISO requirements

Organisation	Overview of organisation	Stakeholder engagement session
National Regulator for Compulsory Specifications (NRCS)	The National Building Regulation Unit of the NRCS is responsible for ensuring uniform understanding and implementation of the NBR and BS Act, entity of DTIC.	• The Building Control Officer enforces standards related to external water supply, does not cover internal network, does not hold senior position in municipality and other departments can override their decision. • Perception of NRCS is water is not a risk (leaking pipes do not present risk), water safety and supply are covered by other regulations under DWS. • New water regulations focus on water supply systems but not on water quality. Recommendation is to separate components of water in buildings: (1) Technical components of network (infrastructure) under the NBR (NRCS) and enforced by building Control Officer, (2) Aspects related to water quality to be incorporated under local by-laws.
South African Bureau of Standards (SABS)	SABS is the statutory body acting as the national standardisation institution in South Africa, mandated to develop, promote and maintain South African National Standards (SANS)	• Standards are voluntary and can only be regulated once they are incorporated in regulation. • TC60 committee: technical committee of SABS which addresses National Regulations standards (10400). Currently reviewing 10400 standards to be in line with current regulations, WRC is part of TC60 committee with observer and participant status – therefore outcomes of this project are of importance to the committee. • Legionella is a voluntary standard – it is not clear under which legislation can be included to become compulsory standard. • New standard: SANS 3088: water use efficiency standard and SANS 1732: Grey water use standard. These are voluntary standards, and not mandatory as they are not included in 10400 (part of the NBR and BS Act).

SUMMARY

The stakeholder mapping identified four classes of stakeholders based on level of interest and level of influence. The two key groups identified are:

- **Promoters**: High Power/High Interest Stakeholders who are usually responsible for regulation/governance of national standards. The NRCS and DWS fall into this group as they will be responsible for adopting, publishing, implementing and enforcing the standards which will be developed in the future:
    - DWS responsible for standards related to water use efficiency and water safety at municipal level which can be cascaded down to building level through by-laws.
    - NRCS responsible for standard related to water use efficiency which apply to new buildings and can form part of compulsory standards under the NBR and BS Act.
- Defenders: Low Power/High Interest Stakeholders which can provide valuable input on user requirement and be effective promoters of the project and help ensure adoption of standards and guidelines. Green Building Council, IOPSA, SAPOA, SALGA and Green Cape are all placed in this category as they have high interest in the project and will support and share recommendations.

The stakeholder engagement sessions with key stakeholders from Promoter and Defender categories assisted in gaining strategic insight into the challenges associated with water use efficiency and water safety in buildings. Key observations from the stakeholder sessions are summarised below:

- Standards are voluntary and can only be regulated once they are incorporated in regulation.
- The Building Control Officer enforces standards related to external water supply, does not cover internal network.
- NRCS is responsible for technical components of network (infrastructure) under the NBR and BS Act, enforced by building Control Officer before construction, but does not apply to internal networks of existing buildings.
- Perception of NRCS is water is not a risk, water safety and supply are covered by other regulations under DWS, and aspects related to water quality to be incorporated under local by-laws.
- DWS provides policies related to water use efficiency and implementation of national programs. However, the onus is on WSI to reduce water losses as DWS's role is purely advisory, does not set targets or enforce policies/programs related to water use efficiency.
- COJ: Lack of enforcement of by-laws due to large, complex organisational structure with no clear section dedicated to water services in the network.
- IOPSA: Enforcement of standards and regulations are non-existent due to lack of standards included in by-laws and lack of capacity at municipal level to enforce by-laws.
- GBCSA: Certification does not cover water quality as assumption that all standards and health and safety regulations are adhered to and water entering buildings is safe. 'New build' tool does make provision for Legionella monitoring.
- GBCSA: Key drivers for certification are cost-savings, resource conservation, reduced footprint, access to green funding.

The outcomes of the stakeholder engagement were included in various sections of this report as the engagements improved understanding of the legislative framework and challenges associated with water services in buildings.

BASELINE ASSESSMENT OF WATER SUPPLY, USE AND SAFETY PRACTICES IN BUILDINGS

INTRODUCTION

A review of available literature has shown that South Africa is a water scarce country with insufficient supply to meet current and future demands.

With regards to water quality, the National Drinking Water Quality Standard 241 is only applicable to municipal supply systems and does not extend to buildings. The SANS 893-1 (Risk Management) and SANS 892-3 (Control) which outlines requirement for monitoring of Legionella under the Occupational Health and Safety Act applies to building: However this is a voluntary standard and there is no there is no information on Legionella monitoring and control in buildings.

In light of the poor water quality of municipal systems as reported by DWS in the 2022 Blue Drop report, building owners can no longer assume municipal water entering their buildings is safe for human consumption and must implement systems to monitor and manage water quality risks in their reticulation networks.

Ideally drinking water quality should be extended to buildings, but this requires local municipality to have sufficient resources to implement, monitor and enforce all private buildings. Due to large number of buildings and lack of resources at municipal level, this will remain a challenge. In addition, maintenance personnel in buildings lack understanding of water quality and are unable to associate water quality risks with infrastructure conditions, including storage of water and use of alternative water sources.

Public awareness campaigns and guidelines are therefore required to make building owners aware of potential health risks associated with internal water reticulation networks and assist them to identify, control and manage these risks.

Development of standards for water storage and alternative water sources and their incorporation into local by-laws may address risks related to water storage and alternative water sources in buildings. Such standards should address issues of construction, operations, routine maintenance, and water quality testing coupled with implemented by registered plumbers/contractors and monitoring of water quality undertaken by EHP in each municipality.

With regards to water use efficiency, there is limited information on status of water use and water efficiency within buildings as there is no single governing body for buildings which can collate this information due to the large variety of buildings across several sectors, i.e. health, hospitality, commercial, retail, industrial, etc.

There are several water use guidelines for various industries such as guidelines for Health Care guidelines for Tourism industry, and guidelines for commercial sector on how to develop and implement water use efficiency plans. While these guidelines are valuable tools to ensure water use efficiency in various industries, they remain voluntary guidelines and therefore cannot be monitored or enforced.

Installation of water-efficient fittings in buildings presents an opportunity to reduce water demand in buildings and address risk of scalding. The current initiatives by SANEDI under the ongoing South African Appliance Standards and Labelling Programme (S&L Programme) and the Collaborative Labelling and Appliance Standards Program (CLASP) are addressing the process of developing and improving standards for taps and showerheads, including thermoregulator mixers to control water temperature at taps. Once this labelling program is completed, it will be adopted into the NBR and BS Act to form part of compulsory

national standards to ensure water use efficiency fittings are installed in all buildings and to address risk of scalding.

Water use efficiency in buildings can be improved if local by-laws include water efficiency measures such as installation of water-efficient fittings, sliding-scale tariffs, penalties for high water use and fines for wastage of water. The challenge remains lack of updated by-laws and perhaps a lack of political will to include and enforce water use efficiency at municipal level.

ASSESSING CURRENT PRACTICES FOR WATER SUPPLY, USE EFFICIENCY AND WATER QUALITY MANAGEMENT IN BUILDINGS

DESCRIPTION OF SURVEY PROCESS

To develop a baseline for water services in buildings, an online survey was conducted to assess current water use efficiency, water supply and water safety practises in various building types throughout South Africa.

The online survey was developed using Google forms and shared via email to all identified participants, stakeholders, extended contact list of team members, and shared on LinkedIn profiles of AHL Water and Emanti to reach a wider audience. Details of the survey as follows:

- Survey contains logo of WRC.
- Survey contains confidentiality clause provided by WRC: We want to assure you that your responses to this survey will be kept completely anonymous and cannot be traced back to the respondent. Additionally, your responses are combined with those of many others and summarized in a report to further protect your anonymity. No personally identifiable information will be captured unless you voluntarily offer personal or contact information in any of the comment fields.
- There are six sections to the survey, including:
    - Overview
    - Building information – required fields to ensure contact details of respondents are captured, including type of building and address (to evaluate provincial differences).
    - Water Supply
    - Water Storage
    - Water use efficiency
    - Water Safety
- Total of 30 questions:
    - 23 multiple choice/drop down list/tick box/specific information – to improve statistical analysis and identify trends.
    - Only 7/23 (30%) with short/long answers where additional information is required.

The survey can be accessed from the following link:

https://docs.google.com/forms/d/1m5LimK0Y6cFUUxPQPXkvojN7Dz1yQlRi1JjAtjUlAHU/edit?ts=61487daf

NOTE: the survey is closed, the link above is for viewing purposes only.

TARGET AUDIENCE FOR THE SURVEY

The target audience for the online survey was buildings in all nine provinces in the country and representing all building types as per the National Building standard SANS:10400 building categories which is based on type of activity with 10 categories and number of subcategories as illustrated in Table 4.1 below.

To have a large representative data set, one requires a large number of participants to complete surveys and participate in feedback sessions. The project team undertook the following actions to identify and contact a wide range of participants for the survey:

- Spreadsheet set up with all building classes and sub classes: A to J
- List of building owners set up for each building class and contacted to participate in survey: e.g. 'Category A1: Entertainment and Public assembly' covers occupancy where people gather to eat. Project team identified major food chains such as Nando's, KFC, Wimpy and these were contacted telephonically to participate in the online survey.
- Contact list of property management companies provides by Reference Group member Harold Carpenter was included in list for categories B: Commercial services, D: Industrial, F: Shops, G: Offices. These organisations were contacted telephonically and requested to participate in the survey.

The final detailed list of participants includes the following:

- 70 organisations,
- 30 property management companies,
- 4 key stakeholders with large database of property owners

Initially the project plan included for Participation engagement workshop which would have provided brief overview of project and guideline on completing survey. Participants committed to complete the survey but did not express interest in attending workshops. Therefore, workshops were not conducted and relevant information was included in the Introduction section of the survey, i.e. confidentiality of information, brief overview of project, guidelines on completion of project and contact details of team members if there are queries.

TABLE 4.1: BUILDING CLASSES AS PER SANS 10400

Category	Building Class	Description
A1	**Entertainment and public assembly**	Occupancy where people gather to eat, drink dance or participate in other recreation
A2	**Theatrical and indoor sport**	Occupancy where persons gather for the viewing of theatrical, operatic, orchestral, choral, cinematographically or sport performances
A3	**Places of instruction**	Occupancy where school children, students or other persons assemble for the purpose of tuition or learning
A4	**Worship**	Occupancy where persons assemble for the purpose of worshipping,
A5	**Outdoor Sport**	Occupancy where persons view outdoor sports events
B	**Commercial Services: B1 (High), B2 (Moderate), B3 (Low)**	
B1	**High risk commercial service**	Occupancy where a non-industrial process carried out and where either the material handled or the process carried out is able in the event of fire to cause combustion with extreme rapidity or give rise to poisonous fumes, or cause explosions.
B2	**Moderate risk commercial service**	Occupancy where a non-industrial process carried out and where either the material handled or the process carried out is liable in the event of fire to cause combustion with moderate rapidity but is not likely to give rise to poisonous fumes, or cause explosions

Category	Building Class	Description
B3	**Low risk commercial service**	Occupancy where a non-industrial process is carried out and where neither the material handled nor the process carried out falls into the high or moderate risk category
C1	**Exhibition Hall**	Occupancy where goods are displayed primarily for viewing by the public
C2	**Museum**	Occupancy comprising a museum, art gallery or library
D	**Industrial: D1 (High), D2 (Medium), D3(Low), D4 (Plant room)**	
D1	**High risk industrial**	D1 – Occupancy where an industrial process is carried out and where either the material handled or the process carried out is liable, in the event of fire, to cause combustion with extreme rapidity or give rise to poisonous fumes, or causse explosions.
D2	**Moderate risk industrial**	D2 – Occupancy where an industrial process is carried out and where either the material handled or the process carried out is liable, in the event of fire, to cause combustion with moderate rapidity but is not likely to give rise to poisonous fumes, or causse explosions
D3	**Low risk Industrial**	D3 – Occupancy where an industrial process is carried out and where neither the material handled or the process carried out falls into the high or moderate risk category. handled nor the process carried out falls into the high or moderate risk category
D4	**Plant room**	D4 – Occupancy comprising usually unattended mechanical or electrical services necessary for the running of a building.
E1	Place of detention	Occupancy where people are detained for punitive or corrective reasons or because of their mental condition.
E2	**Hospital**	Occupancy where people are cared for or treated because of physical or mental disabilities or where they are generally bedridden
E3	**Other Institutional (residential)**	Occupancy where groups of people who other are not fully fit, or who are restricted in their movements or their ability to make decisions, reside and are cared for
E4	**Health Care**	Occupancy which is a common place of long term or transient living for a number of unrelated persons consisting of a single unt on its own site who, due to varying degrees of incapacity, are provided with personal care services or are undergoing medical treatment
F	**F1: Large Shop, F2: Small Shop, F3: Wholesalers Stores**	
F1	**Large Shop**	Occupancy where merchandise is displayed and offered for sale to the public and the floor area exceeds 250 m
F2	**Small Shop**	Occupancy where merchandise is displayed and offered for sale to the public and the floor area does not exceed 250 m
F3	**Wholesalers Stores**	Occupancy where goods are displayed and stored and where only a limited selected group of persons is present at any one time.
G	**Offices**	Occupancy comprising offices, banks, consulting rooms and other similar usage,
H1	**Hotel**	Occupancy where persons rent furnished rooms, not being dwelling units
H2	**Dormitory**	Occupancy where groups of people are accommodated in one room.
H3	**Domestic residence**	Occupancy consisting of two or more dwelling units on a single site.

Category	Building Class	Description
H4	**Dwelling house**	Occupancy consisting of a dwelling unit on its own site, including a garage and other domestic outbuildings, if any.
H5	**Hospitality**	Occupancy where unrelated persons rent furnished rooms on a transient basis within a dwelling house or domestic residence with sleeping accommodation for not more than 16 persons within a dwelling unit
J	**Storage: J1 (High), J2 (Medium), J3 (Low), J4 Parking Garage**	
J1	**High risk storage**	Occupancy where material is stored and where the stored material is liable, in the event of fire, to cause combustion with extreme rapidity or give rise to poisonous fumes, or cause explosions.
J2	**Moderate risk storage**	Occupancy where material is stored and where the stored material is liable, in the event of fire, to cause combustion with moderate rapidity but is not likely to give rise to poisonous fumes, or cause explosions.
J3	**Low risk storage**	Occupancy where the material stored does not fall into the high or moderate risk category.
J4	**Parking garage**	Occupancy used for storing or parking of more than 10 motor vehicles.

SURVEY RESULTS

The survey was launched on 15th December 2021 and closed on the 31 March 2022. In total, 67 respondents completed the survey. The results of the survey are presented below per section of the survey with discussion of findings

GENERAL PROFILE OF THE RESPONDENTS

Figure 4.1 provides an overview of the respondents according to the building category, while overall profile is provided in Figure 4.2.

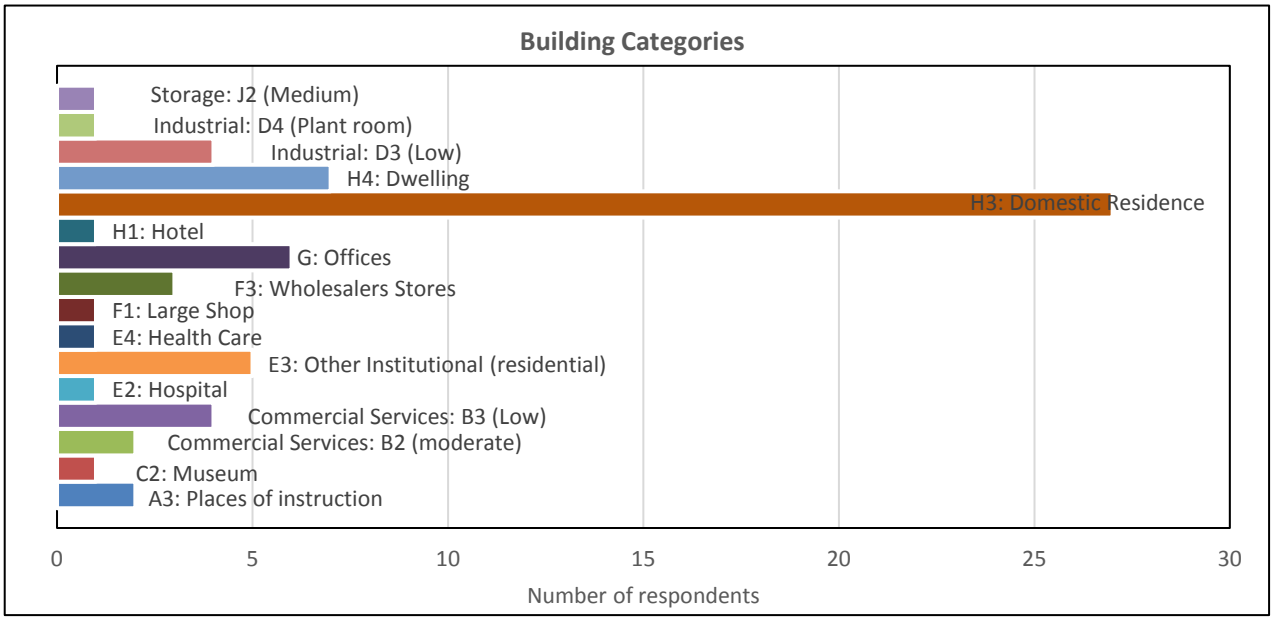

FIGURE 4.1: RESPONDENTS PER BUILDING CATEGORY

16/36 (44%) of building categories were represented in the survey

Every main class of building was represented, i.e. A, B, C, D, E, F, G, H, and J.

40% of respondents were domestic residences (H3) and 10% were dwellings (H4)

72% of respondents were from Gauteng Province

Average size of building = 5000 m².

Largest building in survey is

Average age of buildings is 28 years.

FIGURE 4.2: SUMMARY OF RESPONSES ACCORDING TO LOCATION AND BUILDING INFORMATION

In summary, most respondents were from Gauteng, and the majority of respondents (50%) were from domestic residences (H3) and dwellings (H4). This is reflected in the occupancy time with 69% occupied all day long low number participating in certification programs which is usually undertaken by larger commercial or industrial building types.

WATER SUPPLY

The water supply section considers water sources, types of water use, water pressure, and maintenance teams for water supply. According to the results obtained, 90% of respondents use water for domestic use which includes drinking, cleaning, and ablution (Figure 4.3). About 92.5% respondents indicated that municipal supply as their main water source (Figure 4.4). Most of plumbing work is conducted by external maintenance personnel (plumbers, maintenance contractors) and only a small portion (36%) have qualified personnel for network problems (plumbers, engineers, water specialists). The summary of responses obtained on water supply is shown in Figure 4.5.

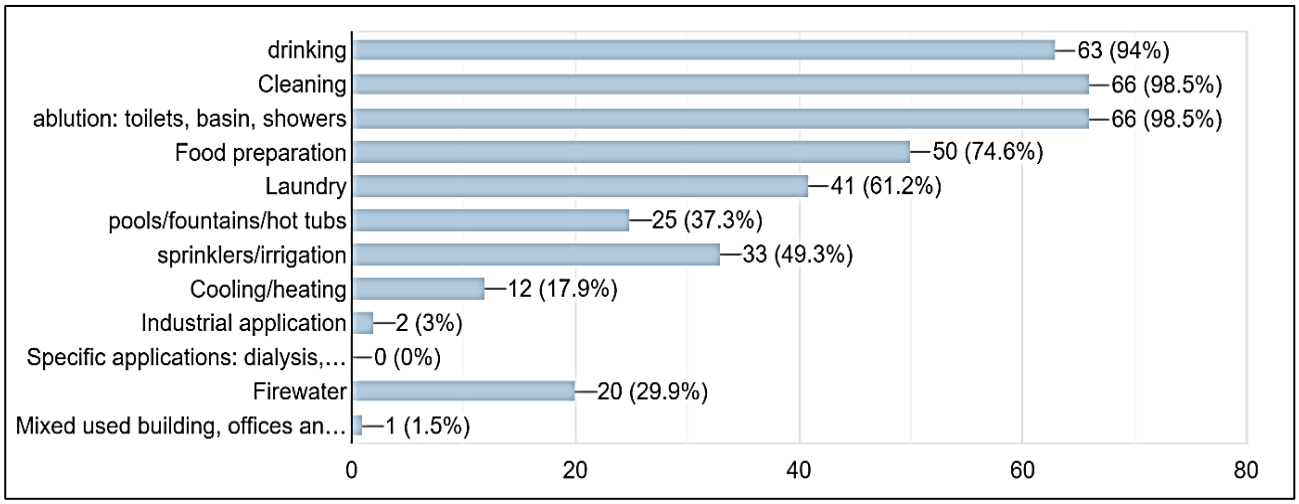

FIGURE 4.3: SURVEY RESPONSES ON WATER USE

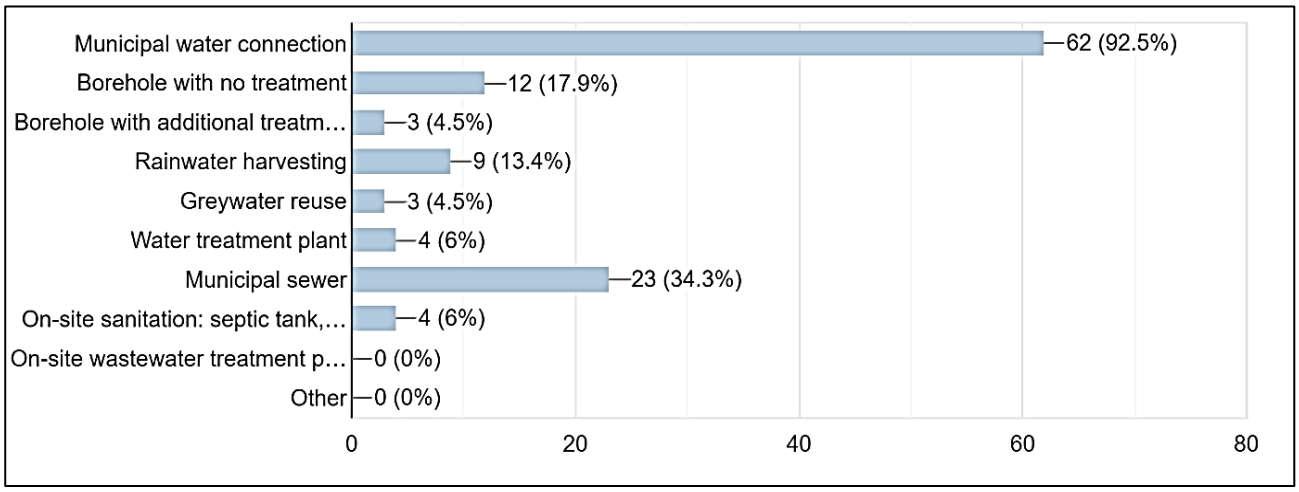

FIGURE 4.4: SURVEY RESPONSES ON WATER SOURCES

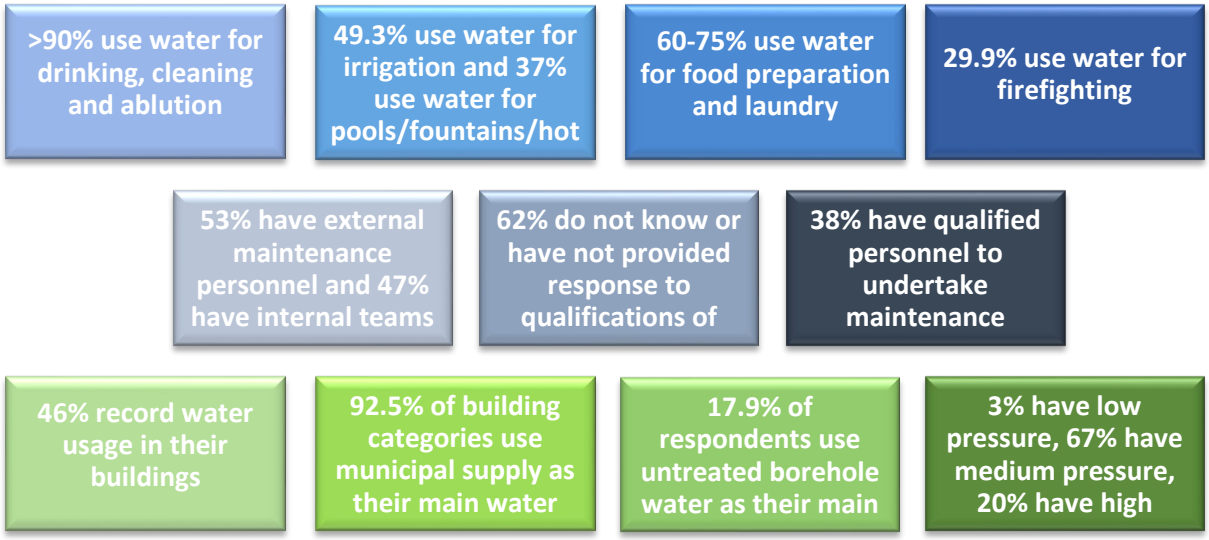

FIGURE 4.5: SUMMARY OF SURVEY RESPONSES ON WATER SUPPLY

WATER STORAGE

To mitigate the risk of insufficient supply or prolonged water interruptions, many buildings have on-site storage tanks with back-up water supply. In addition, some buildings store water for specific activities such as fire water (for sprinkler systems), cooling water (cooling towers), autoclaves, and any other activity that may require large volumes of water.

On-site water storage presents several risks, including:

- Lack of sufficient pressure which negatively impacts on water use,
- Lack of sufficient pressure which can lead to stagnant water,
- Lack of sufficient disinfection residual due to long residence time in storage tanks, and
- Risk of external contaminants entering tanks. Reduced water quality due to possible contamination from external sources or biofilm formation due to lack of disinfectant residual.

Figures 4.6 to 4.8 show the participants responses to questions on water storage. Although 52% of respondents experience water shortages, only 63% of these respondents have on-site water storage tanks. Potable water makes up the largest proportion of stored water (63%), followed by rainwater (25%) and firewater (8%). Number of hours of backup supply varies from 12hrs to 11 days. A positive trend is the 54% of storage tanks which are recirculated daily as this reduces risk of biofilm formation due to lack of chlorine residual/stagnant water.

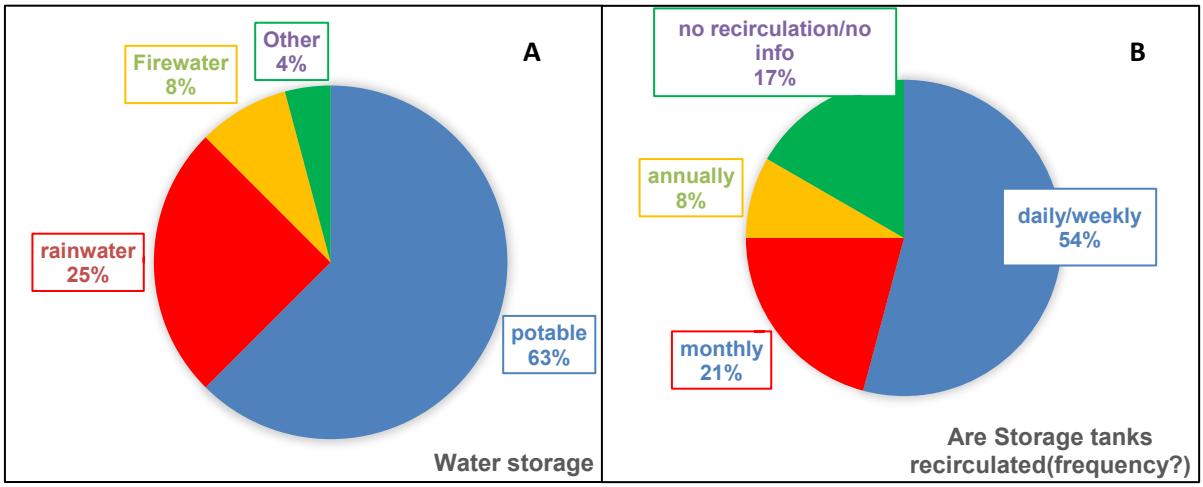

FIGURE 4.6: RESPONSES ON TYPES OF WATER STORAGE (A) AND MAINTENANCE OF STORAGE TANKS (B)

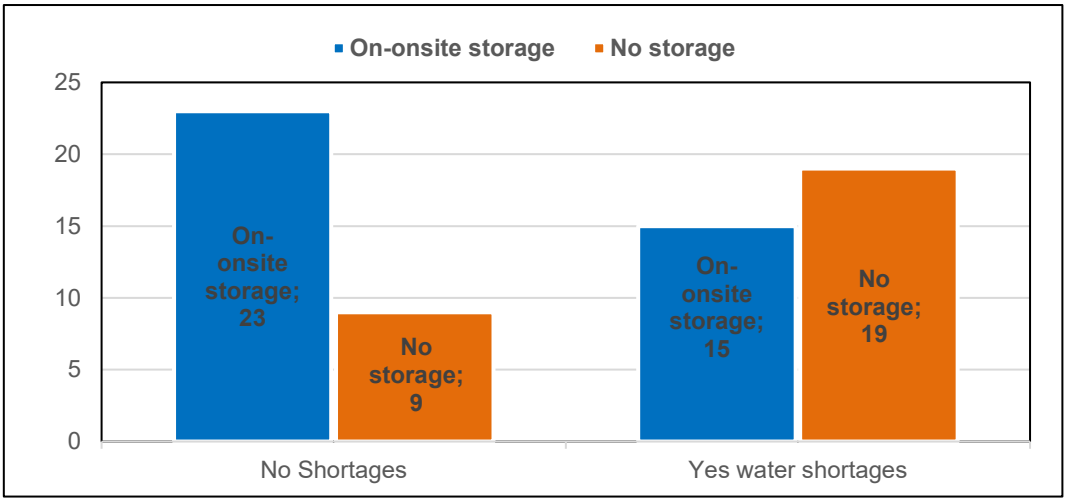

FIGURE 4.7: SURVEY RESPONSES ON WATER SHORTAGES AND ON-SITE WATER STORAGE

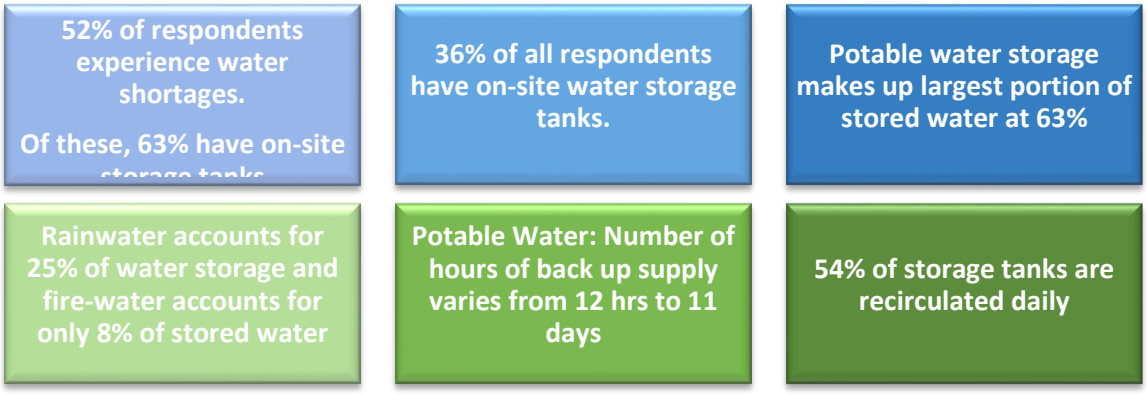

FIGURE 4.8: SUMMARY OF SURVEY RESPONSES ON WATER STORAGE

WATER USE EFFICIENCY

Water efficiency can be defined as the "minimization of the amount of water used to accomplish a function, task or result. Within buildings, water efficiency may refer to limiting the consumption of potable water and maximising the output per drop by various initiatives either aimed at reducing water consumption or reuse of water for non-potable activities. The key question in this section of the survey is a water balance as this allows the building owner to track consumption and highlight areas of high-water usage. Benchmarks have been set for typical building categories; however, this is dependent on several variables, including building size, business/activity type, number of employees, operational hours, occupancy per square meters, etc. Each building must therefore develop a water balance to evaluate its water use efficiency and identify areas where water savings can be implemented.

Figures 4.9 to 4.11 indicate participants responses to questions related to water use efficiency.

About 58% of respondents have <10 people occupancy, which correlates with the majority of respondents coming from domestic residences or dwellings and also with peak water demand during evening hours (40%). About 91% do not have any water savings plan/initiatives in place; however, 48% of all respondents have some water saving initiatives in place to reduce demand. The majority of these water saving measures are sanitary fixtures (47%) which are easily accessible to most households. Only 7% have detailed savings plans in place which are currently being implemented.

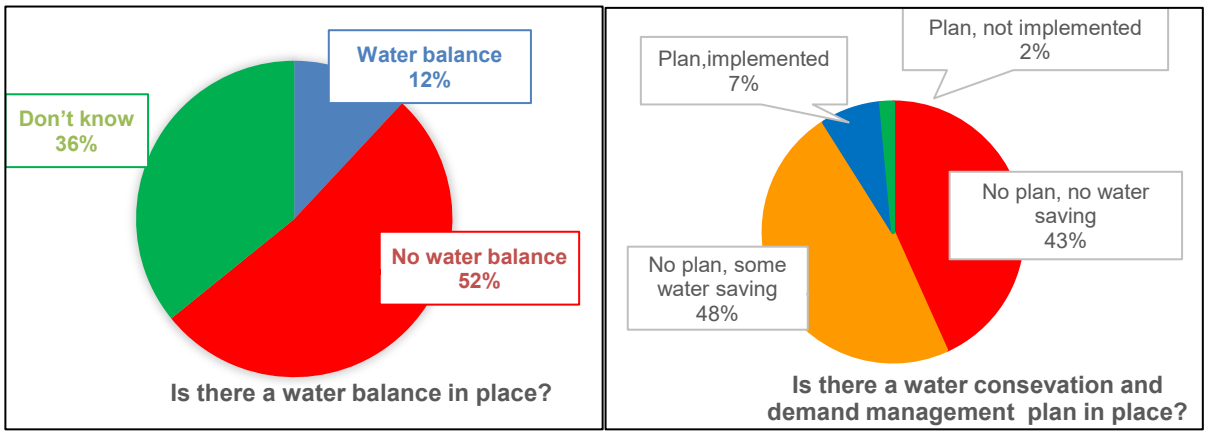

FIGURE 4.9: SURVEY RESPONSES ON WATER CONSERVATION AND DEMAND MANAGEMENT

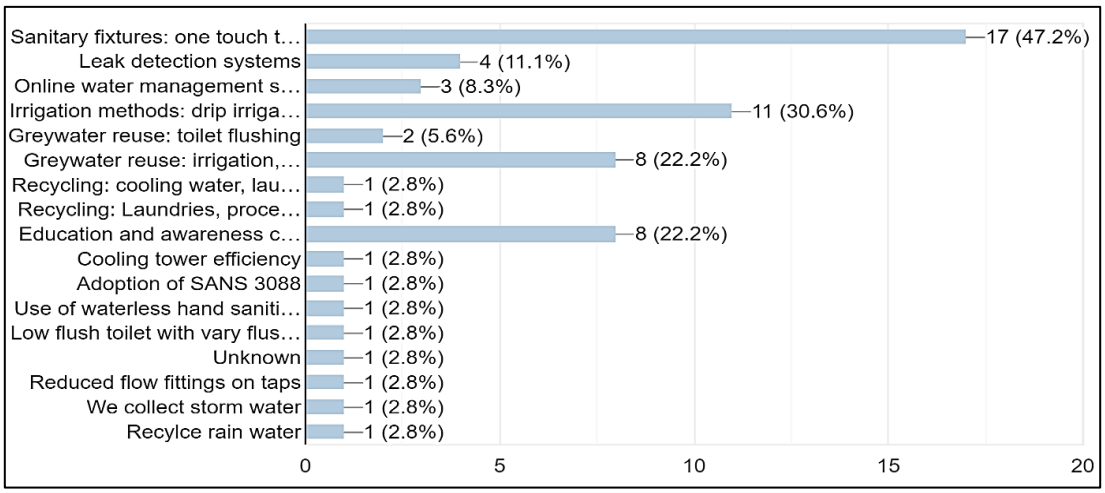

FIGURE 4.10: TYPES OF WATER SAVING INITIATIVES

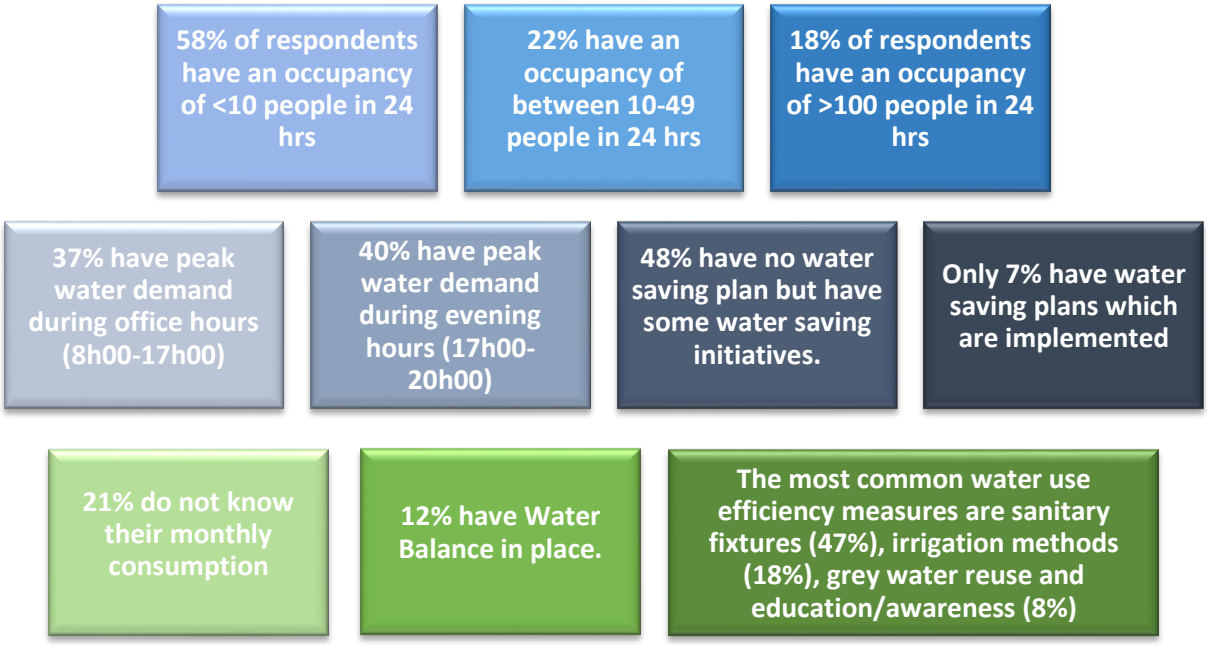

FIGURE 4.11: SUMMARY OF WATER USE EFFICIENCY

WATER QUALITY

Potable Water quality which complies with SANS 241 limits is critical to ensure health of all building occupants. Although there are no regulations for water quality monitoring in buildings, Legionella monitoring is recommended for hot water systems and there are a numerous contamination sources which can negatively impact on water quality within buildings. Public perception is key to understanding perceived risk associated with water quality in buildings and adoption of guideline documents for water monitoring in buildings.

Figures 4.12 to 4.16 indicate participants responses to questions related water quality.

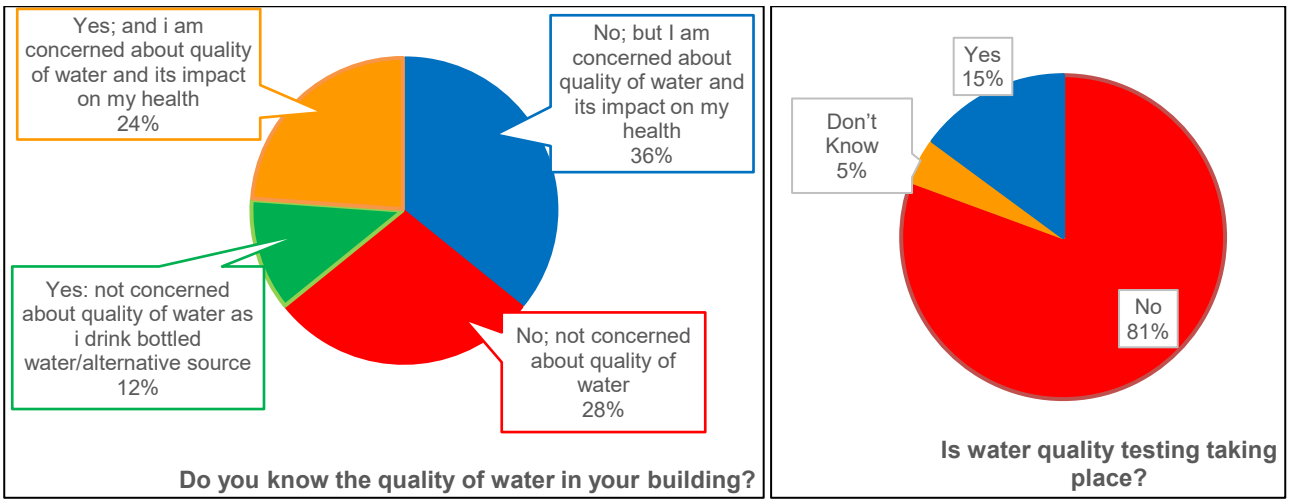

FIGURE 4.12: SURVEY RESPONSES ON AWARENESS OF WATER QUALITY AND WATER QUALITY TESTING IN BUILDINGS

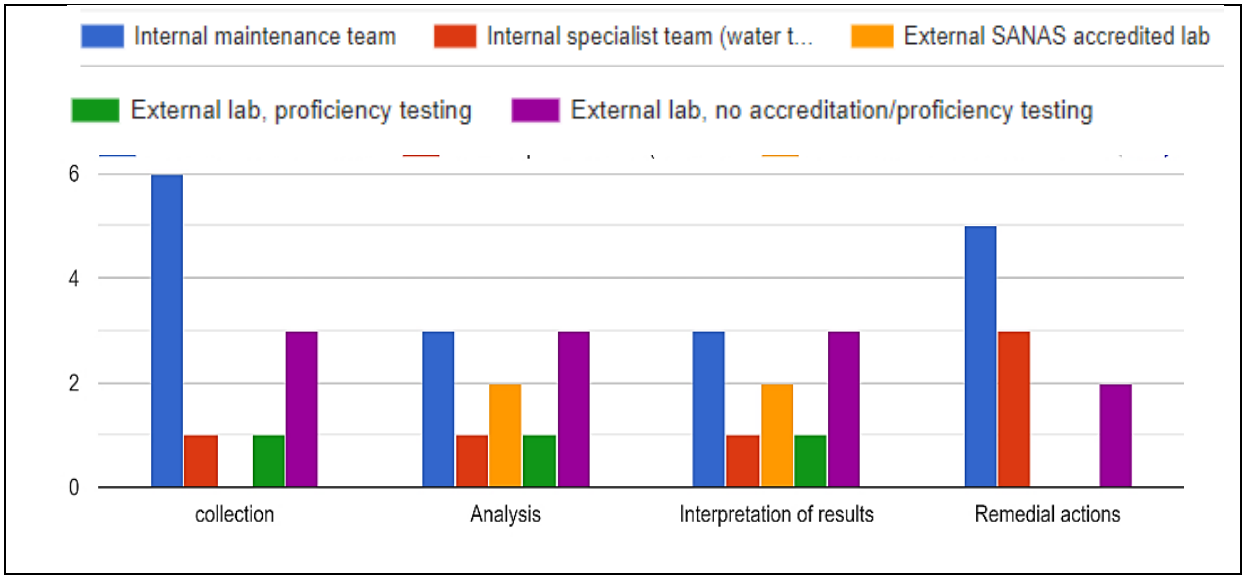

FIGURE 4.13: SURVEY RESPONSES ON RESPONSIBILITY OF COLLECTION, ANALYSIS, INTERPRETATION AND REMEDIAL ACTIONS FOR WATER QUALITY TESTS

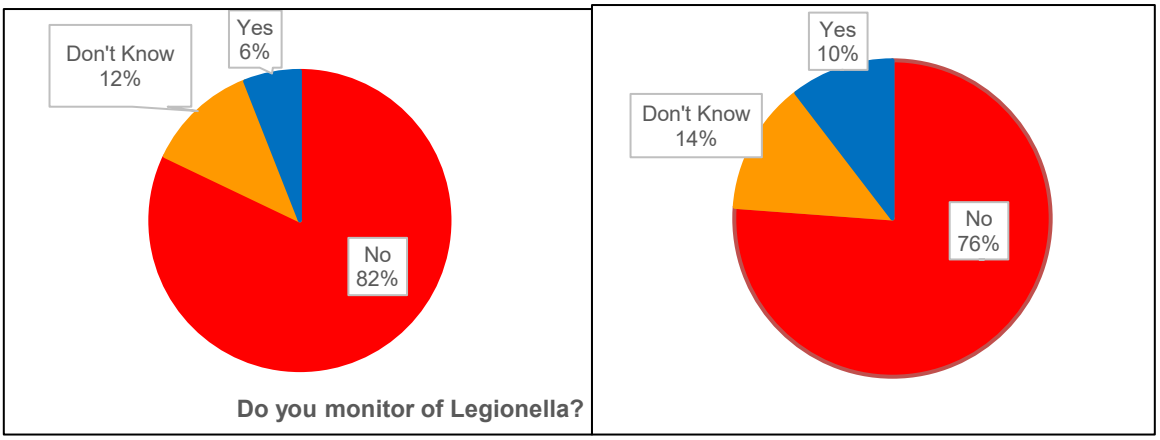

FIGURE 4.14: SURVEY RESPONSES ON AWARENESS OF LEGIONELLA MONITORING AND WATER TREATMENT MEASURES IN PLACE

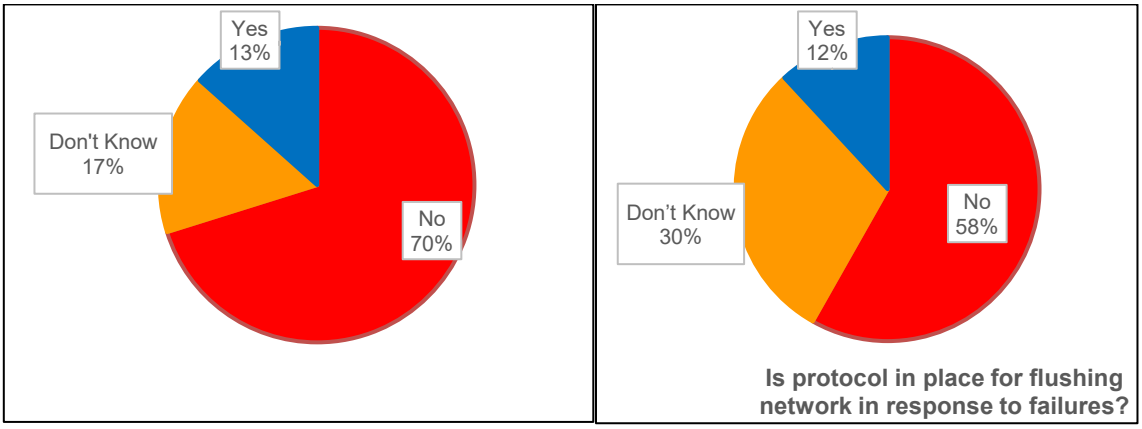

FIGURE 4.15: SURVEY RESPONSES ON WATER QUALITY INCIDENT PROTOCOLS IN PLACE AND PROTOCOLS FOR FLUSHING NETWORK IN THE EVENT OF WATER QUALITY ISSUES

Although 72% of respondents are concerned about water quality and its impact on their health, only 15% are monitoring water quality and only 30% of these are using an accredited laboratory for analysis and interpretation of results. For the rest, interpretation and remedial actions are undertaken by internal maintenance teams who may/may not have no formal water quality training. Only 10% have water quality incident protocols, only 11% have protocols to flush networks in the event of failures, and only 6% are monitoring for Legionella: this emphasises the potential health risk to consumers in buildings.

FIGURE 4.16: SUMMARY OF SURVEY RESPONSES ON WATER QUALITY

DATA ANALYSIS

DESCRIPTION OF DATA ANALYSIS PROCESS

The aim of data analysis is to analyse raw data and make conclusions about that information. Any type of information can be subjected to data analytics techniques to get insight that can be used to improve things.

The first step is the process of collecting data and this was conducted using the online survey. Once the data is collected, it must be organized so it can be analysed. This may take place on a spreadsheet or other form of software that can be used to process statistical data. The data is then cleaned up before analysis. This means it is scrubbed and checked to ensure there is no duplication or error, and that it is not incomplete. This step helps correct any errors before it is analysed. The data analysis begins with descriptive analysis which describes the answer to what happened. The second type of data analysis is diagnostic analysis that evaluates relationships between variables to answer the question of why something has happened.

Data analyses was conducted using Python software which is a popular multi-purpose programming language widely used for its flexibility, as well as its extensive collection of libraries, which are valuable for analytics and complex calculations. All variables were entered into the software program with non-numerical data entered as categorical data, i.e. non-numerical data is categorised into two or more categories to allow for data analysis. Collected qualitative data analysis was carried out using Python programming language by applying previously published code scripts to accomplish content analysis. The data was subjected to successive cleaning and converted to numeric before importing to Python.

OUTCOMES OF DATA ANALYSIS

The results of the data analysis exercise are presented below according to various scenarios described in literature.

SCENARIO 1: SIZE OF BUILDING AND CONSUMPTION

- Assumption – Size of building is not related to consumption as consumption is based on combination of factors such as type of business/activity, number of employees, hours of business, occupancy per square meters, etc.
- Results – There is no correlation (r = 0.) between two tested variables, variables do not appear have any statistical relationship.
- Conclusion – It is difficult to set benchmarks for building types as consumption is based on number of factors, including size, type of business, hours of business, occupancy per square meter, etc.

SCENARIO 2: SIZE/TYPE OF BUILDING AND WATER QUALITY MONITORING

- Assumption – Larger buildings/building which supply large number of people/members of the public have a higher potential risk associated with water quality failures, and will therefore monitor water quality:
    - larger number of people = potential exposure to a large number of people in the event of water quality failure,
    - larger building has higher risk of failures.
- Results – There is no correlation (r = 0.) among tested variables, variables do not appear have any statistical relationship (Figure 4.17). The scatter plot above shows majority of buildings are not conducting quality water tests. While some large building categories such as large shops, commercial services and hotels are monitoring, hospitals are not monitoring and this presents a high risk to patients who may be immunocompromised. Domestic residence, dwelling and offices do not monitor water at all.
- Conclusion – There is no relationship between building type and water quality monitoring. Building owners are not aware of potential water quality risks associated with large internal network or supplying water to large number of people/members of the public.

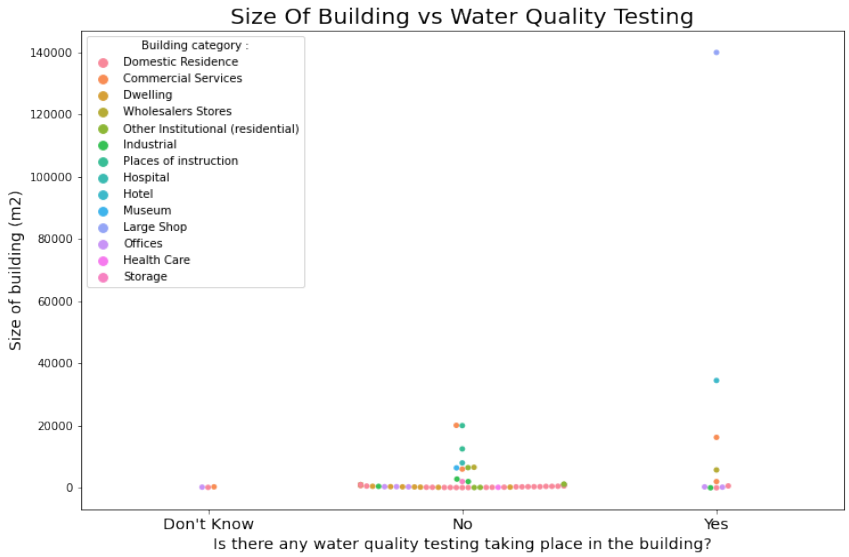

FIGURE 4.17: ANALYSIS OF THE RELATIONSHIP BETWEEN SIZE/TYPE OF A BUILDING AND WATER QUALITY MONITORING

SCENARIO 3: TYPE OF BUILDING AND LEGIONELLA MONITORING

- Assumption – Larger building(s) which supply large number of people/members of the public have a higher potential risk for Legionella growth and distribution.
- Results – Majority of building categories such as domestic residence, dwellings and do not test for legionella, only hotels, large shops and commercial buildings conduct Legionella monitoring (Figure 4.18).
- Conclusion – In general, monitoring of Legionella is very low (only 6% of all respondents) with no correlation to size/type of building. Building owners are unaware of potential health risks associate with Legionella.

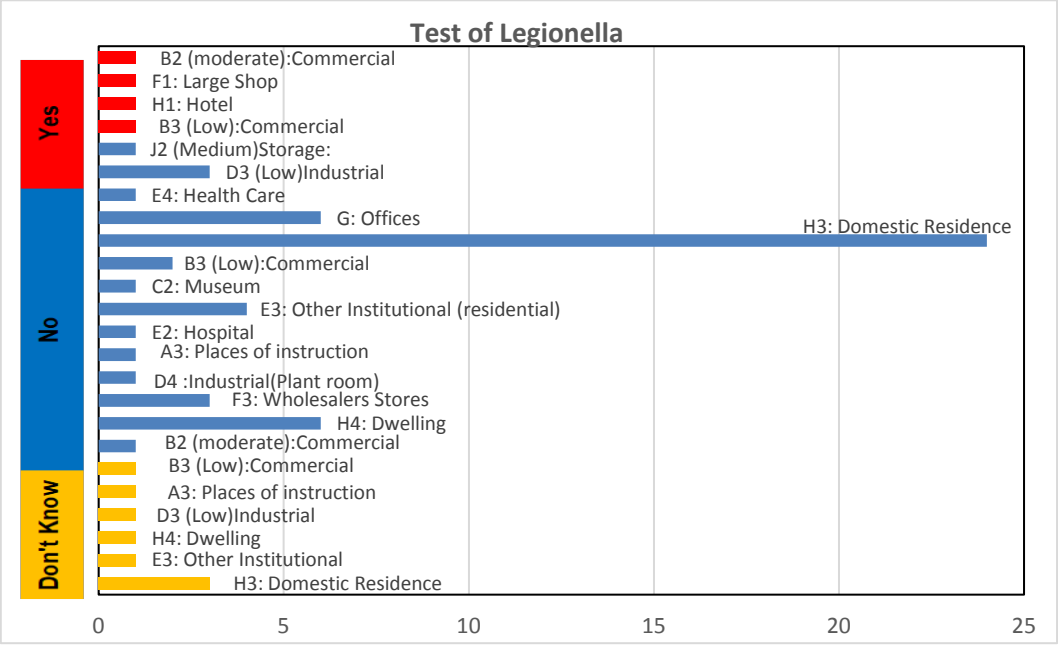

FIGURE 4.18: MONITORING OF LEGIONELLA ACCORDING TO BUILDING TYPE

SCENARIO 4: BUILDING CERTIFICATION AND WATER QUALITY MONITORING

- Assumption – Building owners who participate in certification programs are more aware of risks in their buildings and will therefore monitor water quality.
- Results – There is a strong correlation between the two tested variables (r = 0.711). Among respondents who are testing water quality in their buildings, a higher percentage come from those that are certified (Figure 4.19).
- Conclusion – Building owners who participate in certification programs are more likely to monitor water quality. This group is therefore more likely to adopt proposed water quality monitoring guidelines and certification programs are ideally suited to pilot such guidelines.

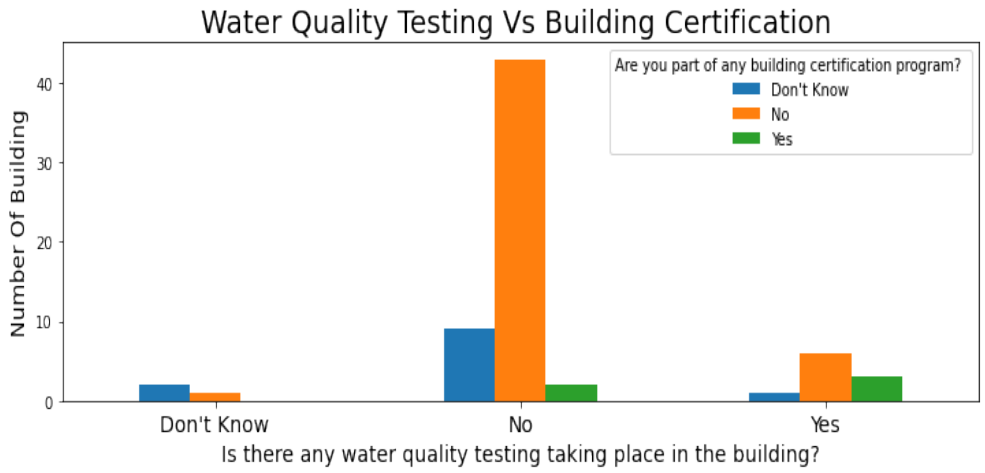

FIGURE 4.19: ANALYSIS OF WATER QUALITY TESTING VS. BUILDING CERTIFICATION

SCENARIO 5: ON-SITE STORAGE AND WATER QUALITY MONITORING

- Assumption – Buildings with on-site storage will monitor water quality due to increased risk associated with storage (external contaminants, lack of sufficient residual, stagnant water, etc).
- Results – There is no correlation (r = 0.) between two tested variables, variables do not appear have any statistical relationship (Figure 4.20).
- Conclusion – Buildings with on-site storage are not aware of potential water quality risks associated with on-site storage.
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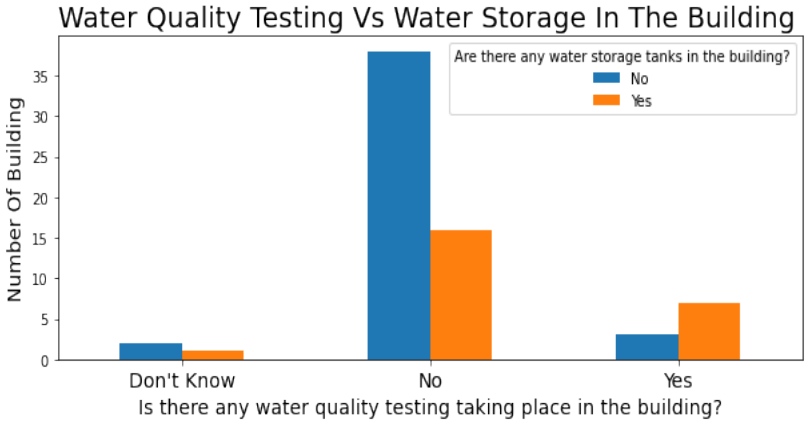

FIGURE 4.20: ANALYSIS OF WATER QUALITY TESTING VS. WATER STORAGE IN THE BUILDING

- Assumption – Buildings who experience more water shortages will be more likely to have on-site storage to ensure constant supply.
- Results – There is no correlation (r = 0.) between two tested variables, variables do not appear have any statistical relationship. About 52% of buildings have water shortage: only 43% of these respondents have on-site storage. About 48% of buildings do not have water shortages: of these 72% have on-site storage (Figure 4.21).
- Conclusion – There is no clear indication that buildings which experience water shortages will have on-site storage. The decision to install on-site storage is probably linked to cost-benefit and impact on daily operations.

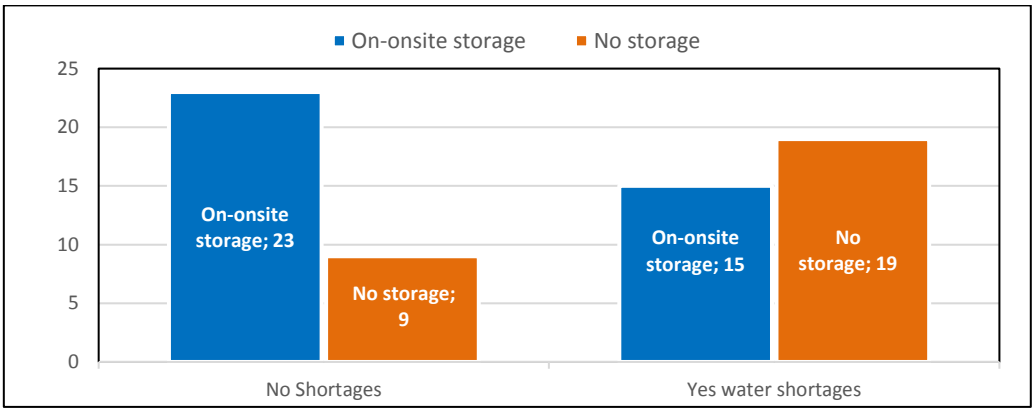

FIGURE 4.21: ANALYSIS OF ON-SITE STORAGE VS. WATER SHORTAGES

SCENARIO 7: WATER SAVINGS AND WATER SHORTAGES DUE TO WATER SERVICES INTERRUPTIONS

- Assumption – Buildings that experience more water shortages will be more likely to implement water saving initiatives.
- Results – There is no correlation (r = 0.) between two tested variables, variables do not appear have any statistical relationship. About 52% of building have water shortages and 57% of these have water saving initiatives. About 48% of the buildings do not have water shortages and of these, 53% have water saving initiatives (Figure 4.22).
- Conclusion – There is no clear indication that buildings which experience water shortages will implement water savings initiatives. The decision to implement water savings is probably linked to cost-benefit of the savings.

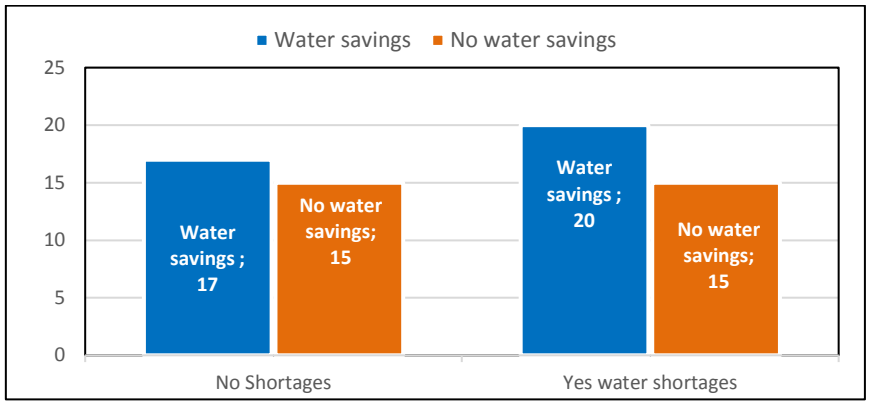

FIGURE 4.22: ANALYSIS OF WATER SAVINGS VS. WATER SHORTAGES

SUMMARY OF FINDINGS

SUMMARY OF CURRENT PRACTICES ON WATER SUPPLY, USE AND SAFETY IN BUILDINGS

BUILDING INFORMATION

In summary, most respondents were from Gauteng, and the majority of respondents (50%) were from domestic residences (H3) and dwellings (H4). This is reflected in the occupancy time with 69% occupied all day long, and the low number participating in certification programs which is usually undertaken by larger commercial or industrial building types. The project team tried several interventions to increase number of respondents and obtain respondents from all provinces and all building categories. However, this did not improve country-wide participation and results may be skewed to reflect situation in Gauteng. Most respondents were from domestic residences of dwellings: future studies should target the building categories which house large number of people and service members of the public such as commercial, industrial, and institutional buildings.

WATER SUPPLY

90% of respondents use water for domestic use, including drinking, eating and ablution and 92.5% use municipal water as their main water source. Most of plumbing work is conducted by external maintenance personnel (plumbers, maintenance contractors) and only a small portion (36%) have qualified personnel for network problems (plumbers, engineers, water specialists).

WATER STORAGE

Although 52% of respondents experience water shortages, only 63% of these respondents have on-site water storage tanks. Potable water makes up the largest proportion of stored water (63%), followed by rainwater (25%) and firewater (8%). Number of hours of backup supply varies from 12hrs to 11 days. A positive trend is the 54% of storage tanks which are recirculated daily as this reduces risk of biofilm formation due to lack of chlorine residual/stagnant water.

WATER USE EFFICIENCY

58% of responder have <10 people occupancy: this correlates with most respondents coming from domestic residences or dwellings and with peak water demand during evening hours (40%). 91% do not have any water savings plan/initiatives in place; however, 48% of all respondents have some water saving initiatives in place to reduce demand. The majority of these water saving measures are sanitary fixtures (47%) which are easily accessible to most households. Only 7% have detailed savings plans in place which are currently being implemented.

The low number of respondents with water saving measures indicates most households are not concerned about water savings. This is reflected in the 2014 No Drop report with average water usage reported at 237 l/c/d compared to international benchmark of 180 l/c/d (DWS, 2014). Gauteng province is reported having the highest water usage in the country at 311 l/c/d followed by the Free State with 296 l/c/d while the average Non-revenue Water (NRW) for the country is estimated at 34.6%.

WATER QUALITY

Although 72% of respondents are concerned about water quality and its impact on their health, only 15% are monitoring water quality and only 30% of these are using an accredited laboratory for analysis and interpretation of results. For the rest, interpretation and remedial actions are undertaken by internal maintenance teams who may/may not have no formal water quality training. Only 10% have water quality incident protocols, only 11% have protocols to flush networks in the event of failures, and only 6% are monitoring for Legionella: this emphasises the potential health risk to consumers in buildings.

The lack of water quality monitoring in buildings is expected as there is currently no legislation that focuses on water quality in buildings. The National Drinking Water Standard SANS 241 is aimed at Water Services

Authorities and monitoring ends where water enters private dwellings. The South African Bureau of Standards (SABS) standard for Legionella monitoring is a voluntary standard and is not part of local by-laws: this may be a contributing factor to the low number of buildings who monitor for Legionella.

SCENARIO ANALYSIS

- It is difficult to set benchmarks for building types as consumption is based on several factors, including size, type of business, hours of business, occupancy per square meter, etc.
- There is no relationship between building type and water quality monitoring. Building owners are not aware of potential water quality risks associated with large internal network or supplying water to large number of people/members of the public.
- In general, monitoring of Legionella is very low (only 6% of all respondents) with no correlation to size/type of building. Building owners are unaware of potential health risks associated with Legionella.
- Building owners who participate in certification programs are more likely to monitor water quality. This group is therefore more likely to adopt proposed water quality monitoring guidelines and certification programs are ideally suited to pilot such guidelines.
- Buildings with on-site storage are not aware of potential water quality risks associated with on-site storage.
- There is no clear indication that buildings which experience water shortages will have on-site storage or implement water savings initiatives. The decision to install on-site storage/implement water savings is probably linked to cost-benefit and impact on daily operations.

In general, there has been little or no correlation between various parameters. This may be attributed to low number of responses, responses largely from private houses or may reflect the actual situation. Based on the survey, the only meaningful correlation was between building certification and water quality monitoring.

TOWARDS ENSURING SAFE WATER SUPPLY AND USE EFFICIENCY IN BUILDINGS

INTRODUCTION

Most countries have laws establishing technical standards and requirements, which detail the minimum requirements to ensure health, safety, and energy efficiency, among other things. They also frequently issue official documents that govern aspects such as standards, approved solutions, and administrative procedures.

When working towards water efficiency and deciding which methods of control or reduction will be implemented, a benchmark of a buildings current water consumption must be developed. The benchmark can be defined based on past consumption within a particular buildings water consumption or, the comparison of consumption to similar building types.

In the United States, as part of the Executive Order (EO) 13693, the National Institutes of Health (NIOH) developed a benchmark for their buildings using water consumption data for 2007. This benchmark was used to develop a target reduction in water use by 2% per annum for 18 years (2007-2025).

CURRENT STATUS OF WATER SUPPLY AND USE MANAGEMENT IN BUILDINGS IN SOUTH AFRICA

WATER USES IN BUILDINGS

POTABLE WATER

Potable water, also known as drinking water, comes from surface and ground sources and is treated to levels that that meet legislative standards to ensure it is fit for human consumption. Potable water is described by the World Health Organisation (WHO) as water that "does not represent any significant risk to health over a lifetime of consumption, including different sensitivities that may occur between life stages ".

In South Africa, the local municipality acts as the Water Service Institution (WSI) who is responsible for treatment and distribution of water to consumers via a reticulation network while ensuring water meets the required health parameters outlined in the National Drinking Water standard SANS 241:2015.

While potable water is used primarily for drinking, washing and food preparation, there are number of other waters uses which must also comply with potable water limits due to possible health risks:

- Cleaning and Laundries: possible risk of contamination through contact/ingestion.
- Irrigation: potable water may be required for irrigation depending on the type of crop (leafy vegetables and fruit which are eaten raw), proximity to humans (risk of contact/ingestion during irrigation), and negative effect of runoff on potable supply
- Industrial water: Potable water may be required for industrial purposes when there is a risk of contact/ingestion of water and negative effect of runoff on potable supply. Water for cooling and heating are examples of potable water use.
- Recreational use: Some forms of recreational use such as swimming requires potable water due to ingestion and contact with water.

Considering the water scarcity in South Africa it is noted that rainwater and groundwater are being used more frequently, with some degree of treatment taking place. Therefore, potable and a combination of rainwater and groundwater may be used buildings for various activities such as flushing toilets, washing

dishes, laundry, washing of vehicles, general cleaning, Cooling and heating, human hygiene and landscape irrigation (Cureau and Ghisi, 2019).

IRRIGATION

Irrigation is the controlled watering of land by artificial means. It is primarily used to sustain crop growth and enable landscaping in urban areas. Irrigation water may originate from a variety of sources, including potable water, fresh water (rainwater, river water or groundwater), greywater and more recently treated wastewater or desalinated water.

There are different methods of irrigation which vary in how the water is supplied. Some of the most common types are:

- Surface irrigation that distributes and applies water under and across land by gravity
- Micro-irrigation (also referred to as localised irrigation, low volume irrigation, trickle irrigation or drip irrigation). This delivers water under low pressure through a piped network that is applied to each plant.
- Subirrigation (or subsurface irrigation) which delivers water to the roots of plants.
- Sprinkler irrigation that distributes water by overhead high-pressure sprinklers from a central location the landscape (Renault *et al*., 2013).

It should be noted that there are disadvantages to using greywater and treated wastewater due to presence of chemicals and bacteria which may pose a health risk to humans (due to ingestion of water or crops) and negative effect on plant growth and soils. The WRC (2017) report provides a software-based Decision Support System (DSS) to provide both generic and site-specific risk-based irrigation water quality guidelines. This tool allows for evaluation of long-term effects of irrigated water quality on soil quality, crop yield/quality and irrigation equipment.

FIREFIGHTING

Fire water in buildings is used to extinguish fire, which may include fire sprinkling systems or built-in fire hoses. This is almost always potable water. The water is distributed throughout the building via piped systems to the areas where a fire is occurring. Automatic or open-orifice fire sprinklers are available and are activated by heat which breaks the sensor mechanism that keeps the sprinkler closed. The water from the pipe runs through the sprinkler, strikes the deflector, and sprays out (Nolan, 2011).

Part W of the SANS 10400 Building Regulations is a compulsory standard under the NBRF and BS Act which is intended to keep people and property safe in the event of a fire. The standard outlines the requirements for fire installations in buildings and addresses municipal connections, water supply, design and deemed-to-satisfy requirements. As this is a compulsory standard, all fire installation must be inspected and approved by the local authority and permission needs to be granted before any water firefighting system is connected to the water supply.

In emergencies, the demand for water can exceed the supply available from the domestic water supply system and many buildings (including hospitals, universities, prisons, police stations) have onsite storage tanks for firewater. The capacity of the water tanks will depend on the size of the buildings/property that needs to be covered in the event of a fire. A series of 10000 litre water tanks would usually be recommended, perhaps in two different locations and may be augmented with borehole water and rainwater (GRUNDFOS, 2021).

COOLING WATER

Chilled water systems provide cooling to a building by using chilled water to absorb heat from the building's spaces. At the heart of the water chilled system, a chiller removes heat from water and transfers the heat to the condenser water, or directly to the outside air. There are two main types of chilled water-cooling

systems: air-cooled chillers, and water-cooled chillers. Both methods make use of cooling towers which lower water temperature through evaporation. Cooling towers vary in size and design but rely on either reused water or potable water. However, the option of reused water is preferred to reduce water consumption (Huber Technology, 2021).

DRAINAGE / WASTEWATER IN BUILDINGS

Wastewater is generated by domestic, industrial, and commercial use. There are various of types of wastewaters that is generated in buildings, including:

- Blackwater – is wastewater from toilets which is typically discharged into municipal sewer systems but may be discharged into on-site treatment such as septic tanks or Ventilated Improved Pits (VIPs). The latter is either treated on-site or transported to a wastewater treatment works via a honeysucker. In some instances, package wastewater treatment plants are installed when there is no municipal sewer network and there is a large volume of sewage which cannot be treated by septic tanks. It must be noted that the owners of such installations must comply with DWS regulations, authorisations and by-laws in treatment and disposal. The WSI is not responsible for the management of these installations.
- Greywater – is untreated household wastewater from all domestic, commercial and industrial activities other than toilet flushing. This can include water from
    - kitchen sinks and dishwashers (which contains grease, fats, oils, bacteria, and food / other solid particles),
    - recreational baths (spas, jacuzzi, pools, etc.),
    - surface run-off greywater can also include water from laundries,
    - Cooling tower blowdown or low-impact industrial activity which produces water of acceptable quality.
- Process/Industrial water – is wastewater produced by industrial activities which may negatively impact on quality. This type of water normally does not comply with discharge limits for municipal sewers and may require additional treatment before discharge or be transported to suitable hazardous site.

WATER USE EFFICIENCY

According to Vickers (2001), water efficiency can be defined as the “minimization of the amount of water used to accomplish a function, task or result. Within the urban context, water efficiency may refer to limiting the consumption of potable water and maximising the output per drop. Improving water efficiency can typically achieved through either:

i) designing or retrofitting buildings with technologies (fixtures) designed to consume less potable water

ii) relying on non-potable (rainwater harvesting, groundwater, or closed loop systems) water sources especially for outdoor water consume (gardening, vehicle washing, etc.); or

iii) water restrictions through the enactment of by-laws, regulations or similar.

Non-revenue water (NRW) is water that has been produced and is "lost" before it reaches the customer. Losses can be real losses (through leaks, sometimes also referred to as physical losses) or apparent losses (for example through theft or metering inaccuracies).

According to the 2012 WRC publication on the state of non-revenue water in South Africa, local consumers in general have little regard for the scarcity of our water resource and use between 182 and 233 litres/person/day compared to a world average of 173 litres/person/day (Mckenzie *et al.*, 2012).

An estimated 37% of the water in South Africa's municipal systems is non-revenue water. This means it is "lost" – through leaks, theft, or metering inaccuracies – before it reaches customers. This water is worth more than 7 billion South African rand ($500 million) annually (2030 Water Resources Group, 2022)

According to the 2014 No Drop report, South Africa average water usage was 237 l/c/d compared to international benchmark of 180 l/c/d. The Gauteng province is reported having the highest water usage in the country at 311 l/c/d followed by the Free State with 296 l/c/d while the average Non-revenue Water (NRW) for the country is estimated at 34.6% (DWS, 2014)

Under periods whereby water availability is low, such as the dry season or droughts, water restrictions can be implemented to reduce water use. Water restrictions play a role in limiting the amount of water than can be used per an activity or can limit water use for activities to cooler times through the day or restricts water use of certain activities. Though not applicable to buildings only, many municipalities have drought management plans that promote and educate households and industry around reduced water usage. These plans are typically designed to respond to water shortages (Barnard, 2020).

The Namibian government, in response to the 2013 drought, developed a drought response plan. The plan sought to ensure continued good quality water for WASH activities especially at the household level (Government of the Republic of Namibia, 2014).

The City of Cape Town used water restrictions in response to the drought which started in 2017 and ended in 2020. At the height of the drought and to prevent "Day-Zero", the city implemented stringent water restrictions and reduced water usage by more than 50% with average combined usage of 500 million litres per day. However, since the drought has ended, average combined usage has steadily increased to > 700 million litres per day from 2020 (City of Cape Town, 2021).

Currently, there is limited information on status of water use and water efficiency within buildings as there is no single governing body for buildings which can collate this information due to the large variety of buildings across several sectors, i.e. health, hospitality, commercial, retail, industrial, etc. The Green Building Council of South Africa (GBCSA) has collected information on both energy and water use at office buildings and developed a benchmark across various building type to evaluate their water use efficiency However, the information is property of the GBCSA and therefore not available to the public (GBCSA, 2014).

There are several water use guidelines for various industries:

- Western Cape Government has developed guidelines for Health Care Facilities with regards to water conservation and water recycling (Yiannou, 2017). Summary of findings from this report are:
    - water usage for different kinds of facilities ranges from 20 to 450 litres per capita per day depending on type of facility (labs, day cares, regional hospitals, provincial hospitals),
    - Domestic water accounts for only 25% (drinking washing),
    - 50% of water is for cooling towers: this does not require potable water and recycling/reuse can results in huge water savings.
- The "Responsible Tourism Manual for South Africa" (Spenceley *et al*., 2002) provides guidelines on water use and disposal for the tourist industry. Useful tips and case studies are presented that focus on how to reduce water use and measure savings, with practical examples on measuring flow rates and reuse of effluent.
- The Trade and Industry Sector has developed guidelines for water use determination and target setting for the commercial sector (The Stakeholder Accord on Water Conservation, 2009). The key outputs of this guidelines are: How to determine baseline water use and establish routine water use monitoring

systems; How to identify opportunities for water conservation; How to translate identified opportunities into short and long-term water use and water intensity targets.

While these guidelines are valuable tools to ensure water use efficiency in various industries, they remain voluntary guidelines and therefore cannot be monitored or enforced.

While building owners experience water shortages and are concerned about water scarcity, there are little/no remedial actions to address their concerns. The greatest driver for South African building owners is indeed affordability and cost-savings as evident by their response to load shedding. Although load-shedding has been taking place since 2007, solar installations have only recently become more popular mainly due to the rising cost of electricity and the decreasing cost of solar. According to Teresa Kok, director of the One Energy Group, "Consumers are increasingly wanting to become self-sufficient and the imminent cost increases coming from Eskom are a key driver" (News24, 2018). Once water use efficiency correlates directly with cost-savings, consumers are more likely to reduce consumption. This can also be coupled with increased cost of water for high-end users to promote water use efficiency in buildings.

WATER SAFETY IN BUILDINGS

Water safety refers to adequately identifying and managing all risks to the water supply across the value chain. This would include and adequate quantity for supply as well as ensuring the quality is suitable for its intended use, as per water quality guidelines.

Many commercial buildings have extensive internal reticulation networks and may have additional on-site storage, treatment, and reuse of water which present additional water quality risks. To identify possible water safety risks within buildings, a thorough knowledge is required of the various components that make up the reticulation network and their possible impact on water quality, including size/age/nature of all infrastructure, quantity, and quality of water at all points, consumption and storage patterns, and maintenance records.

Typical water safety concerns in buildings include:

- Contamination from municipal source,
- Direct contamination from corrosion/leaching of pipes leading to contamination of water,
- Indirect contamination caused by cross-connections between drinking-water systems and contaminated water or chemical storages
- Increase in microbial growth in networks due to long residence time, dead ends.
- Sediment build-up in storage tanks can lead to colour, odour, bacterial contamination in the reticulation network,
- Increased deposits of calcium and magnesium in storage tanks which can reduce the performance of geysers, heat exchanges and autoclaves
- Lack of sufficient chlorine residual due to long internal reticulation networks, long resident times in storage units, or where water has been stagnant can lead to bacterial growth in the network.
- Presence of pathogen such as Pseudomonas aeruginosa, non-tuberculous Mycobacteria and Legionella (SANS 831-1, 2013)

Although maintenance personnel in buildings are aware of the infrastructure conditions within a building, they lack understanding of water quality and are unable to associate water quality risks with infrastructure conditions.

Under the global Covid-19 pandemic and associated lockdowns, commercial buildings were left with low- or no-occupancy for several weeks to several months. Considering the low- no-occupancy and the resultant

under-utilised water supply systems, there was an increased risk related to water quality problems (International Water Association, 2021). This was due to decrease in disinfection residual that can potentially lead to microbiological growth in storage tanks and in the network and provide conditions for proliferation of parasitic protozoans such as Giardia, Cryptosporidium, Legionella and viruses.

The easing of lockdown restrictions brought to light that there were little guidelines on how building owners / managers should rid stagnant water from piping and on-site storage. The International Water Association (IWA) (2020) noted that decreased occupancy in buildings increased the likelihood of opportunistic pathogens that can cause infections. The United States Environmental Protection Agency (US EPA) has published guidelines on maintaining or restoring water quality after long period of lockdown and developed an excellent checklist for restoring water quality in buildings before re-opening (United States Environmental Protection Agency, 2021). The USA Centre for Communicable Diseases (CDC) has published similar guidelines with water management programs to monitor water quality and minimise risk of Legionella infections in various types of facilities (Centres for Disease Control and Prevention, 2021). Laher (2020) highlighted the importance of flushing and cleaning the system upon returning to work after a long period of low- no-occupancy, especially due to disinfectants used in water supply systems (typically chlorine) breaking down over time. The lockdown therefore highlighted the need for appropriate water safety protocols to be developed and implemented within buildings.

The risk of scalding is often overlooked as a water safety issues in buildings. There is currently no compulsory standard for water temperature in networks and there is a disparity between the water temperature requirements to prevent injury through burns and bacterial growth in networks. To effectively prevent the growth and infections of legionella, water temperature should be set to and maintained at 60°C or higher (Heida *et al*., 2021). However, this temperature can result in serious burns to younger child and sensitive groups. A case study conducted in May 2021 at the Red Cross Children's Hospital, showed that nearly 200 children were admitted for burns of which 155 were due to fluid burns (Fokazi, 2021). The burns were caused by hot beverages, burst hot water bottles, electric kettles and bath water. The highest temperature water can be set to prevent scalding is 49°C [44]. Water at a temperature of 60°C takes as little as 1 second to cause a third-degree burn, at 55°C it takes about 10-seconds to cause a third-degree burn and, at 50°C it takes about 5-minutes to cause a third-degree burn (Better Health Channel, 2019). Building owners are more likely to decrease geyser / water heater temperatures to decrease chance of scalding, and to reduce electricity cost, but can increase in risk of Legionella growth in the network.

Though technologies exist to reduce water temperatures at the tap (installation of thermostatic mixers) and this is covered under voluntary standard SANS 10252; IOPSA indicated there is conflicting information on the position of such devices at present. As indicated in the current initiatives undertaken by SANEDI under the ongoing South African Appliance Standards and Labelling Programme (S&L Programme) which is supported by the Collaborative Labelling and Appliance Standards Program (CLASP NGO) may address the positioning of such regulators to reduce risk of scalding. CLASP has recently completed the "South African Tap and Flow Rate Gap Analysis Report" (CLASP, 2022) to inform the process of developing and improving standards for taps and showerheads, including thermoregulator mixers to control water temperature at taps. Once this labelling program is completed, it will be adopted into the National Building Regulations and Building Standards Act (NBR and BS Act) to form part of compulsory national standards to ensure water use efficiency fittings are installed in all buildings.

SUSTAINABLE BUILDING CERTIFICATIONS

As "Sustainablity" is now a major concern for private, public and government sectors; green building certification systems have gained popularity worldwide as a way to showcase commitment by the public and private sectors to sustainablity. Green building certification systems are a set of rating systems and

tools that are used to assess a building or a construction project's performance from a sustainability and environmental perspective (GBCSA). The main objectives of such systems are:

- optimize building performance and minimize environmental impacts
- provide a way to quantify a building's environmental effects
- set standards and benchmarks to assess buildings objectively

Buildings are assessed against specific standards and if they are deemed to meet a certain level of performance and quality (benchmark), the building will receive a certificate proving this achievement. The main goal of the benchmark model is to use several major consumption factors derived from building attributes data to explain the variability in data.

In South Africa, the GBCSA is the main certification program with over 740 certifications since 2010. Key drivers for certification are cost-savings, resource conservation, reduced footprint, access to green funding. The GBCSA collected information on both energy and water use of office buildings and developed a benchmark across various office buildings. The Water use efficiency tool is focused on all building types with benchmarks based on industry standards for specific types of buildings. New buildings are evaluated against predictive water usage and existing building are evaluated against actual performance data of a 12-month period. One of the main focus points is the types of fixtures and fittings (toilets, taps, showers, etc.) with specific flow rate as a criterion of the certification.

Although the updated building tool will make provision for Legionella monitoring, the assumption is that all relevant regulation relating to health and safety are at adhered to by the water service provider and water entering buildings is safe. Hence water quality is not part of certification.

Table 5.1 below summarises the main international certification systems in the world related to water use efficiency and water quality. Many these organisations have various tools available, and the relevant tool is applied based on the nature of the current or intended building use. The tools also provide recommendations where buildings need to improve, to increase water use efficiency and improve water safety.

As per Table 5.1, there are a number of water use efficiency tools avaible worldwide. Building size is an important component in the benchmarking technique because it is one of the few variables that can be tested and confirmed for each specific structure. Furthermore, the size of a structure is likely to be significantly correlated with other characteristics such as the number of residents which will directly affect consumption. Other key factors for water use efficiency benchmarks are type of building, occupancy levels, variety of water usages, and water saving interventions (re-use, recyling, alternative sources, water saving fittings, awareness, etc.). This is in line with the South African GBCSA benchmark model whose key constituents are building size, occupant density, climate and occupancy hours (Bannister & Chen, 2012).

The table highlights the lack of water quality certification systems with only two certification systems that evaluate water safety: WELL and FITWELL. The FITWELL standard evaluates water quality in buildings based on water quality analysis and provides guidelines on collection, sampling and analysis of key determinants, and advocates development of water safety plan for water reuse projects. The WELL System provides limits based either WHO of US EPA standards for various categories of contaminants: (dissolved metals, herbicides, organic pollutants, etc. The system provides guidelines for Legionella management, maintaining aesthetic quality of water and promoting awareness on water quality.

TABLE 5.1: SUMMARY OF BUILDING CERTIFICATION SYSTEMS / PLATFORMS

Name of system	Overview	Building types assessed	Grading system	Water Use Efficiency	Water Quality standard	Link to rating system
LEED rating system	Aims to have buildings use their resources more efficiently and create a safe environment for all its occupants throughout the building's life cycle. Nine areas of focus, including location and transportation, sustainable sites, water efficiency, and energy (LEED rating system, 2021)	Office buildings; Landscapes; Residential; Education buildings; Commercial buildings; Medical buildings	Points-based system with four certification levels	Benchmarking tool: based on consumption and occupancy levels	N/A	https://www.usgbc.org/leed
BREEAM	Oldest green building rating system. Created in 1990, it has since certified projects in over 50 countries, has over 560,000 certified projects, and over 2 million registered. 9 categories: management, health and well-being, transport, water, materials, land use and ecology, and pollution (BREEAM, 2021)	Residential; Commercial buildings; Community buildings; Various infrastructure	Points-based system	Benchmarking tool and water efficiency	N/A	https://www.breeam.com/BREEAM2011Scheme Document/content/08_water/wat01.htm
Green Globes	Green Globes is a building rating system used in the US and Canada; structured so that it can be done as a self-assessment in-house with the project manager and design team. Focuses on energy usage, water, waste management, emissions, indoor environment, and environmental management (Green Globes Building Certification, 2021)	Commercial; Residential; Hotels	Self-assessment using percentage-based system	Water Consumption calculator (benchmark): consumption, occupancy, area	N/A	http://www.greenglobes.com/home.asp
Living Building Challenge	Consists of seven performance categories: place, water, energy, health and happiness, materials, equity and beauty (International living future institute, 2021)	Residential; Commercial buildings; Education buildings; government buildings; Medical buildings; Laboratories; Landscape	Certification system with various levels.	Net Positive water imperative: assess usage of water from construction, promote closed loop system	N/A	https://living-future.org/

Name of system	Overview	Building types assessed	Grading system	Water Use Efficiency	Water Quality standard	Link to rating system
WELL building certification	Managed by the International WELL Building Institute (IWBI). Focuses mostly on building design attributes that impact occupant health and well-being. WELL evaluates buildings on 11 concepts: air, water, nourishment, light, movement, thermal comfort, sound, materials, mind, community, and innovation (WELL, 2021)	Office buildings; Retail spaces; Residential; Educational; Airports; restaurants	Points-based system	Checklist	WHO; EPA; California Water Boards; ANSI/ASHRAE Standard 188-2015; New York State Department of Health	https://www.wellcertified.com/ https://v2.wellcertified.com/v/en/water/feature/2#
Fitwell	Focuses on the health and wellbeing of the building occupants as well as the surrounding. Focus area are location, building access, outdoor spaces, entrances, stairs, indoor environment, workspaces, shared spaces, water supply, cafeterias and prepared food areas, vending machines and snack bars, and emergency procedures (FITWELL, 2020)	Office buildings; Retail spaces; Residential	Points-based system	Excel-based tool	Internal Fitwell standards; EPA National Primary Drinking Water Regulations; WHO national regulation and standards for drinking-water quality	https://www.fitwel.org/
Green building Council of South Africa	The GBCSA is one of about 75 members of the World Green Building Council, ensure that buildings and homes are designed, built and operated in an environmentally sustainable way. Tools are based on 9 different categories, including management, energy, water, land use, transport, materials and emissions (Green building Council of South Africa, 2014)	Commercial, residential and public sectors	Certification conducted by accredited professionals	The water (Potable) tool considers water use efficiency in a building based on usage over a 12-month period. Water sources are considered those from municipal sources and groundwater. Recycled / reused water. and rainwater are not considered as they are considered to be sustainable sources of water. it should be noted that water quality	N/A	https://gbcsa.org.za/wp-content/uploads/2017/12/GBCSA-Energy-Water-Benchmarking-Tool-v1-20112014-1.xls

Name of system	Overview	Building types assessed	Grading system	Water Use Efficiency	Water Quality standard	Link to rating system
				is not covered in the standard		
City of Cape Town – Water star Rating Certification	Recognises the integrated water management system, and promotes best practices in water management, conservation and pollution control in every sector. Participants receive star rating based on compliance with relevant water legislation and the City's Water By-law (2010) and Amendment (2018) (City of Cape Town, 2021)	Office Buildings, Industrial buildings	Self-Assessment with various 5-star rating system	Assessment form to evaluate consumption, sources of water, metering, water saving initiatives, use of alternative water sources.	Only refer to quality of effluent discharge to reduce pollution, not water quality	https://www.capetown.gov.za/City-Connect/Apply/Municipal-services/Water-and-sanitation/apply-for-water-star-rating-certification
Blue Drop and Green Drop Certification	The recently revived Blue and Green Drop Water Services Audits provides an incentive-based regulation managed by DWS, in terms of the water services act. Institutions are audited against best practice criteria on their operation and management of water and wastewater supply systems, e.g. Sun City and the Department of Public Works form part of the audit process.	Hotels, correctional centres, border controls	DWS formal audit process	Benchmarking facilities against best practice	Drinking water SANS-241 Wastewater Water use license or general authorization	http://ws.dwa.gov.za/IRIS/login.aspx

NEED FOR IMPLEMENTING RISK PRINCIPLES FOR WATER SERVICES IN BUILDINGS IN SOUTH AFRICA

WATER SAFETY PLANNING IN BUILDINGS

In 2004, the World Health Organisation (WHO) and the IWA Bonn Charter for Safe Drinking Water introduced the concept of risk-management in drinking water systems called Water Safety Plans (WSP). This was described as" The *most effective means of consistently ensuring the safety of a drinking-water supply is through the use of a comprehensive risk assessment and risk management approach that encompasses all steps in water supply from catchment to consumer. In these guidelines, such approaches are called Water Safety Plans (WSPs)* (WHO, 2009).

The objective of a WSP is to consistently ensure the safety of the drinking water system, and includes three key components:

- System assessment to determine whether the drinking water supply chain (up to the point of consumption) as a whole can deliver water of a quality that meets health-based targets.
- Identifying control measures in a drinking water system that will collectively control identified risks and ensure that health-based targets are met. For each control measure identified, an appropriate means of operational monitoring should be defined that will ensure that any deviation from the required performance is rapidly detected in a timely manner.
- Management plans describing actions taken during normal operation or incident conditions and documenting the system assessment (including upgrade and improvement), monitoring and communication plans and supporting programmes.

Since then, more than 93 countries from around the world have adopted or implemented the Water Safety concept and nearly 70 countries have policies or regulations pertaining to WSP in place or under development.

The third edition of the WHO *Guidelines for drinking-water quality (*GDWQ) (WHO, 2008) (Figure 5.1) includes specific reference to issues associated with large buildings, such as health care facilities, schools and day-care centres and recommend that these buildings have their own WSPs to ensure the maintenance of safe water supplies.

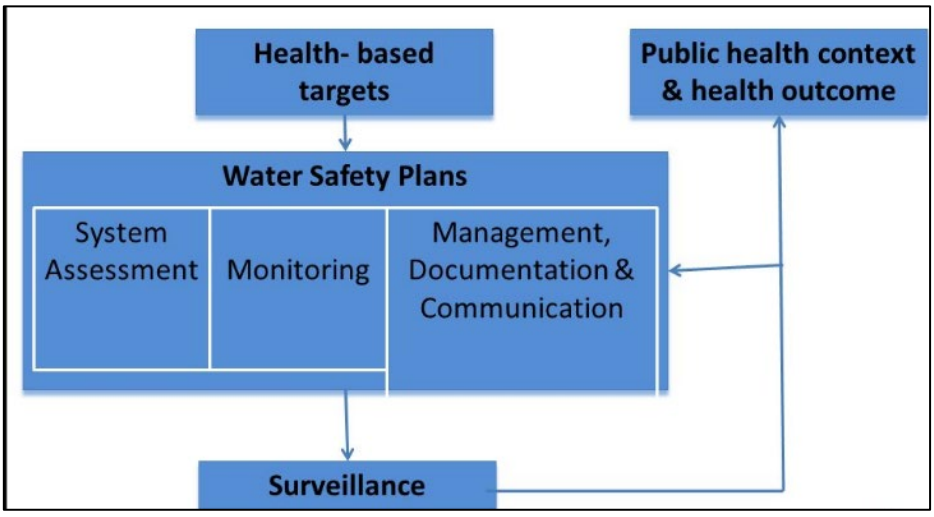

FIGURE 5.1: FRAMEWORK FOR SAFE DRINKING WATER (WHO, 2008).

As per the World Health Organisation (WHO), inadequate water management in buildings has significant health consequences, as well as significant direct and indirect economic and social while the benefits of interventions to reduce the risks of contaminated water outweigh the costs by a wide margin (WHO & International Water Association, 2011). The intention is that such building plans should complement the WSPs of water suppliers. This has led to the development of several guidelines, including a guideline for WSP in buildings (WHO & International Water Association, 2011).

Figure 5.2 outlines the methodology for developing a WSP, the steps are discussed herewith.

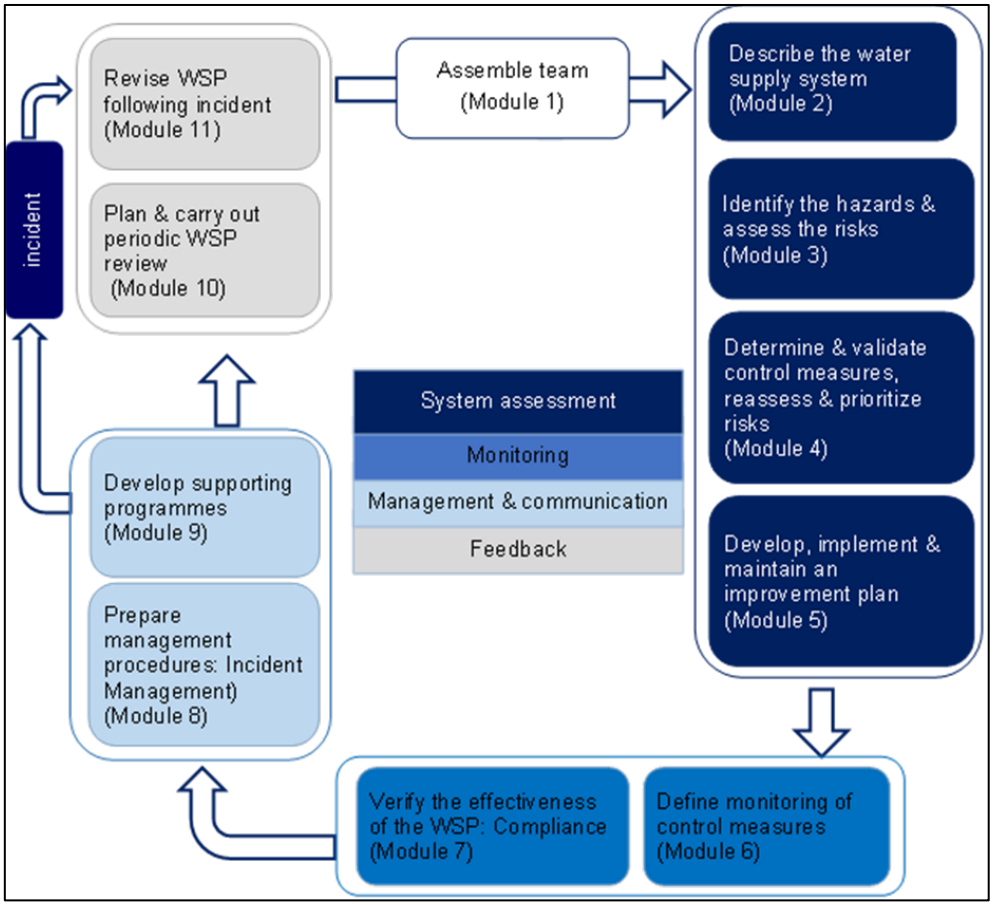

FIGURE 5.2: WATER SAFETY PLANNING METHODOLOGY AS PER WHO WSP MANUAL, 2007.

- **Module 1: Assemble a team**

A prerequisite for WSP is a qualified, dedicated, multi-disciplinary WSP Team that is responsible for developing, implementing and maintaining the WSP. The WSP Team must be led by a WSP Coordinator to in development and implementation of WSP. The WSP Coordinator can be the building manager or a competent person delegated to this task by the manager/owner of the building. They are ideally a senior member of the organisation with the required authority to secure resources (people and funds), and external support (if required). The person should have (or acquire) a good knowledge of the technical facilities in the building, and their daily work should be related to the building. Although technical knowledge in drinking-water and/or sanitation is useful, this is not a requirement. Team members should include the range of expertise needed for a thorough analysis of the building's water system.

- Expertise in design, operation and management of water network: engineering; plumbing; maintenance.
- Expertise in water quality: can be external service provider – scientist, engineer, laboratory.

The WSP team must include both Internal and external stakeholders to ensure transparency and accountability in the risk assessment process.

- Internal stakeholder can include employees with relevant specialist expertise, as well as representatives of key users of the building water systems: tenants, representative of staff, OHS representative.
- External stakeholder should include the local Water service Authority or any other regulatory body that oversees building water services.

- **Module 2: Describe the Water Supply System**

The next step is to describe the water supply system by consolidating all available information on the design and operation of the water system in the building. This can be in the form of a high-level flow diagram to capture the various elements of the building water system supported by a library of reference documents that covers all aspects of water in the building. Guidelines for describing the water supply system are listed below:

- As-built drawings are critical for compiling flow diagrams and latest version must form part of the library. Technical information such as manufacturers specifications, feasibility reports, maintenance records should form part of the reference documents.
- On-site verification is critical to ensure correct information is captured and will highlight gaps in information.
- Flow diagram can contain additional technical information such as flow rates, pressure, size of units, etc. This will depend on the type of building and expertise of the WSP team.
- The description must address all types of water networks: hot water, cold water, process water and wastewater.
- Water usage patterns must be recorded for all sources of water: drinking, showering, preparing food, cleaning, toilet flushing, irrigation, firefighting, laundries, water-using devices (e.g. cooling towers, swimming pools, water coolers, water fountains) or specific applications (medical: autoclaves, surgery, dialysis, etc.). Usage determines the required volume and flow rate at each PoU and this will assist in identifying areas of low flow, stagnation, or variability in usage due to occupancy rates.
- Process layout must cover the full value chain of water:
    - Point(s) of entry (PoE) to the building, including possible PoE treatment;
    - Building-specific sources of water and associated treatment (boreholes, rainwater harvesting, water reuse),
    - Water piping systems: hot and cold systems,
    - Storage systems: for potable water, wastewater, other waste streams (process water, cooling tower blowdown water),
    - Connections between potable and non-potable systems, including
        - intended connections (e.g. between drinking water systems and fire systems), and
        - unintended connections (e.g. between drinking-water systems and sewage or recycled-water systems);
    - Devices for heating and supplying hot water (geysers, heat exchangers, boilers, etc.),
    - Equipment installed at PoU (e.g. dishwashers, washing machines, drinking-water fountains,);
    - Water treatment systems at PoU (tap connections, under-counter units, conventional treatment, specialised processes, etc.).

The WSP and the library should be stored on a shared drive or in the Cloud where it can be accessed by the WSP and updated annually. This will build institutional memory and improve understanding of process operations and management.

- **Modules 3: Identify the hazard and assess the risk, and Module 4: Determine and validate control measures, reassess and prioritise risks**

Modules 3 and 4 form the basis of the risk assessment process (Figure 5.3) where risks are identified, rated and then evaluated to determine if current control measures are sufficient to mitigate the risk. Effective risk management requires the identification of potential hazards and potential hazardous events:

- A **hazard** is a biological, chemical, physical or radiological agent that has the potential to cause harm:
    - contaminants in sources water,
    - external contaminants (bird droppings, rat faeces, sediment deposit in storage tanks, etc.),
    - internal contaminants (corrosion/scaling of pipes, contamination with wastewater, biofilm formation, Legionella due to temperature fluctuations, etc.)
- A **hazardous event** is an incident or situation that can lead to the presence of a hazard (what can happen and how). In buildings this can include interruption to supply – scheduled or unscheduled, contamination of the incoming water, temperature changes in hot water systems, equipment failure, incorrect equipment, incorrect operations of treatment units or water use devices, etc.
- **Risk** is the likelihood of identified hazards causing harm in exposed populations in a specified time frame, including the magnitude of that harm and/or the consequences. Once the risk has been defined, the risk rating is calculated using the following formula:

    Risk = Likelihood x Consequence,

    Where,
    - **Likelihood** is determined by **"how often' or "how likely"** a hazard or a hazardous event occurs. It should consider hazards that have occurred in the past and their likelihood of re-occurrence and should also predict the likelihood of hazards and events that have not occurred to date.
    - **Consequence** is the **severity of the results** of the hazard/hazardous event and the seriousness or intensity of the impact of the hazard. When dealing with impact we are concerned with human health and environmental integrity.

FIGURE 5.3: RISK ASSESSMENT PROCESS

For each hazard/hazardous event, the risk rating is calculated using the risk rating guideline (Table 5.2) and each risk is categorised as either as a low, medium or high risk as per the risk categorisation matrix (Table 5.3) below. Management will use Table 5.4 to prioritise implementation of mitigating measures.

In the WHO WSP Manual, the consequence is directly linked to water quality. For a WSP that applies to buildings, the definition of consequence has been extended to water supply and management of buildings. The next step in the process is the identification and evaluation of **control measures** which is described as "*Any action or activity that can be used to prevent, eliminate, or reduce to an acceptable level any water safety hazard".* In this case, the control measure extends to any action or activity that can reduce risk associated with water quality or supply. Typical control measures are treatment processes, water storage facilities, pressure management, routine inspections and maintenance, non-return valves, security, etc.

To verify the efficacy of the current control measure, the process of **validation** is conducted: *Validation is the process of identify the effectiveness of control measures with supporting evidence to prove/disprove the effectiveness of the control measure*. The information required for validation can come from a variety of source:

- Quantitative assessment with actual numbers, i.e. water quality results, flow meters, pumping hours, operating hours of equipment, maintenance records, etc.
- Visual inspection: smell/colour/sound/condition of infrastructure and pipes.
- Records: number of OHS incidents, days without power, number of consumer complaints, number of unresolved incidents.

Based on the efficacy of the existing control measures, the residual risk either remains the same or is reduced.

- If the current control measure is effective in reducing the risk, then the residual risk is lowered and no further actions are required.
- If the current control measure is not effective in reducing the risk, then the residual risk remains the same or may be increased. Additional mitigating measure must be identified and implemented to reduce medium and high risks in the supply system.

TABLE 5.2: RISK RATING GUIDELINE

Risk Rating = Likelihood X Consequence								
Probability/Likelihood				**Impact/Severity of Consequence**				
Category	**Score**	**Definition 1**	**Definition 2**	**Category**	**Score**	**Definition for water quality**	**Definition for water supply/quantity**	**Definition for building management**
Almost certain	5	Once per day	Is expected to occur in most circumstances	Catastrophic	5	Potentially lethal to all people using the building, including vulnerable groups (e.g. immunocompromised patients, infants and the elderly), following acute exposure	No water supply for more than 48 hrs or more than 15 days per year/ flooding in building resulting in damage to building infrastructure and catastrophic ingress (water is unconsumable)	Major impact for whole of facility, complete failure of systems
Likely	4	Once per week	Will probably occur in most circumstances	Major	4	Potentially harmful to all people using the building following acute exposure	Major interruption in supply for more than 24 hrs due to major leaks/ Damaged building water network leading to major ingress of contaminants	Major impact for part of facility, systems significantly compromised, abnormal (if any) operation, high level of monitoring required (e.g. temporary closure of part of facility requiring extensive disinfection)
Moderately likely	3	Once per month	Might occur or should occur at some time	Moderate	3	Potentially harmful to vulnerable groups (e.g. immunocompromised patients, infants and the elderly) following chronic exposure	Moderate Interruption in supply (12-24hrs) due to localised leaks / Damaged building water network leading to moderate ingress of contaminants	Minor impact for most of facility, significant but manageable modification to normal operation, increase in operating costs, increased monitoring
Unlikely	2	Once per year	Could occur at some time	Minor	2	Aesthetic impacts, potentially harmful to all people using the building following chronic exposure (>1 year)	Minor interruptions in supply (<12hrs) due to small leaks / Damaged building water network leading to minor ingress of contaminants	Minor impact for part of facility, some manageable disruption to normal operation, some increase in operating costs
Rare	1	Once every 5 years	May occur only in exceptional circumstances	Insignificant	1	No impact or not detectable	No impact / damage or not detectable	Insignificant impact, little disruption to normal operation, low increase in normal operating costs

TABLE 5.3: RISK CATEGORISATION MATRIX

Risk rating categorisation			Impact/Severity of Consequence				
			Insignificant	Minor	Moderate	Major	Catastrophic
			1	2	3	4	5
Probability/ Likelihood	Almost certain	5	5	10	15	20	25
	Likely	4	4	8	12	16	20
	Moderately likely	3	3	6	9	12	15
	Unlikely	2	2	4	6	8	10
	Rare	1	1	2	3	4	5

TABLE 5.4: RISK MANAGEMENT ACTIONS

Risk Rating	Range	Management actions required
LOW	0-9	No immediate action required. Keep under review and introduce any simple and inexpensive control.
MEDIUM	10-15	Evaluate underlying factors, set timescale for putting extra control measures in place.
HIGH	> 15	Immediate substantive action is required to bring the situation under control, and then introduce extra control measures (barrier).

- **Module 5: Develop, implement and maintain an improvement plan.**

The next step is to develop an improvement plan to mitigate all medium and high risks. The implementation plan should outline specific actions to address each uncontrolled or ineffectively controlled risk in a structured manner using risk rating as the basis to allocate resources. Prioritisation is based on risk rating and the implementation plan should provide for short, medium and long-term activities that will maximises effectiveness of resources (budget, personnel). The WSP Team must complete the following actions to ensure implementation of the corrective measures.

- Outline specific actions to mitigate all remaining risks,
- Identify Targeted risks, i.e. risks which will be implemented in next financial year as well as risks for medium and long-term implementation,
- Allocate budget, timeframe, and responsibility for implementation of targeted risks,
- Ensure implementation plan is communicated to all personnel who are responsible for implementation,
- Conduct annual review to track implementation and update the WSP (See Module 10).

- **Module 6: Define Monitoring of Control Measures and Module 7: Verify the effectiveness of the WSP**

Module 6 outlines the development of a comprehensive monitoring program that covers all existing and proposed control measures to allow for validating the efficacy of the control measures. Monitoring programs must outline all aspects of monitoring: where will it take place, what is being monitored, how will it be monitored, when will it be monitored (frequency), and who will monitor. In addition, each operational monitoring check should have a critical limit assigned to it; this is the point where a control measure is operating outside of an acceptable limit and a potential risk exist.

Monitoring of water quality is essential to verify the effectiveness of the WSP to provide water that is fit for its planned use.

With regards to potable water, the National Drinking Water Quality guideline, SANS 241 (2015) lists the water quality parameters and associated limits which verify the safety of drinking water. Although the SANS 241 (2015) does not extend to buildings, the standard outlines key operational water quality parameters for distribution networks and provides guidelines on development of risk-based monitoring programs as per WHO WSP methodology. Section 9.3 of the SANS 10252-1:2012 (Edition 3) deals with disinfection of building networks and recommends analysis of water quality in terms of SANS 241 (2015) to verify the performance of the disinfection process.

Therefore an annual water quality assessment of all determinants listed in the SANS 241 Standard will serve to verify the effectiveness of the WSP with regards to water safety. Daily/weekly/monthly monitoring is required to constantly check water quality in buildings. A typical risk-based water quality monitoring program as outlined in the SANS 241 will include the following:

Analysis of source water and final water for all acute and chronic health determinants listed in the SANS 241 (2015) to identify existing water quality risks.

- Any water quality determinants which exceed the prescribed limit as per SANS 241 (2015) are identified as 'problem determinants" and must be monitored frequently to ensure they are controlled.
- The frequency of monitoring will depend on the type of determinants: SANS 241 recommends weekly/twice monthly monitoring for acute health determinants and monthly monitoring for chronic health/aesthetic determinants.
- Building owners are advised to conduct this full assessment of the final water annually as this serves to verify the efficacy of the WSP as per *Module 7*.
- Addition of any other water quality risks identified during the risk assessment, e.g. monitoring of lead due to old lead pipes in some sections of the building.
- Inclusion of any chemical that are added during treatment or in network: anti-scaling/corrosion products, active ingredient in coagulant, etc.

Operational monitoring as per SANS 241 is defined as "*essential for assessing the efficient operation of treatment systems and risk to infrastructure".*

- Operational monitoring may be conducted by on-line sensors connected to centralised SCADA system which records additional operational information such as flow, pressure, temperature, etc.
- The main operational determinants for water quality in buildings are pH, Turbidity, Colour, E. Coli, HPC (Heterotrophic Plate Count), and disinfection residual (free chlorine).
- Operational monitoring for on-site treatment processes will depend on the type of treatment process and may include typical operational determinants listed in the SANS 241 (2015).

Operational monitoring extends beyond water quality and building owners must ensure all other technical information related to operations and maintenance are recorded for purpose of verification. These include daily/weekly/monthly/annual inspections of network and equipment, inspection of PoU applications by service provider, maintenance records, flow meter readings, temperature measurements, pressure measurements, water balance for facility, etc.

In addition, monitoring of Legionella is requirement as per SANS 893-1 (2013) and SANS 893-2 (2018) and OHS Act (No 85 of 1993). The monitoring also follows a risk-based approach, i.e.

- Conduct a risk assessment done by a competent person (OHS Act and SANS 893)
- Establish a Legionella Risk Management system for continuous control and review (SANS 893 part 1)
- Ensure specific water systems are treated correctly, tested, actioned and recorded (SANS 893 part 2)
- Ensure temperature settings on calorifiers and point of use temperatures meet SANS 893 requirements
- Train and inform staff on all Legionella related matters (OHS Act and SANS 893).

- **Module 8: Prepare Management Procedures and Module 9: Develop Supporting Programs**

Management procedures are the actions to be undertaken during normal operational conditions (SOP's) and in response to specific "incidents" where a loss of control of the system may occur.
Incidents occur when the operational monitoring check exceeds the critical limits assigned to it and a potential risk exists. For example, a critical limit for treated water turbidity in the distribution system may be 5 NTU and immediate corrective actions are required with the limits is exceeded. For operational checks related to water supply, critical limit may be maximum number of hours without supply after which alternative water supply must be secured.

Management procedures to deal with incidents are outlined in an incident protocol which include the following components:

- Alert levels/Critical limits,
- Response times
- Required actions
- Roles & responsibilities
- Communication vehicles/methods,
- Contact details, and
- Incident Register to record and track incidents. Incident registers should include date, location and description of incident, action taken, date of resolution, and outcome of root cause investigation.

Management has a responsibility to ensure all management procedures are updated regularly, are accessible to all relevant personnel and provide staff with adequate resources to implement corrective actions.
Supporting programmes are activities that support the development of skills and knowledge, commitment to the WSP approach, and capacity to effectively manage the water supply system to deliver a reliable supply of safe water at all times. Programs relate to training, research and development, and management practises.
Typical supporting programs include public awareness on hygiene/water savings, skills development program, organisational realignment, document storage and control, communication protocols.

- **Module 10: Plan and carry out periodic review of WSP and Module 11: Review the WSP after an Incident**

Risk management is a continuous process of identify, assess, control and review risks. Therefore, the WSP must be periodically reviewed to ensure current risks have been mitigated, control measures are effective, new procedures have been implemented and emerging risks are identified and managed. The WSP Team must decide on the frequency of review: the Blue Drop guidelines recommend an annual review of WSP to

ensure all new and emerging risks are identified. However, this is at the discretion of the WSP team with less frequent review required when there are few risks (small systems) and good operations and management practises.

WSP review is required after the following incidents or events:

- Near misses: aesthetic water quality issues, frequent interruptions.
- Major events: water quality failures, extended periods of no supply,
- Significant changes in network: upgrade/refurbish/new infrastructure,
- New procedures.

The WSP review process must be comprehensive and transparent detailing why the incident occurred and report on adequacy of response to reduce the risk. Key components of the review process are summarised below:

- Update risk assessment: reassess risks based on implementation of mitigating measures, identify new risks
- Critically assess the methodology, technical adequacy and effectiveness of the WSP to support implementation.
- Conduct quality assurance of results: laboratory accreditation, legal requirements, calibration certificates
- Evaluate management responses:
    - Implementation of mitigating measures: Reasons for poor implementation, KPI to measure performance of personnel, budget/organisational constraints.
    - Incident management: is it working, are there "near misses", is it logical/achievable?
- Communication of documents: record keeping, accessibility, version control
- Who is responsible of review? Are they qualified and independent?
- When/how often must you conduct review?
- Incorporation of lessons learned into WSP documents and procedures to ensure continuous improvement in the WSP process.

Implementation of Water Safety Plans in buildings

The guideline states that management of building water systems is more complicate as buildings are owned by private people making it more difficult to regulate. Other challenges associated with managing building water systems include:

- Regulatory authorities often provide oversight of public water supplies, but this more challenging with building managers as there may be thousands of independently owned buildings in urban areas,
- A general perception by building owners is that water systems in buildings connected to public supplies are safe, ignoring the potential for contamination (both chemical and microbial) and growth of waterborne opportunistic pathogens within the building water systems,
- Complicated systems which can lead to source of contamination due to supplementary water supplies in buildings (roof rainwater, greywater, boreholes) and/or connections with water-using devices (cooling towers, evaporative condensers, boilers, swimming pools, water fountains, point-of-use treatment, medical devices and industrial equipment).
- Water systems are often managed by general maintenance staff with little training or expertise in managing water quality.

As a result, there are many examples where faults within buildings have led to outbreaks of drinking-water-derived disease, including gastrointestinal disease associated with contamination of drinking-water by Cryptosporidium and Cyclospora, legionellosis (Legionnaires' disease) associated with hot and cold-water systems and cooling towers, and methemoglobinemia from boiler fluid contamination of drinking-water. During the COVID-19 lockdown, many buildings experienced aesthetic was quality issues after prolonged periods of shutdown or low occupancy. These include taste and odours are common problems in buildings caused by water stagnation, and turbidity and colour caused by corrosion or resuspension of biofilms and sediments from storage tanks and hot-water tanks.

The guideline deals with all buildings where people use or are exposed to water, with a particular focus on buildings that include public use or shared facilities. Although many of the principles also apply to sole occupancy dwellings and homes, it is not expected that management actions, such as the implementation of water safety plans (WSPs), will be applied in private homes. The guideline covers the following areas:

- Overview of core issues related to water safety in buildings with list of potential biological and chemical hazards in building water supplies.
- Roles and responsibilities of stakeholders who influent the safety of water systems within buildings.
- Steps in developing and implementing WSPs with examples of how key principles can be applied and case studies to typical WSP for buildings.
- The environment required to support the delivery of safe water within buildings but does not affect water quality directly. This includes independent technical inspection and surveillance, disease surveillance and detection of outbreaks, regulatory and policy frameworks, and capacity building and training.

This report serves as an important guideline to implementing risk management principles related to water quality in buildings. However, the document does not deal with the management or protection of water resources and use of recycled water.

The Water Supplies Department (2017) of Hong Kong has developed an incentive-based program for building owners to develop Water Safety Plans and mitigate water quality risks in their networks. The methodology is based on the WHO guidelines with basic guideline for hazard identification and mitigating measures. There are several documents and resources, including brochures, promotional YouTube Video, a guideline for the developing of a water safety plan, lists of accredited professionals who are qualified to compile plans, and generic water safety plans for hospitals, schools, and elderly care facilities.

However, as the Water Supplies Department is the Water Service Authority, they are confident that the quality of water entering the buildings is safe for human consumption and the water safety plans only address possible risks associated with plumbing and storage which may negatively impact on the quality of water in the buildings network. The WSP responsible for development and implementation is the person familiar with the operations of the building, e.g. the property management officer and supported by plumbers. Mitigating measure are limited to infrastructure (flushing systems, improving network designs, replacing plumbing equipment, etc.) and do not extend to water quality testing. As with the WHO WSP guideline for buildings, the risk assessment does not cover management of water resources, on-site treatment, and alternative water resources.
A study conducted in 2019 in Germany evaluated the benefits of WSP approach for buildings. The study entitled "Implementation and evaluation of the water safety plan approach for buildings" (Schmidt *et al*., 2019) presents the results of a pilot project conducted on four building types by the German Environment Agency to evaluate the experiences of various stakeholder on practical implementation of WSPs in buildings and the advantages for managing drinking-water quality in buildings. Four different types of

public buildings were selected: Nursing home for elderly, school, Psychiatric institution, and factory. Results indicate the feasibility of the WSP concept resulting in an increased system knowledge and awareness for drinking-water quality issues. WSPs also led to improved operation of the plumbing system and provided benefits for surveillance authorities. The study reports that most countries in the European Union are aware of the importance of reducing risks that are caused by deficiencies in the premise plumbing systems and have individual approaches to control them. However, a legally binding requirement for risk management in buildings is not in place in most cases and there is very little expertise in implementing WSP in buildings.

In summary, the use of risk-based procedures outlined in the WHO WSP approach provides great potential to discover deficiencies and to improve the conditions of building's water systems thereby ensuring delivery of safe drinking water in buildings. However, there are several challenges with regards to adoption and implementation of WSP by building owners; these challenges are summarised below:

- Developing legislation that extends to water services within buildings.
- Difficulty with regulating large number of private building owners
- Lack of expertise in developing and implementing WSP in buildings: both at national level (regulator) and within buildings as they are managed by general maintenance staff with little training or expertise in water quality.
- Extension of WSP concept to address reliability of supply (water interruptions, insufficient supply).
- Further development of WSP approach to address site-specific water risks: water reuse, alternative water supplies, point-of-use devices (tap fitting, under-counter units, autoclaves, dialysis machines, cooling towers).

GAP ANALYSIS OF CURRENT LEGISLATION IN SOUTH AFRICA

The risk-based methodology was used to conduct a risk assessment of current legislation on water use efficiency and water safety in building as outlined in this report. The risks were categorised according to type of legislation, assigned a risk rating based on likelihood and consequent, control measures were identified and validated to determine the residual risk. Additional control measures to mitigate risks have been defined based on the status quo assessment and stakeholder engagements. The results are summarised below with details given in Table 9.

- Water Quality risks in municipal supply have a major impact due to potential harm to all people using the building following acute exposure. This translates to a high risk as the impact will not only affect individual buildings but will also affect the entire municipality.
- Water supply interruptions or insufficient water are medium risks as they have a moderate impact on buildings which may lead to short periods of water interruptions.
- Lack of standards for building networks and lack of comprehensive by-laws which address aspects of water quality and water use efficiency have moderate impact on buildings and are also categorised as medium risks. The impact is localised to buildings.

This exercise demonstrates how the risk-based approach allows for prioritisation of risks based on severity of consequence. The outcome of such a risk assessment will guide implementation of recommendations by stakeholders in a targeted manner by addressing high risks first, thereby ensuring safety of consumers in buildings.

TABLE 5.5: SUMMARY OF RISKS FROM LEGISLATIVE OVERVIEW

Risk No.	Identified Risk	Likelihood	Consequence	Risk Rating	Control Measures	Tests for efficacy of existing control measures	Likelihood	Consequence	Residual Risk Rating	Additional Control Measures to mitigate risks
	National Legislation									
1	Risk of insufficient water supply due to lack of water conservation targets	5. Once per day	3.Moderate impact	**15**	Water use efficiency is responsibility of Water Service Institution, Regulations outline requirements for water balance and water use efficiency	DWS has not set water savings targets, no enforcement for lack of water balance or lack of water savings which can lead to prolonged water shortages	5. Once per day	3.Moderate impact	**15**	DWS to set water savings targets for all municipalities aligned with National Policies. DWS to monitor and enforce annual review of municipal Water balance and savings.
2	Risk of unsafe municipal drinking water quality due to various reasons.	5. Once per day	4.Major impact	**20**	DWS requires municipalities to provide safe water as per their mandate.	Not effective; 60% of water supply systems in the country do not comply with microbiological determinants and 60% have insufficient monitoring.	5. Once per day	4.Major impact	**20**	DWS to strengthen regulation to ensure water is safe and monitored.
3	Risk on unsafe water in buildings due to lack of legislation	5. Once per day	3.Moderate impact	**15**	None: drinking water standards does not extend to buildings	No legal requirement for water quality testing in buildings, not taking place.	5. Once per day	3.Moderate impact	**15**	Voluntary use of WSP tool by building owners with routine monitoring to verify safety of water within buildings.
4	Risk of Legionella infection due to lack of compulsory standards	5. Once per day	3.Moderate impact	**15**	Current standard is voluntary.	Lack of data on Legionella monitoring or incidents.	5. Once per day	3.Moderate impact	**15**	Adoption of Legionella Monitoring into legislation to make this a compulsory standard. Development of national database to monitor Legionella infections in buildings?

Risk No.	Identified Risk	Likelihood	Consequence	Risk Rating	Control Measures	Tests for efficacy of existing control measures	Likelihood	Consequence	Residual Risk Rating	Additional Control Measures to mitigate risks
	NBR and BS Act									
1	Risk of sub-standard water services within buildings due to lack of enforcement.	5. Once per day	2.Minor impact	**10**	Building control officer not responsible for internal network	There is no information to check this: however many buildings use sub-standard fittings and unqualified people	5. Once per day	3.Moderate impact	**15**	1) By-laws to stipulate use of professional plumbers and compliance with voluntary standards (SANS 10252)
2	Lack of adherence to SANS 3088 (Water Use efficiency) by building owners	5. Once per day	2.Minor impact	**10**	Building Control Officer will only ensure compliance of fixtures/fittings during construction:	Building control offices is not responsible for monitoring water usage in buildings after the construction of the building has been completed	5. Once per day	2.Minor impact	**10**	By-laws to incorporate SANS 3088 into local by-laws and set up division to enforce regulation.
3	Risk of unsafe water in buildings as the NBR and BS Act does not address water quality	5. Once per day	3.Moderate impact	**15**	NRCS assumes all water entering building is safe and water quality and supply is covered by other department such as DWS	Municipal water quality may not be safe and there are additional water quality risks in network, therefore cannot assume water in buildings is safe	5. Once per day	3.Moderate impact	**15**	By-laws to address issues related to water quality and alternative water sources; with required skills to enforce these regulations
	Local by-laws									
1	Lack of updated by-laws to regulate internal water services in buildings	5. Once per day	3.Moderate impact	**15**	None	Lack of updated by-laws due to various reasons: political will, long approval processes. Lack of enforcement of by-laws due to insufficient capacity and skills.	5. Once per day	3.Moderate impact	**15**	Municipalities to update all by-laws and ensure there is sufficient skilled personnel to implement the by-laws.

NEED FOR GUIDANCE ON RISK-BASED WATER SERVICES MANAGEMENT IN BUILDINGS

In SA, the WSP approach is adopted into the National Drinking Water Quality standard, SANS 241: 2015 which requires each supply system to:

- Development of a Water Safety Plan,
- Undertake an annual risk assessment of water supply systems (from catchment to tap) to identify, mitigate and manage current and potential risks,
- Develop risk-based monitoring programs, and
- Develop a Water Quality Incident protocol to manage water quality failures

The WSP is a requirement for DWS Blue and Green Drop Incentive-Based Regulation Program requiring a Water Services Institution (WSI) to develop and implement risk management procedures as outlined in the WHO (2009) Water Safety Planning manual. However, as both the Blue/Green Drop requirements and the SANS 241 (2015) apply to water services provision by Water Services Authorities (municipalities) as outlined in the Water Services Act, the scope of the WSP ends when water is delivered to the consumer and does not extend to private buildings.

The DWS (2022) Blue Drop Progress report which was released by the Minister of Water and Sanitation, Mr Senzo Mchunu in May 2022, states 60% of water supply systems in the country do not comply with microbiological determinants and 77% of water supply systems do not comply with chemical determinants. In addition, 66% have insufficient number of samples to verify microbiological quality and 77% have insufficient number of samples to verify chemical water quality as per the SANS 241 (2015) requirements. The poor performance of the majority of supply systems indicates serious health risk to consumers of municipal water supply due to water quality failures or insufficient information to verify the safety of municipal water supply. Building owners therefore can no longer assume municipal water entering their buildings is safe for human consumption and must implement systems to manage and mitigate water quality risks.

In SA, interruptions in water supply are steadily increasing due to a variety of factors, including ageing infrastructure, lack of municipal resources to respond timeously to water services interruptions, theft, vandalism, and load-shedding. SA remains a water scarce country and the effect of climate change will result in increased flooding or drying in some areas. The prolonged drought in the Eastern Cape has results in Nelson Mandela Bay Municipality facing “Day Zero” at the end of May 2022, while the recent floods in KZN (April 2022) has damaged critical water infrastructure in eThekwini leaving many communities with no water supply. This presents a high risk for buildings which cater for large number of people such as health care facilities, old age homes, prisons, schools, and universities.

To ensure a sustainable supply of clean, safe water in buildings, building owners need to take responsibility for their assets and implement management action that will cover the full chain of water services and address risks related to safe drinking water and sufficient water supply.

In light of the challenges faced with adoption and implementation of national standards within buildings, The WSP methodology offers a holistic approach to manage risks in buildings and places the responsibility of risk management on the building owner. There are a number of benefits associated with using the risk-based approach to manage water services in buildings:

- Building owners understand risk management as this is a universal business concepts used by all sectors to identify, assess, and control risks. Therefore the use of this risk-based approach will ensure building owners understand the methodology and procedures to manage risks within their water supply systems.

- The systematic approach of the WSP can be modified to cover all aspects of water services and extended to water scarcity:
    - The WSP methodology has been successfully extended to wastewater services by DWS with the development of guideline report to compile “Wastewater Risk Abatement Plans” (Van Der Merwe-Botha & Manus, 2011). The Wastewater Risk Abatement Plan (W_2RAP) is the equivalent of a WSP for sanitation services and is a requirement for Green Drop Certification. Other countries use the WSP methodology as is to develop Sanitation Safety Plans.
    - WSP have been extended to address issues of water scarcity and are termed “Water Safety and Security Plan”. The consequence of the risks reflects water scarcity instead of water quality and risks address issues of water losses in network, climate change, population growth, and ageing infrastructure.
    - Risk management provides a systematic method to prioritise risks thereby facilitating the process of allocating funds for implementation of corrective actions as high risk are prioritised before medium and lower risks.
    - The risk prioritisation method allows for both short-term and long-term plans to reduce risks with clearly defined timelines and budgets for each item.
    - Risk management method allows for constant checks to ensure the implemented actions have indeed reduced the risk (validation of the efficacy of the mitigating measure)
    - The greatest benefit of the WSP approach is the cycle of continuous risk management that will ensure new and emerging risks are constantly identified and managed.

Due to the lack of water quality regulations in building, adoption of WSP in buildings may result in self-regulation by building owners through awareness of potential risks, and this may prove to be an effective mechanism to improve water use efficiency and water safety in buildings.

SUMMARY

Currently, the only SABS standard which addresses water quality monitoring in buildings is the SANS 893-1 (Risk Management) and SANS 892-3 (Control) which outlines requirement for monitoring of Legionella under the Occupational Health and Safety Act. As this is a voluntary standard, there is no information on Legionella monitoring and control in buildings.

The DWS (2022) Blue Drop Progress report states that only 40% of municipal supply systems comply with microbiological parameters and only 23% comply with chemical parameters outlined in the SANS 241 (2015) standard. Building owners therefore can no longer assume municipal water entering their buildings is safe for human consumption and must implement systems to monitor and manage water quality risks in their reticulation networks.

Development of standards for water storage are also critical to ensure stored water is free from external contamination and network is not susceptible to increased biofilm formation which can compromise quality and quantity. Such a standard must address construction, operations, routine maintenance, and water quality testing. Aspects related to construction of on-site storage can be implemented by registered plumbers/contractors while aspects related to monitoring of water quality can be incorporated into local by-laws and undertaken by EHP in each municipality.

Public awareness campaigns, guidelines and standards are required to ensure building owners are aware of potential health risks associated with internal water reticulation networks and have information to identify, control and manage these risks.

Ideally, drinking water quality monitoring should be extended to buildings. However, responsibility for adoption and enforcement of such standards remains a challenge due to lack of capacity at local municipal level to implement and enforce by-laws.

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

WATER SERVICES IN BUILDINGS

NRCS is responsible for implementation of the NBR and BS Act, Building Control Officer is the entity responsible for ensuring all new buildings comply with the act and compulsory standard SANS 10400.

- The Building Control officer is only responsible for new buildings and does not apply to internal networks of existing buildings which is covered by voluntary standards (SANS 10251).
- Water use efficiency is not currently addressed under the NBR and BS Act. Proposed revision to the NBR and BS Act will incorporate voluntary SANS 3088:2019: Water efficiency in building. However, Building Control Officers will only ensure compliance of fixtures/fittings during construction; not responsible for monitoring water usage in buildings after the construction of the building has been completed.
- Perception of NRCS is water is not a risk based on assumption that all water entering building is safe, water has not killed anyone in buildings, and water quality and supply is covered by other departments such as DWS. Therefore the NBR and BS Act does not cover aspects related to water quality and supply and recommends standards related to water quality and supply in buildings should rather be included in local by-laws as WSI have required knowledge and skills to enforce these regulations.

NRCS, together with DWS are identified as key stakeholders (Promoters with High Power/High Interest) as they will be responsible for adopting, publishing, implementing and enforcing the standards which will be developed in the future.

As buildings are privately owned, there are a number of stakeholders with low power but have high interest (Defender Stakeholders) such as Green Building Council, IOPSA, SAPOA, SALGA and Green Cape. These Defender Stakeholders can provide valuable input on user requirement and be effective promoters of the project and help ensure adoption of standards and guidelines.

Although the GBCSA certification only covers water use efficiency, proposed new tools make provision for Legionella monitoring. Participation by the GBCSA in this stakeholder engagement process has highlighted the poor quality of municipal water in many areas in the country and this challenges the GBCSA's current assumption that all standards and health and safety regulations are adhered to and water entering buildings is safe. Although the key drivers for certification are cost-savings, resource conservation, reduced footprint, and access to green funding, a case can be made for adoption of risk-management procedures (Water Safety Plans) to be incorporated into future certification programs aimed at ensuring health and safety of occupants.

IOPSA, together with the PIRB advocates for municipal by-laws to require all water services installations in buildings be conducted by professional plumbers as this will ensure compliance to all compulsory standards (SANS 10400) as well as voluntary standards such as SANS 10251.

ONLINE SURVEY

Summary of online survey results:

- Most respondents were from Gauteng, and the majority of respondents (50%) were from domestic residences (H3) and dwellings (H4) – not a true reflection of water services in all building types. Future studies should target the building categories which house a large number of people and service members of the public such as commercial, industrial, and institutional buildings.
- 90% of respondents use water for domestic use, 92.5% use municipal water as their main water source, most of plumbing work is conducted by external maintenance personnel such as plumbers and contractors. This highlights the importance of ongoing training for plumbers to ensure they are aware of new standards related to water services in buildings. By-laws should stipulate requirements for professional plumbers to conduct internal water services work as this will ensure the plumber are trained on all required standards.
- Although 52% of respondents experience water shortages, only 63% of these respondents have on-site water storage tanks and potable water makes up the largest proportion of stored water (63%). A positive trend is the 54% of storage tanks which are recirculated daily as this reduces risk of biofilm formation due to lack of chlorine residual/stagnant water. As water interruptions increase due to various reasons, including load shedding, the percentage of buildings with on-site storage is likely to increase. Development of standards for water storage is therefore critical to ensure stored water is free from external contamination and network is not susceptible to increased biofilm formation which can compromise quality and quantity.
- 91% do not have any water savings plan/initiatives in place; 48% of all respondents have some water saving initiatives in place to reduce demand and most of these are sanitary fixtures (47%) which are easily accessible to most households. The low number of respondents with water saving measures indicates most households are not concerned about water savings. This is reflected in the 2014 No Drop report with average water usage reported at 237 l/c/d compared to international benchmark of 180 l/c/d (DWS, 2014). Public awareness on water scarcity is clearly lacking: National public awareness campaigns to reduce consumption and enforcement of water restrictions at municipal level will motivate building owners to implement water use efficiency measures.
- Although 72% of respondents are concerned about water quality and its impact on their health, only 15% are monitoring water quality. Only 11% have protocols to flush networks in the event of failures, and only 6% are monitoring for Legionella. The lack of water quality monitoring in buildings is expected as there is currently no legislation that focuses on water quality in buildings and Legionella monitoring standard is voluntary. In light of deteriorating municipal water quality reported in 2022 Blue Drop Report, public awareness campaigns are required to ensure consumers are aware of the potential health risks associated with their municipal supply, and guidelines are required to assist building owners to identify and manage water quality risks within their buildings
- Scenario analysis between various parameters found no meaningful correlations. This may be attributed to low number of responses, responses largely from private houses or may reflect the actual situation. Scenario analysis summarised below.
    - There is no relationship between building type and water quality monitoring. Building owners are not aware of potential water quality risks associated with large internal network or supplying water to a large number of people/members of the public.
    - No correlation between Legionella Monitoring and size/type of building. Building owners are unaware of potential health risks associated with Legionella.
    - Building owners who participate in certification programs are more likely to monitor water quality. This group is therefore more likely to adopt proposed water quality monitoring guidelines and certification programs are ideally suited to pilot such guidelines.

- Buildings with on-site storage are not aware of potential water quality risks associated with on-site storage.
- There is no clear indication that buildings which experience water shortages will have on-site storage or implement water savings initiatives. The decision to install on-site storage/implement water savings is probably linked to cost-benefit and impact on daily operations. Consumers are likely to implement standards related to water use efficiency if there is a direct cost-benefit to them. Such standards, together with increased water tariffs for high end users can motivate building owners to reduce consumption and save water

Development of guidelines/standards for water use efficiency and water quality is critical to address the status. The biggest challenge remains adoption and implementation of guidelines/standards by building owners and enforcement by local municipalities.

WATER SAFETY

As per the National Water Act (NWA), Water Services Institutions (WSIs) are responsible for provision of safe drinking water which complies with the National drinking quality standard SANS 241. However the SANS 241 standard is only applicable to municipal supply systems and does not extend to buildings.

Currently the only other legislation that covers water quality in buildings is the SANS 893-1 (Risk Management) and SANS 892-3 (Control) which outlines requirement for monitoring of Legionella under the Occupational Health and Safety Act. As this is a voluntary standard, there is no regulation of this standard and hence no information on Legionella monitoring and control in South African Buildings.

Ideally, drinking water quality monitoring should be extended to buildings. However, responsibility for adoption and enforcement of such standards remains a challenge due to lack of capacity at local municipal level to implement and enforce by-laws.

In light of the poor water quality of municipal systems as reported by DWS in the 2022 Blue Drop report, building owners can no longer assume municipal water entering their buildings is safe for human consumption and must implement systems to monitor and manage water quality risks in their reticulation networks.

Ideally drinking water quality should be extended to buildings, but this requires local municipalities to have sufficient resources to implement, monitor and enforce all private buildings. Due to large number of buildings and lack of resources at municipal level, this will remain a challenge. In addition, maintenance personnel in buildings lack understanding of water quality and are unable to associate water quality risks with infrastructure conditions, including storage of water and use of alternative water sources.

The WSP methodology offers a holistic approach to manage risks in buildings and places the responsibility of risk management on the building owner. Because risk management is a universal business concept used by all sectors to identify, assess, and control risks; the concept can be easily understood and adopted by building owners. The systematic approach of the WSP can be modified to cover all aspects of water services and extended to water scarcity while the cycle of continuous risk management will ensure new and emerging risks are constantly identified and managed.

Due to the lack of water quality regulations in building, adoption of WSP in buildings may result in self-regulation by building owners through awareness of potential risks, and this may prove to be an effective mechanism to improve water use efficiency and water safety in buildings.

Public awareness campaigns are required to ensure building owners are aware of potential health risks associated with both municipal supply and internal water reticulation networks, while adoption and use of WSP will allow building owners to identify, control and manage these risks.

Development of standards for water storage and alternative water sources and their incorporation into local by-laws may address risks related to water storage and alternative water sources in buildings. Such standards should address issues of construction, operations, routine maintenance, and water quality testing coupled with implementation by registered plumbers/contractors and monitoring of water quality undertaken by EHP in each municipality.

WATER USE EFFICIENCY

While DWS as the Promoter stakeholder (High power, High Interest) is the custodian of Water in South Africa, the responsibility of water services provision has been allocated to Water Services Authorities (WSIs).

With regards to water use efficiency, DWS provides policies related to water use efficiency and implementation of national programs. However, onus is on WSI to reduce water losses as DWS's role is purely advisory, does not set targets or enforce policies/programs related to water use efficiency.

There are several industry-specific water use efficiency guidelines, benchmarks and tools which are valuable resources to ensure water use efficiency in various industries. However, they remain voluntary guidelines and therefore cannot be monitored or enforced unless they are incorporated into legislation.

Installation of water-efficient fittings in buildings presents an opportunity to reduce water demand in buildings and address risk of scalding. The current initiatives by SANEDI under the ongoing South African Appliance Standards and Labelling Programme (S&L Programme) and the Collaborative Labelling and Appliance Standards Program (CLASP) are addressing the process of developing and improving standards for taps and showerheads, including thermoregulator mixers to control water temperature at taps. Once this labelling program is completed, it will be adopted into the NBR and BS Act to form part of compulsory national standards to ensure water use efficiency fittings are installed in all buildings and to address risk of scalding.

Water use efficiency in buildings can be improved if local by-laws include water efficiency measures such as installation of water-efficient fittings, sliding-scale tariffs, penalties for high water use and fines for wastage of water. The challenge remains lack of updated by-laws, lack of enforcement of by-laws due to insufficient capacity and skills, and perhaps a lack of political will to include and enforce water use efficiency at municipal level.

While building owners experience water shortages and are concerned about water scarcity, there are little/no remedial actions to address their concerns. The greatest driver for South African building owners is indeed affordability and cost-savings. Once water use efficiency correlates directly with cost-savings, consumers are more likely to reduce consumption. This can also be coupled with increased cost of water for high-end users to promote water use efficiency in buildings.

RECOMMENDATIONS

- Future study to expand on baseline assessment of water services in building to improve understanding of water services in all building classes. This can be achieved by obtaining responses to online survey from all building categories and from all provinces.
- DWS to set national, regional targets to reduce non-revenue water and improve water use efficiency at municipal level. The use of Incentive-based Regulation such as No Drop Certification provides a tool to monitor implementation of targets and this should be coupled with some form of punitive measures (reduced funding) to drive water use efficiency.
- DWS to enforce regulations that will ensure delivery of safe drinking water to all consumers. Adherence to Norms and Standards and Incentive-based regulations (Blue Drop Certification)

should be coupled with Punitive regulation (Enforcement) to ensure consumers receive safe water which does not present a health risk.

- NRCS to finalise revision of the NBR and BS Act to promote water use efficiency by incorporation of voluntary SANS 3088:2019 (Water efficiency in building) into compulsory standard SANS 10400.
- Implementation of CLASP report to ensure standardised labelling for taps, showerheads, and thermoregulator mixers with subsequent development of compulsory standards for all plumbing fixtures to promote water use efficiency and water safety in buildings. These standards must be incorporated into the NBR and BS Act as requirement for all new buildings.
- As WSI is the authority for water services provision, local municipal by-laws must be updated to address issues of water safety and water use efficiency:
    - DWS and SALGA to provide updated local by-laws for adoption by local municipalities.
    - Updated by-laws to include the following:
        - Installation of water-efficient fittings, sliding-scale tariffs, penalties for high water use and fines for wastage of water. Once water use efficiency correlates directly with cost-savings, consumers are more likely to reduce consumption.
        - Requirement for water storage and alternative water sources:
            - Address issues of construction, operations, routine maintenance, and water quality testing,
            - Monitoring of water quality undertaken by EHP in each municipality.
        - All water services installations in buildings be conducted by professional plumbers as this will ensure compliance to all compulsory standards (SANS 10400) as well as voluntary standards such as SANS 10251.
    - Municipal officials to ensure updated by-laws are adopted and promulgated as soon as possible.
    - Municipalities to ensure sufficient skills and resources to enforce by-laws.
- In light of deteriorating municipal water quality in South Africa, GBCSA and other certification programs to expand certification programs to address water quality in buildings. By incorporating risk-management procedures (Water Safety Plans) aimed at mitigating water risks into future certification programs, certification programs will ensure health and safety of occupants.
- National public awareness campaigns to reduce consumption and enforcement of water restrictions at municipal level will motivate building owners to implement water use efficiency measures.
- Public awareness campaigns are required:
    - To emphasise water scarcity and promote water use efficiency amongst all consumers,
    - To ensure consumers are aware of the potential health risks associated with their municipal supply and internal networks.
- Due to the lack of water quality regulations in building, self-regulation of internal water services network may be the solution. This can be achieved through adoption of WSP by building owners, thereby promoting awareness of potential risks and providing an effective mechanism to improve water use efficiency and water safety in buildings. An Incentive-based program promoting WSP may provide the ideal platform for such an initiative.

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