DESKTOP REVIEW OF
POLICIES, REGULATIONS, STANDARDS AND BY-LAWS LOW-FLUSH / WATER EFFICIENT TOILETS

M van der Merwe-Botha & G Quilling

WRC Report No. 3051/1/22

SASTEP
South African Sanitation Technology Enterprise Programme

WATER RESEARCH COMMISSION

DESKTOP REVIEW OF POLICIES, REGULATIONS, STANDARDS AND BY-LAWS LOW-FLUSH / WATER EFFICIENT TOILETS

Review of Technology, Policy, Standards, Regulations and By-Laws

Report to the

South African Sanitation Technology Enterprise Programme (SASTEP)

by

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WATER GROUP HOLDINGS (Pty) Ltd.

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SASTEP
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EXECUTIVE SUMMARY

Introduction

Drought, climate change and dwindling water resources have become key drivers in the selection and application of sanitation technology in South Africa. The choice of technology is instrumental in establishing sustainable water use and water sensitive cities and settlements. The conveyance of human waste from homes and businesses through reticulation systems to wastewater treatment facilities requires large volumes of high-quality potable water, which makes up a significant portion of the water consumption profile of a municipality. The current toilet-use paradigm is water intensive and, in a water-stressed country like South Africa, high volume flush toilets pose a threat to water security and sustainable use of water resources. Low-flush water efficient toilets use low amounts of water for flushing which, if upscaled, would have a significant nett water saving on country scale. Apart from the water conservancy benefits, several economic benefits are offered linked to each component of the Toilet Value Chain.

Aim of Project

This project aims to review policies, regulations, standards and by-laws, and identify gaps that deter adoption of-, and make recommendations to facilitate the effective uptake and implementation of low-flush / water efficient toilet technology in South Africa. This study proposes a Policy Brief for the establishment of an enabling environment for uptake of the water efficient toilet technology.

Findings

Low-flush toilets are predominantly viewed to be part of sustainable water efficient toilet industry in SA that would contribute to protecting and conserving the scarce water resources of the country. However, a number of constraints, negative perceptions, lack of an organised approach, and poor access to credible information, all contributes to a limited uptake of the technology. This study identifies the underlying reasons rooted in policy, standards, by-laws and technology, and discuss each challenge in detail. Experts from the water and plumbing sectors contributed by offering their experience from leadership and coal-face positions. A is developed Toolbox that respond to the most pertinent challenges and gaps identified, coupled with learnings from international best practice where low-flush toilets are successfully implemented.

The Full Toilet Value Chain

In identifying the aspects that would enhance the uptake and adoption of low-flush / water efficient toilet technology, context is provided in terms of *full (holistic) system development* for new technologies. Such system thereby includes components that collectively and individually, work together to complete a full value chain to deliver quality low-flush toilets, in an enabled environment, to a satisfied customer base. The Toilet Value Chain is inclusive of aspects such as logistics, packaging, commercialisation, selling, manufacturing, scaling, market development, industry development, enterprise development, partnerships with vendors, end-user support and development of an active research and development system for sanitation technologies.

Stakeholders

Potential key participants in a water efficient toilet policy include:

- Policy and Regulatory chain;
    - National Government Departments: DWS, DTIC, DEFF; DPWI, COGTA
    - Government Bodies: JASWIC, SALGA, Agrément SA
    - Professional Bodies: IOPSA; PIRB
    - Standard and Regulatory Bodies: SABS, NCRS

- Research, Development and Innovation;
    - Academic: WRC, CSIR and Tertiary Institutions
    - Manufacturers R&D departments
    - International Programmes, WADER, SASTEP, SALGA Technology & Innovation
- Supply chain;
    - manufacturers
    - importers
    - wholesalers
    - retailers.

Toolbox

A Policy and Regulatory Toolbox was developed to provide practical guidelines to assist cross-functional organisations, including government, to have access to structured and relevant information that will enhance the adoption and uptake of low-flush / water efficient toilets. The Toolbox consist of the various tools, including:

1) Establish and reference Water Efficient Toilets as part of the Sanitation (Toilet) Value Chain;
2) Policy Toolbox;
    a. Standardise low-flush terminology for SA,
    b. Develop a rating system,
    c. Develop incentives aligned with the value chain,
    d. Introduce a grant and rebate funding programme,
    e. Development policy concepts in more detail.
3) By-laws Toolbox;
4) Model Standard Toolbox.

Recommendations

The following recommendations informed the Policy Brief:

- Standardise water efficient toilet terminology in the South African context
- Enact water efficient accommodations in the National Sanitation Policy (2016) regarding Appropriate Sanitation Technologies
- Develop a national policy on water efficient technologies
- Adopt and Develop a Water Efficiency Labelling and Standards (WELS) rating system for water efficient appliances and fixtures
- Identify potential Water Efficiency Labelling and Standards (WELS) system Regulator and its legislative home
- SANS 10400 amendments and extend with Part XB – Efficient water usage in buildings for water
- Ensuring synergy and alignment between the Dept of Human Settlements' Guidelines for Human Settlement Planning and Design, the various Municipal design requirements and the NBR and to ensure that the norms and standards for Housing meet those of the National Housing Regulations
- Legislation to allow the enactment of a Water Efficiency Labelling and Standards (WELS) rating system for water efficient appliances and fixtures
- Policy concepts relating to further technical research, required in relation to performance measurement and verification, sustainability and system robustness and O&M, training, national integration and research
- Policy concepts relating to further Consumer research, required in relation to consumer awareness, cost comparison and information to municipalities and consumers.

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ACRONYMS

Abbreviation	Description
ABCB	Australian Building Codes Board
ADM	Amatole District Municipality
ASME	American Society of Mechanical Engineers
AT	Appropriate Technology
CASCO	ISO's Committee on Conformity Assessment
CEMM	City of Ekurhuleni Metropolitan Municipality
CoCT	City of Cape Town
COGTA	Department of Cooperative Governance and Traditional Affairs
CoJ	City of Johannesburg
CSA	Canadian Standards Association
CSIR	Council for Scientific and Industrial Research
CTMM	City of Tshwane Metropolitan Municipality
DEFF	Department of Environment, Forestry and Fisheries
DKM	Dawid Kruiper Municipality
DLM	Drakenstein Local Municipality
DPWI	Department of Public Works and Infrastructure
DSA system	Direct Sanitation Application system
DST	Department of Science and Technology
du	Discharge Unit
DWS	Department of Water and Sanitation
EEA	European Environment Agency
EWS	eThekwini Municipality's Water and Sanitation Department
FSM	Faecal Sludge Management
GBCSA	Green Building Council of South Africa
GNR.509 - June 2001	Government Notice R. 509 : Water Services Act (108/1997): Regulations: Compulsory national standards and measures to conserve water. Published 8 June 2001
gpf	gallons per flush
GSAP	Global Sustainable Aid Project
HS system	Hungerford Schroeder system
IAPMO	International Association of Plumbing and Mechanical Officials
IAS	International Accreditation Service
imp gal	Imperial Gallon – Imperial gallon is about one-fifth or 20 per cent greater in volume than the American gallon
IOPSA	Institute of Plumbing of South Africa
ISO	International Organisation for Standardisation
IPAP	Industrial Policy Action Plan
JASWIC	Joint Acceptance Scheme for Water Services Installation Components
JGDM	Joe Gqabi District Municipality
ℓ	litre and litres
ℓ/m	litres per minute
ℓ/s	litres per second
LITRP	Low-Income Toilet Replacement Programme

ℓpf	litres per flush
LPMD	Litres per measurement per day
MaP	Maximum Performance
MDWASD	Miami-Dade Water Sewer Department
MLM	Moqhaka Local Municipality
MTSF	Medium Term Strategic Framework
NBR	National Building Regulation
NBR & BS Act	National Building Regulations and Building Standards Act, No 103 of 1977
NDP	National Development Plan
NHBRC	National Home Builders Registration Council
NMBM	Nelson Mandela Bay Metropolitan Municipality
NPP	Non-price policies
NRCS	National Regulator for Compulsory Specifications
NRF	National Research Foundation (of South Africa)
NSF	National Science Foundation
OECD	Organisation for Economic Co-operation and Development
Ø	diameter
PID	Partners in Development
PIRB	Plumbing Industry Registration Board
PLIFR	Pensioner and Low-Income Family Full Retrofit Programme
PP	Priced Policies
PRG	Pollution Research Group
R&D	Research and Development
RDI	National Water Research, Development and Innovation Roadmap
SABS	South African Bureau of Standards
SACPS	South African Product Certification Services Pty Ltd
SALGA	South African Local Government Association
SAMCO	Structural Assessment, Monitoring and Control
SANAS	South African National Accreditation Systems
SANS	South African National Standard
SASTEP	South African Sanitation Technology Demonstration Programme
SATAS	South African Technical Auditing Services (Pty) Ltd.
SDG	Sustainable Development Goals
SFWS	Strategic Framework for Water Services
SLIFR	Senior and low-income family full retrofit program
SME	Small to Medium Enterprise
SMME	Small Medium and Macro Enterprise
SPI	Service Provider Interface
T&E	Testing and Evaluation (facility)
TBC	Toilet Board Coalition
the DTI	The Department of Trade and Industry (pre June 2019)
the DTIC	Department of Trade, Industry, Trade and Competition (pre June 2019, known as dti)
UGU	Ugu District Municipality
ULF	Ultra-Low Flush
US gal	American gallon
VIP	Ventilated Improved Pit Latrines

VUNA	Valorisation of Urine Nutrients
WADER	Water Technologies Demonstration Programme
WADI	Water Distribution
WE&RF	Water Environment and Reuse Foundation
WEF	Water and Environmental Federation
WELS	Water Efficiency Labelling and Standards Scheme
WET	Water and Environmental Technology
WPC	Water Performance Certificates (part of Green Building Policy)
WRC	Water Research Commission
WRRF	Water Resources Research Foundation
WSD	Water Sensitive Design
WSI	Water Services Institutions
WSUD	Water Sensitive Urban Design
WWF	World-Wide Fund for Nature (World Wildlife Fund)
WWTW	Wastewater Treatment Works

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1 CHAPTER 1: BACKGROUND

1.1 Introduction

Drought, climate change and dwindling water resources have become key drivers in the selection and application of sanitation technology in South Africa. The choice of technology is instrumental in establishing sustainable water use and water sensitive cities and settlements. Not only are appropriate technologies an important tool in the water demand management toolbox to support the socio-economic well-being of the country, but also have a distinct advantage in delaying capital expenditure for larger supply systems that are required to meet the water demands of a high urban growth future (Water Research Commission, 2020).

The conveyance of human waste from homes and businesses through reticulation systems to wastewater treatment facilities requires large volumes of high-quality potable water, which makes up a significant portion of the water consumption profile of a municipality. The current toilet-use paradigm is water intensive and, in a water-stressed country like South Africa, high volume flush toilets pose a threat to water security and sustainable use of water resources. The reduction of flush water volumes, as well as the volumes required for reticulation, will assist in minimising water use and demand on municipal treatment capacity.

The WRC has championed various initiatives to drive reduced water use for sanitation, such as pour-flush and low-flush toilets. Anecdotal evidence indicates that such systems have a low adoption rate and offers various barriers for this low uptake. Reasons given include that the flush volume is inadequate to move the waste from the toilet to the back end or conveyance system, and that the human waste coats the conveyance piping which results in odours and blockages (Matier,P; Ross,A, 2011). These perceptions have stalled the realisation of the benefits that low-flush technology can provide.

Low-flush water efficient toilets are designed to use low amounts of water for flushing, which if upscaled, would have a significant nett water saving on country scale. Apart from the water conservancy benefits, low-flush systems offer economic benefits such as the local manufacture of the toilets, creating incentive and driving a demand for low-flush toilets in new building construction projects, as well as retrofitting existing toilets and thereby offering opportunities for installation by small contractors. The increase in demand for locally manufactured low-flush toilets holds potential to create employment across the value-chain and contribute to the Gross Domestic Product (GDP). National- and even regional standardisation can unlock further potential such as export markets, whilst a designated national sanitation regulator could accelerate procurement by government entities, whilst ensuring quality of product and service. The Industrial Policy Action Plan (IPAP 2018) highlights the importance of regional trade being key to growing the South African economy, whereby standards are central to market access. Similarly, South African Bureau of Standards (SABS) intends to use the ISO's Committee on Conformity Assessment (CASCO) Chairmanship to establish the regional conformity assessment platform (DTI, 2018).

The World Wildlife Fund (WWF) publication “Water Facts & Futures: Rethinking South Africa’s Water Future” illustrates a picture for South Africa in “Looking Ahead: Factors Contributing to Sanitation for All” which shows the linkage between technology, knowledge and scalable implementation in a water-scarce region (Colvin, et al., 2016):

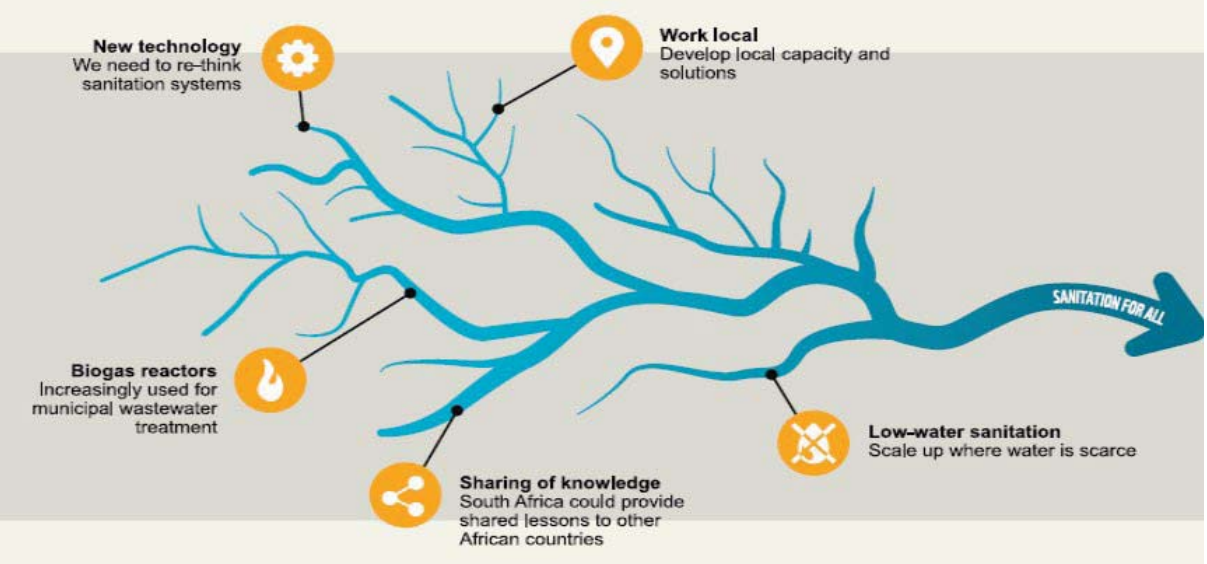

Figure 1: Factors contributing to sanitation for all (Colvin et al., 2016)

The WRC intends to unlock opportunities to enhance the uptake of water efficiency sanitation technology by creating a cross-organisational intervention, represented by relevant players in the sanitation value chain, coupled with research and knowledge in the fields of characterisation and specification of a low-flush toilet, and developing standardised protocol to ensure quality, flush volume assurance and user acceptance.

To this end, a deeper understanding of the enabling factors and hinderances in terms of policy, regulations and standards will enhance the positioning, adoption and uptake of low-flush water efficient toilets in the South African market space. Likewise, a deeper understanding of the existing products, their limitations, impact on existing systems and an outline of a testing and standardisation protocol will form a basis for driving the initiative.

1.2 Aim of Project

Two SASTEP studies are being undertaken as part of the WRC initiative, as parallel studies by two research groups:

1. The first study (a separate report by University of Kwa-Zulu Natal) investigates the technical scope of water efficient toilets and address the limitations and impact on existing systems and provide guidelines on changes that needs to occur in building practices so that existing buildings and systems can be retro-fitted and new builds can be optimised to accommodate this type of toilets. The study will also prescribe a standard protocol for testing the toilets;
2. The second study (this report by WaterGroup) aims to review policies, regulations, standards and by-laws, and identify gaps that deter the adoption and make recommendations to facilitate the effective uptake and implementation of low-flush / water efficient toilet technology in South Africa. This study will also propose a Policy Brief for the establishment of an enabling environment for uptake of the water efficient toilet technology.

In lieu of the above background, it is the aim of this project to:

- Establish a working group (Reference Group) whose function is to provide expert advice and guidance in the adoption and implementation of low-flush / water efficient toilet technology in South Africa;
- Carry out a systematic review South African policies, regulations and standards governing low-flush / water efficient toilets in relation to readily available comparative International information;

- Identify gaps in policies, regulations and standards that deter the adoption and uptake of low-flush / water efficient toilets, specifically in terms of the South African context;
- Make recommendations to allow for enabling South African policies, regulations and standards that encourage the adoption and uptake of low-flush / water efficient toilets;
- Comment on mitigation concepts and actions for any other aspects that may deter the recommendation from being adopted and implemented; and
- Make recommendations for incentives and rebates that could be utilised to enhance the uptake of the technology.

1.3 Methodology

The research approach comprises of seven concurrent phases:

- Phase 0: Identify and establish a working / reference group of specialists
- Phase 1: Inception report
- Phase 2: Literature review
    - Sub-Phase 2A: Technology review
    - Sub-Phase 2B: Policy review
    - Sub-Phase 2C: Standards & regulatory review
    - Sub-Phase 2D: Municipal by-law review
- Phase 3: Review workshop and sector consultation
- Phase 4: Develop a policy and regulatory toolbox
- Phase 5: Development of a Policy Brief
- Phase 6: Peer review
- Phase 7: Refine and issue final report.

These phases are unpacked in the sections following.

1.3.1 Phases 0&1: Working Group and Project Inception

Phases 0 and 1 consist of the establishing a working / reference group of specialists to ensure maximum synergies and consists of relevant representatives who can facilitate a cross-organisational intervention amongst relevant players in the sanitation value chain. The group consist of several subject experts who meet 2-3 times during the project period to offer guidance, peer review and sign-off of the quality of the report and toolbox.

The cross-organisation committee ideally need to include the following representation:

- Department of Water and Sanitation (to drive policy and regulation);
- South African Bureau of Standards (SABS) (to drive testing and certification);
- Department of Trade, Industry, Trade and Competition (the DTIC) (to drive designation and industrialisation policies to support local manufacturing and market access); and
- Various municipalities and water boards (to drive the development of by-laws and tender specification and give guidance on municipal procurement).

1.3.2 Phase 2: Literature Review and Gap Analysis

The aim of this review is to review available information that would confirm the current situation, as well as the strengths and gaps related to the environment that governs low-flush sanitation technology. Ultimately, this

information will inform a policy and regulatory toolbox that aim to enhance the adoption and uptake of low-flush / water efficient toilets. The review will cover the following categories:

- ✓ Technology;
- ✓ Policies;
- ✓ Standards and Regulations;
- ✓ By-laws;
- ✓ Model standard (comment on available specifications).

1.3.2.1 Technology Review

This section consists of a desk-top review of low-flush water efficient toilets and its role in water conservancy and drought management in order to:

- Identify and confirm the concept and definition of low-flush / water efficient technology;
- Outline applicable technologies available and in use;
- Identify potential- or critical short comings and gaps in available literature relating to specific technologies and its impact on water conservation and drought management; and
- Indicate further research opportunities.

1.3.2.2 Policy Review

A review will be conducted of existing national policy with regard to water conservancy as pertaining to water efficient toilets, by assessing the following:

- Current inclusion of water conservation, with specific reference to water efficient toilets in existing national policy;
- Identify critical gaps in policy relating to the conceptual / specific technologies;
- Identify incentives and rebates that could be utilised to enhance the uptake of the technology; and
- Engage with selected industry specialists towards drafting a sectorial perspective on the perceived and actual challenges and gaps that existing national policy as pertaining to water efficient toilets and its opportunities in the market space.

1.3.2.3 Standards & Regulatory Review

This activity comprises of a detailed review of local and international standards and regulations that govern low-flush / water efficient toilets, to include:

- International standards and regulations;
- South African standards and regulations;
- Identification of gaps in existing local standards and regulations and recommendations to resolve these gaps;
- The National Building Regulation (NBR) view on water conservancy and water efficient design at household level;
- Interviews with selected industry specialists to collate perspectives, challenges and gaps in the current NBR with regard to water conservancy and water efficient design at household level; and
- Recommendations on the inclusion of low-flush water efficient toilets in the NBR.

1.3.2.4 Municipal By-Law Review

This sub-phase consists of a review of municipal by-laws in terms of the manner in which by-laws typically comment, specify, guide, govern, regulate, monitor and/or instruct on the deployment and installation of low-flush / water efficient toilets within the municipal areas of jurisdiction. Information indicates that, other than eThekwini, City of Cape Town and Sekhukhune DM, few municipalities encourage and facilitate low-flush technology or water efficient toilets. The research will evaluate by-laws of a selection of District Municipalities, Metros and Local Municipalities in consideration of:

- Identify, review and comment on at least 6 municipalities whose by-laws include governance aspects relating to the installation and deployment of low-flush/water efficient toilets.

1.3.3 Phase 3: Review Phase Workshop and Sector Consultation

This section summarises the outcome of interviews and engagement with sector specialists in consideration of the following:

- Collate the core aspects that have been derived from the literature review;
- Draft a questionnaire to focus and prepare for interviews with sectoral experts;
- Consult the identified sector groups on the key findings from the literature review; and
- Incorporate the questionnaire feedback from the specialists in report format.

The following specialist groups are covered during this sector engagement process:

- Local government who are implementing low-flush systems;
- Local government who are not implementing low-flush systems;
- Academic and research institutions with know-how in this field;
- CSIR and DSI in terms of technology development and implementation;
- NHBRC in terms of the built environment aspects;
- National or provincial institutions responsible for low-flush systems funding and roll out; and
- National institutions mandated to in terms of technology development and implementation (JASWIC);
- SASTEP specialist.

The output of this phase is to discuss, test and collate the recommendations, gap analysis and elements of the literature review phase, in order to inform the conceptual content and format of the Toolbox.

1.3.4 Phase 4: Develop a Policy and Regulatory Toolbox

Phase 4 entails the development of a policy and regulatory toolbox that will enhance the adoption and uptake of low-flush / water efficient toilets, by targeting specific enablers in the following categories:

- ✓ Policies;
- ✓ Standards & Regulations;
- ✓ By-laws; and
- ✓ Model standard (comment on specifications).

The results of the Literature Review Phase, Gap Analysis, and Industry Expert Consultation phases are collated per listed category, in the section named, *Policy and Regulatory Toolbox*. The purpose of the toolbox is to provide practical guidelines to assist cross-functional organisations, including government, to have access to structured and relevant information that will enhance the adoption and uptake of low-flush / water efficient toilets.

1.3.5 Phase 5: Development of a Policy Brief

Following on Phase 4, this phase involves the development of a Policy Brief to support and promote a national policy for the adoption, support and promotion of low-flush / water efficient toilets. The Brief includes recommendations for potential incentives and rebates that would enhance uptake of the technology. This section will contain critical focus points, and is to be attached as a separate Appendix to this report.

1.3.6 Final Deliverable

This research study will produce a comprehensive report that reviews the technology, policy, standards and regulatory environment, coupled with the associated strengths, gaps and recommendations, as pertaining to the uptake of low-flush / water efficient toilet technology in South Africa.

2 CHAPTER 2: LITERATURE OVERVIEW

2.1 Technology Review

2.1.1 Defining low-flush / water efficient technology

There seems to be no clear accepted definition or standard terminology regarding the concept ''low-flush / water efficient toilets" in literature available on this subject. Instead, a number of different terminologies are used to refer to a similar concept, essentially being: '*a water efficient toilet that reduces water use, either through reduced flow or dual flow*'. In addition, there appears to be a differentiation between the concepts of flushing toilets and pour-flush toilets. Terminologies most widely used for flushing toilets range from standard flush toilet, low-flush toilet, low-flow toilet, ultra-low-flow toilet, high-efficiency toilet, micro- and super flush systems. The social understanding of the concept also plays a role, whereby flush toilets are viewed as the standard residential option linked to either a sewer system or an on-site system such as a septic tank.

It is important to confirm and standardise the definition and description of low-flush water efficient toilet technology if the sector holds any prospects to understand and implement the technology on a national scale.

The following descriptions are found in literature with specific reference to water efficient or low-flush toilets:

International Definitions and Descriptions:

According to the *American Society of Mechanical Engineers (ASME) and Canadian Standards Association (CSA)* definition of water efficient toilets as contained in the *International Association of Plumbing and Mechanical Officials (IAPMO) standards:*
A "water closet" is defined as a fixture with a water-containing receptor that receives liquid and solid body waste and on actuation conveys the waste through an exposed integral trap into a drainage system. A high-efficiency water closet (high-efficiency toilet) – is defined as one of the following (IAPMO Standards, 2018):

a) a single-flush water closet with an average water consumption of 4.8 litres per flush (ℓpf) or1.28 gpf or less when tested in accordance with this Standard; or
b) a dual-flush water closet with an effective flush volume defined as the composite, average flush volume of two reduced flushes and one full flush when tested in accordance with this Standard and ASME A112.19.14.

U.S. EPA's WaterSense program – high-efficiency toilets:
WaterSense toilets follow the water use standard of high-efficiency toilets (4.8 ℓpf) and also adhere to rigorous third-party verified performance standards. WaterSense labelled high-efficiency toilets to be able to flush a minimum of 350 grams of soybean paste and include a flush valve flapper or seal on the flush with a resistance to chlorine and hard water (JCSA, n.d.).

Europe and United Kingdom (pre-Brexit):
The European Commission adopted new ecological standards in 2013, which regulates toilets and urinals to reduce their environmental impact. The average toilet uses about 11 ℓpf or 2.9 gpf. The new guidelines are expected to suggest maximum urinal flush volumes of 1 ℓ and maximum toilet flush volumes of 3.5-5 ℓ. By way of comparison, the 1992 US Energy Policy Act set the American standard for toilet flush volume at just over 6 ℓ (Stephenson, PA, 2013).

EU Ecolabel certification further confirms that water efficiency toilets must comply with the following (EU Ecolabel, n.d.):

- The full flush volume shall not exceed 6 l/flush for flushing toilet equipment or 1 ℓpf for flushing urinal equipment.
- A water saving device should be added to either a toilet suite* or to the toilet flushing systems** where the full flush volume of >4,0 ℓ. When placed on the market, the reduced flush volume shall not exceed 3,0 ℓpf;
- On-demand flush control should be integrated into urinal suites and urinal flushing systems. Individual on-demand flush control for slab urinals with flushing systems should be integrated when there is less than 60 cm width of continuous wall;
- A sensor-based flush should ensure that the flush is delivered only after actual use of the product and should prevent false flush triggering;
- The average flush volume of flushing toilet equipment shall not exceed 3,5 ℓpf when placed on the market. Toilet suites that deliver a full flush volume of 4,0 ℓ or less are exempted; and
- Flushing system adjusting devises should be integrated so that the installer can adjust the flush volume to consider the local conditions of the drainage system. After adjustment, the full flush volume shall not exceed 6 ℓpf for toilets or 4 ℓpf if the toilet is not equipped with a water-saving devise, and 1 ℓ per flush for urinals.

Toilet suite = cistern & pan designed to flush a specific volume
***Flushing system = the equipment that flushes, irrespective of the actual cistern & pan design size, e.g.*

Australia introduced the Water Efficiency Labelling and Standards (WELS) scheme in 2005 to compare the water efficiency of a range of appliances and fixtures. WELS-regulated products include washing machines, dishwashers, showers, toilet suites, urinals, taps and flow controllers. The products are tested for water consumption and given a rating of up to 6 stars. Similar to the energy rating labels, the increase in stars indicate the increase in water efficiency. The rating label is displayed on the product. In the case of toilets, the water rating label shows how much water is used in an average flush, half-flush and full-flush. The "WELS lavatory product search" can be used by consumers to compare the efficiency and flush volume of different toilets before buying (DISER, 2020).

Figure 2: Examples of the Water Efficiency Labelling and Standards (WELS) labels (BUILD, n.d.) (otctiles, 2017)

The WELS scheme for toilets (lavatories) requires a basic level of water efficiency, being that an average flush can't exceed 5.5 ℓ per average flush. An average flush is calculated for one full flush and four half-flushes for each toilet (BUILD, n.d.).

***General*:**

Low-flush toilet is also known as low-flow toilet or high-efficiency toilet, as is generally defined as a flush toilet that uses significantly less water than a full-flush toilet. Low-flush toilets use 4.8 ℓ (1.3 US gal; 1.1 imp gal) or less per flush, as opposed to 6 ℓ (1.6 US gal; 1.3 imp gal) or more. Low-flush systems came into use in the United States in the 1990s, in response to water conservation concerns, and typically include single-flush models and dual-flush toilets, which uses 6 ℓ for full flush and 4.8 ℓ for a reduced flush. There is some disagreement on the terminology of low-flush, as it displays an US bias, whereas the term high-efficiency toilet is more commonly used in EU and UK. Other water reduction practices include the placing of a brick or water bottle into the existing high flush toilet's tank or through modifications of the water system to use greywater for flushing (Wikipedia, 2020) (Wikipedia contributors, 2020).

Sustainable Sanitation, Water Management (SSWM):

A low-flush or low-flow toilet is a flush toilet that is adapted in order to use significantly less water than a full-flush toilet. The exact amount of water varies between less <1 ℓ (for urine only) up to 6 or 8 ℓ. Low-flush toilets use a special design of the cistern and the siphon in order to allow the removal of faeces and excreta with less water. These systems mostly include a dual-flush system, with one flush designed for urine only, using even less water than the other designed for faeces. Today, the market is filled with many suppliers that offer different models of low-flush toilets on a global scale, operating by gravity or vacuum. Although low-flush toilets reduce the water consumption, a large amount of fresh water is still required. With certain models, users have to flush twice or more in order to achieve the complete removal of faeces from the bowl (Stauffer, 2020).

Micro-flush technology toilets:

A number of toilets falls within the micro-flush technology ambit, although it seems to be subjective in terms of the exact range that would qualify under this technology type. Some literature refers to this category as being an 'off-grid' option, whereas others refer to it in terms of the quantity of water use. Examples of these differing refences include:

- The Arumloo micro-flush toilet uses between 1 to 2,5 ℓpf, using a dual-flush mechanism (Pillay, S, 2016);
- Global Sustainable Aid Project (GSAP) microflush toilets are more in line with pour-flush compost option toilets, offering an off-grid toilet that low volumes of greywater from a previous user's hand wash to isolate waste and flush waste directly into a filter-digester, where the solids and liquids are separated (GSAP, n.d.);
- EcoVac Toilet is a urine diverting vacuum WC with a double flush function using 100 ml per small front flush (urine) and 600 ml per main flush. The EcoVac vacuum toilet requires electricity and uses advanced technology suitable for the commercial market such as hotels, restaurants and public buildings; and
- EcoFlush Toilet is a urine diverting classic WC with a dual-flush option. The small flush releases 300 ml into the front part of the bowl (urinal section), and the large flush releases 2,5 ℓ into the entire bowl.

South African Definitions and Descriptions:

South African literature covers the following descriptions relating to low-flush toilets.

SANS 1733:2011:
A low-flushing capacity system is a WC flushing system that is designed to operate on flushing capacities of ≤6 ℓ. The system comprises of all the components necessary to ensure the effective and efficient operation of the system on low-flushing capacities.

SASTEP:
Water efficient toilets minimise the amount of water used to convey the waste collected in the bowl to the back-end treatment, collection or conveyance system (Akinsete, 2020):

- Traditional toilets use between 10-15 ℓpf;
- Modern toilets use 6-8 ℓpf;
- High efficiency toilets operate at 2-3 ℓpf;
- Vacuum technology can be used to achieve 0.5-1.0 ℓpf.

PID – Low-Flush Toilet (Upgraded Pour-flush) & Eaziflush™ (Envirosan):
In developing a low-flush latrine for application in public schools, Partners in Development (PID) identified that pour-flush and low-flush sanitation systems bridge the gap between on-site dry sanitation and full waterborne sanitation sustainably (Still, et al., 2013). Using a small amount of tap water or grey water (1-2.5 ℓ) to flush, a pour system can terminate in a simple soak away. This overcomes problems involved with constructing sewers between widely spaced rural homes or tightly spaced informal settlements, represents a large water saving compared to regular waterborne sewage – a loss which is compounded if hardware begins to leak. The pour-flush toilets were converted to low-flush by providing a 1-3 ℓ flush cistern. Currently, this style of toilet is being marketed by Envirosan under the trademark Eaziflush™. The Eaziflush™ is a toilet used to convert Ventilated Improved Pit (VIP) and urine diversion toilets to a flush system. The toilet can connect to an existing piped sewer network or operate as a pour-flush or low-flush toilet in areas with no piped water available.

In South Africa, and as confirmed by several municipal by-laws, cisterns with flushing capacity of 9 ℓ or larger are the standard flush toilet installation (at time of this research). In order to remove uncertainty and ambiguity, it is recommended that low-flush terminology is standardised as follows:

Low-flush toilet (also termed low-flow toilet, water efficiency toilet or water closet):
Defined as flushing system that is designed to operate on flushing capacities of 6 ℓ or less, through either one of the following:

- *a single-flush water closet with an average water consumption of 6* ℓpf *(1.6 gpf) or less when tested in accordance with the Standard; or*
- *a dual-flush water closet with an effective flush volume defined as the composite, average flush volume of two reduced flushes and one full flush.*

Ultra-low-flush toilet (also termed a super flush, high-efficiency toilet or water closet):
Defined as flushing system that is designed to operate on flushing capacities of 4.8 ℓ or less, through either one of the following:

- *a single-flush water closet with an average water consumption of 4.8* ℓpf *(1.28 gpf) or less when tested in accordance with the Standard; or*

- *a dual-flush water closet with an effective flush volume defined as the composite, average flush volume of two reduced flushes and one full flush.*

Microflush toilets:

Microflush toilets are defined as a flushing system, as well as a urine diverting flushing system, that is designed to operate on flushing capacities of 3 ℓ or less of either grey/rain/river/potable water, through either one of the following:

- *a single-main flush water closet with an average water consumption of 3 ℓ*pf *(0.8 gpf) or less when tested in accordance with the Standard; or*
- *a dual-flush water closet with an effective flush volume defined as the composite, average flush volume of two reduced flushes and one full flush, may also include a urine diversion option with a flush volume of 1 ℓ or less.*

It is recommended that a similar rating system as the Australian WELS system for water efficient appliances, which includes toilets, is adopted in South Africa. This makes provision for a labelling system which can provide consumer guidance on three critical aspects, being:

- Star Rating – overall water efficiency of product;
- Rate of consumption (for toilets it's the flush volume); and
- Registration and product details.

The efficacy of the water efficient system is not always based on the volume of flush alone, but also by other sustainability factors. It is deemed necessary to undertake comparative testing on various aspects that potentially impact on the efficiency of the toilet functions as a whole. The star rating thus could include tests for aspects such as:

- endurance of inlet and outlet cistern valves;
- leakage;
- effective flushing of surfaces;
- flushing performance (water closet and urinal flush devices);
- water-tightness (water closet and urinal flush devices);
- performance in discharging material at full and reduced flush;
- physical distortion;
- splashing; and
- water consumption.

In addition, it will provide clarity on:

- Rate of consumption, being the flush volumes (e.g. ℓ per half-flush and ℓ per full-flush) as well as the average flush volume when tested against the accepted SANS standard; and
- Registration and product details which include the company that registered the product, the licence number and the standards that guide how products are tested.

2.1.2 International application of low-flush technologies

Internationally, there are a number of different types of toilets available. [Refer to *Appendix 1* for images of these different types of toilets]. The toilet types can be broadly classified as (Mani,V, 2019a):

- European or Western Water Closet (EWC) – Types of water closet toilets classified according to trap design (S Trap types & P Trap), or visibility of the trap way (Concealed trap way type or Visible Trap way). Standardly available as either a Two-piece Toilet or One-piece toilet (close coupled);

- WC Health – A unique design by Güral Vit, a Turkish sanitaryware manufacturing company. The WC is designed by combining water closet comfort and squatting pan health benefit;
- Squatting Pan – Most commonly used in Asian countries, although the Indian, Chinese & Japanese squatting pans have substantial differences in design. Other names include Indian pan, Orissa pan and also Asian pan toilet. There is various types available ranging from the standard, sleek, with footrest and without a footrest;
- Anglo-Indian – A combination of squatting pan Indian and Western water closet style toilets, allowing for squatting or sitting, depending on preference. This toilet is also called as a combination toilet and universal toilet. A smaller squatting option for children under 12 is also available and known as the Kid's toilet;
- Elderly toilet – Designed for older people to sit and rise easily (same level as chairs). The pedestal height of the toilet is higher than the normal water closet. The height of the elderly toilet is around 70 cm height piece making sitting and standing effortless;
- Smart Toilet – An advanced toilet using built-in smart technology, or technology capable of interacting and connecting with the user. These toilets are often found in smart homes around the world and in high-tech regions such as Japan. Smart toilets sense how much water is needed and flush using just the right amount. The smaller flushes can use as little as 2.2 ℓpf and options available include:
    - Massaging bidet wash
    - Air dryer
    - Heated seating
    - Foot warmer
    - Automatic flush
    - Remote control
    - Self-cleaning features
    - Built-in sensors that alert the user to possible tank leaks
    - Self-deodoriser
    - Emergency flushing system during power outages
    - Nightlight
    - Slow closing lid
    - Bluetooth and MP3 capabilities for the user to listen to tunes.
- Squatty Potty toilet – This is not particularly a type of toilet, but merely a method of using the toilet. To circumvent some of the health problem that arise when using a European water closet, a ceramic stand is kept where one' leg is normally placed alongside a water closet. In this manner the angle of sitting will be nearly equal to squatting, thereby reducing the health problems;
- Rimless Toilet – A simple toilet structure without a traditional rim. Instead of water flowing into the bowl all the way round the rim, a direct flush technique shoots water around the edge of a smooth pan. As there is no rim, rimless toilets are easy to clean and more hygienic than a traditional toilet;
- Tornado Toilet – Features two powerful nozzles that create a centrifugal, cyclonic rinsing action which reduces waste build-up and keeps the bowl cleaner. By only using only 4.8 ℓpf, this high-efficiency system is more effective in one flush than most toilets are with multiple flushes.

In the US and international market, a number of technologies have recently emerged as high-efficiency toilet designs (JCSA, n.d.) (Mani,V, 2019b). The focus is mainly on the flushing aspects of the different toilet designs (not waterless or pour-flush toilets). Some of the flush type options available are:

- Dual-flush is a gravity-flush toilet that saves water by offering different flush volumes – a full-flush for solids; and a half-flush for liquids;
- Pressure-assist toilets have a sealed compartment inside the tank that contains air and becomes pressurised when water from the supply line fills the compartment. When the flush button is pressed, pressurised air exerts force on the water in the compartment and water shoots into the bowl. The pressure-assist fixture creates a fast flush, but is considered a noisier flush than standard gravity-flush

toilets. Of note, is the use of <3.8 ℓpf (1 gpf). Negative reviews have been posted on this technology relating to exploding tanks leading to product recalls and further improvements (Mani,V, 2019b);

- Single-flush gravity, also known as gravity-flush toilet, operates by the force of gravity on the water and has no mechanical assistance;
- A flushometer is a metal water-diverter that uses an in-line handle to commercial toilets or urinals (flush tankless), offered as a product of the Sloan Valve Company. It uses water from a flushometer valve to convey the waste through a trap seal into a gravity drainage system. This component is not applicable to standard residential use as residential water supply lines are not equipped to deliver this level of volume and pressure simultaneously;
- Siphonic water efficient toilet includes a siphonic toilet trap way that is almost twice as long as the regular toilet. The traps are available in different flushing capacities, being a 4 ℓpf and 3 ℓpf. These systems are available as one-piece or two-piece models and have little noise compared to vacuum- or pressure assist flushing;
- The No Water Tank Toilet gives the impression to have no tank, however, it does have a very small tank attached. The toilet flush is 2 ℓpf (0.528 gpf) and does not require electricity or battery assistance, only a direct tap water connection;
- Spiral Flush or Tornado flush uses centrifugal force for better flushing (circular motion in bowl) providing a 360 degrees cleaning, which is not always achieved in other toilets. This makes this toilet cleaner in the bowl area every time it is being flushed. These toilets include the siphonic principle as part of its design which enables a better flushing action. Although numerous companies produce this type of toilet, the Toto Cyclone and Duravit Tornado are considered the better-known models; and
- Recycled water toilet does not display a particular mechanism and uses grey water for flushing. Usually, a washbasin is attached to the top of the toilet similar to a tank lid, or the separate washbasin's outlet is linked to the tank and fills during handwashing events.

2.1.3 Application of low-flush technologies in South Africa

The South African market has a number of water efficient toilets systems, components and options available to reduce the amount of water used for each flush, typically by 1-2 ℓ. These include the low-flush or dual-flush version (e.g. 6 ℓ: 3 ℓ dual flush cisterns), hold-flush toilet system (fits a variable flushing device to the existing higher flush toilets); or high flush cisterns which are installed with a water displacement device ('Save-a-Flush').

In addition, there are several ultra-low-flush to micro-flush technologies available in the commercial market for use in standard residential buildings. These are often marketed as micro-flush toilets and include:

- *Calcamite low-flush systems: Upgraded low-flush ventilated improved lined pit (VILP):*
    - Developed by Calcamite in 1994 (Agrément certification achieved), the toilet has a purpose-made pan of vitreous china as well as a 1 ℓ flush cistern manufactured from polyethylene. A 9 ℓ top up tank is mounted above a 0.6 ℓ tank. When the flushing mechanism is released, the lower tank is refilled from the reserve tank. The top up tank can be filled manually or connected to a water-mains. This was initially marketed and tested in Gauteng and Eastern Cape, but discontinued due to lack of interest (PID, 2012);
- *Hungerford Schroeder (HS) system:*
    - The HS system has a 13 ℓ cistern which dispenses 1 ℓ of water around the edge of the pan when flushed. The HS system was installed in various communities around Kwa-Zulu Natal. In some cases, the digester was modified, and a number of different soak pit designs were used. There were some operational and quality assurance issues (breaking tipping tray, leaking cisterns, etc.), as well as blocked pipes and full or overflowing soak pits which caused

discomfort to householders. Lack of locally available spare parts were also problematic (PID, 2012). Being a pit-based system there are the potential problems of geological incompatibility and pit maintenance;

- *Direct Sanitation Application (DSA) system:*
    - Developed in 2006, the DSA system consists of 36 ℓ reserve water tank is installed on the outside wall of the toilet which can then be filled from the closest water source. The tank supplies the cistern inside which holds 9 ℓ, allowing 45 flushes before the system must be refilled. A pull knob dispenses 1 ℓ of water from the cistern around the pan. Contents are washed down a 110 mm long radius bend pipe out of the house into a liquefier tank. Reported problems related to damage to outside tank, the cistern and pipe blockages (PID, 2012);
- *The Arumloo micro-flush toilet:*
    - Funded by the WRC, this toilet flushes on 1-2,5 ℓpf, using a dual-flush mechanism. A flush is achieved using an innovative pan design that creates a vortex to remove stools more efficiently and a gush of water ('gush flush') that enters into the P-trap. The elongated P-Trap with an inverted egg shape profile enables effective conveyance of waste at low water volumes and the convex shape toilet pan promotes an accelerating vortex action for effective clearing of waste. The prototype has been tested with synthetic stools made from soya paste and newspaper and toilet paper, and has passed the international Maximum Performance (MaP) tests for toilets (Pillay, S, 2016);

Figure 3: Arumloo water savings (IBP, 2020)

- *GSAP Microflush toilets: (align with pour-flush option):*
    - This microflush toilet is marketed as an off-grid, sustainable, eco-friendly, low cost, odour-free private toilet that reuses a small volume greywater from a previous user's hand wash to isolate waste and flush. In the GASP Microflush toilet, a user's flush of waste directly falls into a filter-digester where the solids and liquids are rapidly separated. The solids are composted aerobically and enhanced by earthworms (e-fetida). The filtrate is processed naturally in a soakaway, with no need for sludge removal or processing. The rear cover is removed every two to harvest an organically rich compost for reuse in agriculture. GSAP claims to have created a unique and financially sustainable distribution system to support small businesses and job creation (GSAP, n.d.);

- *EcoVac Toilet:*
    - EcoVac is a urine diverting vacuum WC with a double flush function using 100 mℓ per small front flush (urine) and 600 mℓ per main flush. The vacuum toilet uses advanced technology suitable for the commercial market such as hotels, restaurants and public buildings. Since the sewage pipes are empty and the transport takes place with air, low water consumption is possible. The EcoVac is controlled by a control box, mounted next to the electrical distribution board in the house, which sets the amount of water being used, adjusts vacuum time and pause time. This technology is marketed to septic tank owners, people living on islands and other remote areas, or where water needs to be used sparingly (Wostman Ecology AB, 2019);

Figure 4: Wostman EcoVac system

- *EcoFlush Toilet (urine diverting classic WC):*
    - The EcoFlush toilet has a unique dual-flush option, however the small flush releases 300 mℓ into the front part of the bowl (urinal section), and the large flush release 2,5 ℓ into the entire bowl. The volume of the big flush can be set to use more water if necessary. The toilet is designed with sewer pipelines laid into the floor to optimise water consumption and make use of the Syphon effect to empty the bowl. In toilets installations which have sewage pipes in the wall, a plumber need to be consulted (SWSP, 2018).

Figure 5: Eco-Flush toilet (SWSP, 2019)

- *Eaziflush™ (Envirosan)*
    - The Eaziflush™ uses 2 ℓ of water per flush. It forms part of the upgradable pedestals from VIP to UD to flushing. This implies that existing VIP and UD applications can be converted to full flush without having to install a new pedestal. It can also be used as a pour-flush unit when piped water is not available to the residence. The unit can be connected into any back-end system ranging from leach pit to sewer networks. The toilet system has achieved an Agrément certificate. The certificate covers the use of Eaziflush Ceramic and Polymer Pedestals components in water- and non-waterborne, for off-grid, formal and informal applications in all regions of South Africa – for internal and external use. The toilet system components must be installed in accordance with the certificate holder's installation brochure, and comply with the terms and conditions for certification.

Figure 6: Eaziflush™ (Envirosan)

A number of new ultra-low-flow technologies have been piloted in several municipalities, of which only one is a low-flush option (SPIH, 2019):

- *Toilets;*
    - Pour-flush (low-flush on-site waterborne) – PID and EWS/PRG;
    - Earth Auger (dry sanitation, composting)
    - Andy Loo (incinerating)
    - LUSEC (composting)
    - Eco-Loo (dry sanitation, composting).
- *On-site septic tanks and waste treatment;*
    - Bubbler – septic tank
    - Flush Tech – on-site waste treatment
    - Smart San (self-contained waterborne wastewater treatment).

The PID low-flush latrine is typically applied in public schools but can be installed as a residential upgrade to a VIP latrine, a pour-flush toilet or to replace a standard flush toilet linked to a septic tank. The system can be installed indoors, thereby providing greater convenience, social acceptability, and greater safety to household members, but it can also be installed in an existing VIP structure outside space if limited in the house. It is a practical option in rural areas or low-density settlements where sewer networks are costly. An alternative to collecting sludge in a soak pit, is by connecting the system to a small-bore sewer which removes effluent to a digester or small treatment plant. The system has performed well on a small-scale in both residential and institutional contexts (Still, et al., 2013).

This technology is considered ready for piloting on a larger scale in both residential and institutional contexts. The particular advantages of the low-flush system would make it an appropriate option in the following contexts:

- Rural or urban schools;
- Community or public ablution blocks;
- Other institutional contexts;
- Homes where householders are seeking an upgrade to an on-site flush system; and
- Communities where existing sanitation systems have failed or been rejected.

It is essential that wherever low-flush systems are installed, pedestals and other parts are made available to local hardware shops and plumbers to ensure that systems can be repaired over time (Still, et al., 2013).

An aspect that needs to be considered when investigating low-flush options for a specific area or consumer, is that of the current 6 kℓ Free Basic Water (FBW) policy and the confusion (perceptions) that there is not enough water available to flush the toilets. As shown by the pour-flush option, there are viable and socially acceptable indoor and outdoor flush options available that use little water or grey water, which could be supplemented with rain harvesting options. These toilets can be linked directly to the sewer system by connecting the system to a small-bore sewer connected to a digester, or small treatment plant, or through existing on-site collection systems.

Toilet technologies can be operationalised through installation as part of new developments or by retrofitting less efficient systems with more efficient components. In doing so, the design and capacity of the downstream sewer system needs to be considered in terms of the lower flow that will be discharged. As with any technology option, literature indicates advantages and disadvantages to using low-flush and ultra-low-flush toilets, summarised in the table hereunder.

Table 2-1: Advantages and disadvantages of low-flush and ultra-low-flush toilets

Toilet Type	Advantages	Disadvantages
Low-flush (single flush gravity)	• Reduce water consumption (max consumption is 6 ℓ) • No reports of waste transport problems due to low-flow toilets, providing that adequate gradients and modern pipe sewer system (PVC) are maintained Standard toilets can be cost effectively retrofitted with water efficiency devices (hold flush or displacement bag) to function at ≤6 ℓ)	• Need to confirm outlet pipe direction fit to the model selected (through wall or vertical) • May require more than one flush at times (not the norm) • Retrofitting could result in the possible interference of the flushing mechanism resulting in possible water wastage
Low-flush (dual flush gravity)	• Reduce water consumption (max consumption is 6:3 ℓ). • No evidence of waste transport problems due to low-flow toilets, providing that adequate gradients and modern pipe sewer system (PVC) are maintained	• Need to confirm outlet pipe direction fit to the model selected (through wall or vertical) • May require more than one flush at times (not norm)
Pressure-assist type	• Reduce water consumption (max consumption is 3.7 ℓ)	• Noise • Reports of exploding due to over pressurised parts
Vacuum Water Saving Toilets (installed in commercial malls, public toilets, etc.)	• Reduce water consumption – single flush is less than 0.5 ℓ	• Installation cost is high because of the required equipment for the vacuum suction • Noise during flushing of the waste (suction of the waste during vacuum process) • Electricity power source required, costly and potential problem during load shedding
Ultra-low-flow toilets	• Reduce water consumption and • costs to the consumer (in some instances)	• Some models may require flushing more than once to adequately clean the toilet bowl • Some, like Eco Flush, limited design application – not designed for walled sewer pipes and will require additional plumbing solutions
Ultra-low-flow toilets	• Contribute to preserving the environment by protecting ground water from depletion and possible contamination • Easy to use and clean	• Risk of clogging/plugging if the sewer system is not steep enough • Requires a constant source of water to function
Eaziflush™ Toilet (SuSanA, 2012)	• Unlike a pit latrine, it can be built onto a house • Minimal flush volume (liter or two for flushing) • Cheaper to build than a full flush toilet with septic tank and soak pit • Flushed manually & can use grey water	• Care must be taken to ensure that groundwater is not impacted • Pour-flush pit is not designed to dispose of general household sullage (greywater, principally wash water). If sullage is disposed of through the pour-flush toilet, or by a separate pipe into

Toilet Type	Advantages	Disadvantages
	• Users cannot use the pit as a receptacle for domestic waste (unless they access the pit separately) • A pour-flush pit can be emptied using a vacuum tanker, due to being less dense and dry than standard pit latrines.	the pour-flush pit, it will not operate correctly.

It is recommended that before a waterborne consumer or developer utilises low-flush technology, the local authority confirm whether the sewer system can accommodate low-flow technologies in a specific drainage area. Likewise, the internal sewer system needs to accommodate the lower flow in terms of adequate gradients, pipe material, and sizing.

2.1.4 The impact of low-flush toilet technology on water conservancy and drought management

Literature highlights that water- and cost savings achievable in domestic water usage by commercial and industrial facilities are often overlooked. It is generally accepted that water efficiency measures should begin with the highest water use operations such as cooling, cleaning, rinsing, heating, etc., thereby disregarding the easy improvements that can be made in domestic devices such as toilets, urinals, sink faucets, and showers. This is specifically relevant to industries, commercial and office undertakings that have large on-site personnel numbers or guest numbers. A WRC study found that that water efficient devices are becoming more common in commercial and institutional settings (Still, et al., 2008). Case studies include the City of Cape Town's programme to replace all the automatic flushing urinals in public buildings and install Hippo Bag displacement devices in all the old large capacity school toilet cisterns, as well as the sophisticated infrared operated taps and urinals that are becoming standard at airports. Likewise, it was noted that larger hotel groups are signing onto environmental programmes, of which one component is sustainable water use. Encouraging examples are presented where universities and public buildings are being retrofitted with water saving cisterns, taps and showers.

Commercial buildings and hotels reportedly exert the greatest negative footprint on the environment. It is estimated that an average hotel releases between 160 kg and 200 kg CO_2 per m^2 room floor area per year and the water consumption per guest per night is between 170-440 ℓ in an average five-star hotel (Mbasera, 2016). In arid Middle East countries, water is seen as a luxury and water restrictions are practiced all year-long. Most hotels have sensors on their taps and all toilets have half-flush buttons, while most hotel rooms have water saving showerheads. It is thus reasonable to argue that South Africa, being a water-scare country, consider instituting water restrictions all year-long, even if it only pertains to specific activities (WaterOnline, 2017).

The hospitality industry, specifically hotels, is known for its commercial and moral imperative to address water use. The commercial imperative is that water accounts for around 10% of utility bills in hotels, with many hotels paying twice for the water they consume – first by purchasing fresh water and then by disposing the resultant wastewater. The UK's Environment Agency commented that water efficient hotels can reduce water consumption per guest per night by up to 50%, compared with establishments with poor performance in water consumption. Likewise, an IHG property (Holiday Inn in Australia) experienced substantial savings by implementing low-flow technology and was able to recoup its investment in low-flow technology after 18 months and cut water usage by 50% (Tuppen, 2013). These savings were achieved through comprehensive low-flow technology installations and not just by replacing toilets alone. The effectiveness of installing low-flow technology is further supported by the article, "Hospitality sector doing its share for water conservation", where

Tsogo Sun Hotels in Cape Town reduced their water usage by almost 300 000 ℓ/day over 6 months (WaterAfrica, 2017).

Although water efficient plumbing devices, which include low-flush toilets, are readily available from major plumbing suppliers in South Africa, suppliers do not push the concept of water efficiency and the consumer is still wary of the efficacy of low-flush toilets (Still, et al., 2008). Likewise, the building profession also shows a hesitancy to utilise these technologies, unless the client indicates clear preference for water efficiency or sustainable water use. This hesitancy appears to be linked to:

- lack of exposure to such devices and SANS accreditation;
- lack of incentivisation, normally brought on by municipal building regulations (contained in planning regulations and by-laws), supported by National Building Regulations and Red Book requirements (for designing with a focus on sustainable water use by utilising water efficient technologies).

Consumers appears to be hesitant in the uptake of these low-flush technologies due to social and financial factors such as (Still, et al., 2008):

- lack of familiarity with water efficient devices/technologies;
- lack of home ownership (i.e. they are renting);
- financial challenges either in terms of affordability or recouping the investment;
- reluctance to make any changes, due to disinterest, not understanding the need or urgency, or lack of change management; and
- lack of effective incentives.

Older toilet models use between 13-26 ℓpf, although some literature reports around 10-11 ℓpf. Based on the larger use number, a family of four people can save up to 80 000 ℓ of water a year with a 6 ℓpf toilet, and even more with a high efficiency model, which constitutes a 20% reduction in household consumption (Danielsson, 2019). This concept is supported by the U.S. Environmental Protection Agency's (EPA) WaterSense program, which confirms that water-efficient toilets use at least 20% less water than the current US federal standard of 1.6 gpf (JCSA, n.d.).

Analyses of residential cost-saving in USA (Miami-Dade County) have proven that the adoption of multiple water efficiency appliances contributed to the highest annual monetary savings (i.e. high water-savings and moderate product costs). Future conservation planning should thus take both water savings and product cost into account to maximise the benefits. Miami-Dade County have multiple water conservation programmes, such as the senior and low-income family full retrofit program (SLIFR), high efficiency showerhead (SH) exchange program, high efficiency toilet (HET), and high efficiency cloth washer (HEW) rebate programs. The participants in the REBATE programs (i.e. SH, HET, HEW) were required to purchase eligible high efficiency appliances approved by the US EPA WaterSense program and submitted their receipts to MDWASD for rebate redemption. The study focused mainly on the senior and low-income family full retrofit program (SLIFR). The analysis focussed on high efficiency toilets with a low-flow rate of 4.8 ℓpf (lower than a conventional toilet with 13.2 ℓpf). The study also commented that among all proposed efficiency type water intensive appliances, toilets had the highest potential in water saving (109.8 LPMD estimated and 131.4 LPMD observed). The fractions of residential water use affected by implementation of toilet, showerhead and aerator are 20.2%, 16.3% and 7.0%, respectively. These values were calculated using the potential observed water savings divided by the average household consumption from 2006 to 2009 (650.2 ℓ/household). It was concluded that the implementation of high efficiency toilets would be an effective method to reach the water conservation goals (Lee, et al., 2013).

Similar studies in Europe and the UK have shown that toilet flushing accounts for about 25-30% of total domestic water use. The European Environment Agency Report "Towards efficient use of water resources in Europe" (EEA, 2012) estimates that 20% of water abstraction across Europe supplies public water systems (accepting that significant variation exists between countries). Public water includes the supply to households, small businesses, hotels, offices, hospitals, schools, and some industries. Technological developments and measures can be applied to address leakage in public water supply systems and reduce water demand. These include water-saving devices; greywater re-use and rainwater harvesting; behavioural change through awareness-raising; metering; and leakage reduction in distribution and supply networks.

Regarding water-saving devices and products in toilets, the report highlights some key facts:

- Savings of 30 ℓ/day per property day can be achieved by using dual flush and low-flush toilets;
- Cistern replacement devices (e.g. 'hippos') are a simple and cheap means of reducing flush volumes, typically by about 1 ℓpf and are particularly useful in older toilets with large cistern volumes; and
- Water can also be conserved with a delayed action inlet valve, which prevents the cistern refilling during the flush. Without such a valve, the water released is greater than the cistern's capacity, potentially by 17%, as cited by in a UK Environment Agency report (EEA, 2012).

In South Africa, a number of water efficient options have indicated their water saving potential. Examples of some of these are discussed below.

The ultra-flow EcoFlush style toilet is available in South Africa, but was developed in Sweden for remote areas without municipal sewers or water infrastructure. In these areas, potable water is scarce and most home-owners have toilets connected to septic tanks which need to be emptied regularly, which is expensive and cumbersome. Hence, the toilet was developed to work more efficiently and use less water, thereby also saving on the additional expense and discomfort by reducing the regularity of septic tank emptying. The local suppliers of the ultra-flow EcoFlush style toilet identified the following usage patterns and potential savings (SWSP, 2018).

Table 2-2: Usage patterns and potential savings associated with the ultra-flow EcoFlush toilet (SWSP, 2018)

Toilet Type	**Litres used per day to flush 5 times after urinating (**ℓ/day)	**Litres used per day for flushing once after emptying bowels** (ℓ/day)	**Total litres of water used per day** (ℓ/day)
Conventional toilet (10 ℓ/flush)	50	10	60
Eco Flush (0,3 and 2,5 (ℓ/flush)	1,5	2,5	4
Cape Town Water Restrictions 6B recommendation for flushing	10 (1 flush allowed per day)	10	10

Above data implies that a family of 4, who each uses the toilet 6 times a day, saves 81 782 ℓ/annum compared to a conventional toilet (4 x 4 x 365 = 5 840 ℓ/a vs 4 x 60 x 365 = 87 600 ℓ/a) (SWSP, 2018).

JG Africa identified an example of saving and payback period for the Hold-flush toilet concept, which is a Do-It-Yourself (DIY) concept of converting a standard toilet to a hold-flush (multi-flush or interruptible flush) system that flushes for as long as the handle is held down. This can be achieved by adding a stainless-steel spring or lead fishing cup sinkers (counter-weight), etc. Hold-flush systems can result in savings of up to 20% on a water bill. With the Hold-flush toilet retrofits in the example below, a household can save 68% of the toilet flushing volumes and costs, with a simplified payback period of 1 month and annual saving of R1 392 (Biggs,B, 2017).

Table 2-3: Cost and saving for hold-flush installation (Biggs, B, 2017) (JG AFRIKA (Biggs, B), 2017)

Device description	Flush type	Flow volumes	Flushes per day per capita	Water usage (kℓ/yr)	Water cost (R/yr)	Payback (yrs)
Standard cistern (existing)	solids	12	1.5	26	R 619	
	liquids	12	3.5	61	R 1 443	
Total			**5**	**88**	**R 2 062**	
Hold-flush system (efficient)	solids	6	1.5	13	R 309	**0.07**
	liquids	3	3.5	15	R 361	
Total			**5**	**28**	**R 670**	
Saving				**59 (68%)**	**R 1 392**	

Note: Water efficient toilets and technology is one of a number of water efficient actions and technologies that can be applied at residential-, commercial- and industrial sites, as well as public- and institutional levels, that will assist with water conservation. Literature also points out its significant potential for initial water saving within a household's water use and as such, impact on the water demand for the area. This concept is well recognised by South African municipalities, although not necessarily well enacted.

It is recommended that documentation be developed that provides guidelines to consumers about the various options of retro-fitting their facilities with water efficient concepts or fittings. Likewise, such a guideline would include for a range of options ranging from relatively cost-effective DIY options (e.g. hold-flush) to smart toilets, thereby allowing South African consumers to apply water efficiencies within their homes and offices in a manner that suits their pocket and inclination, but that results in effective reduction on the overall water demand and costs.

2.1.5 Critical gaps and strengths in literature relating to water efficient technologies

Technical Research

In South Africa, the upscaling of low-water sanitation options (specifically in water scarce areas) is critical for sustainability. Social franchising partnerships for the maintenance of infrastructure have been identified by the Council for Scientific and Industrial Research (CSIR) and the WRC as a mechanism that could alleviate and address challenges in the management of water services (Colvin, et al., 2016).

A CSIR study indicated that limited research is available on residential water-use attitudes and household behaviour (Jacobs-Mata, et al., 2018). The study was undertaken with a focus on attitudes of households to their water consumption in search for ways in which domestic demand for water in South Africa's urban areas could be measurably reduced.

Several local reports confirmed the success of low-flush systems. However, some contradictory reports, mostly anecdotal from the municipal sector, are found on low-flush and ultra-flush technology's problems related to:

- Inefficacy of the flush volume to adequately move the waste from the toilet to the back end or conveyance system (with one flush);
- Coating of the conveyance piping with human waste resulting in odours; and
- Blockage of sewer pipes.

In a case in San Francisco in 2011, low-flows resulted in sludge build-up in sewer lines near AT&T Park and surrounds, specifically in dry summer months (Matier,P; Ross,A, 2011). In this case, the sewer system had been designed based on a larger percentage of water, and the resulting backups caused undesirable odours across

the city (Pipe Spy Inc., 2020). Likewise in 2009, Germany reported low-flow sewer problems related to their water conservation programmes. Germany had achieved an overall reduction in consumption of 16% since the 1990s, with the average daily consumer use at 123 ℓ /cap/day. Due to low flows in the sewer, which had been designed for higher flows, stagnation in sections of the network was occurring. This in turn resulted in higher disinfection requirements, which posed a greater negative ecological impact. Changing engineering designs for the network (e.g. narrower pipes) would be most feasible for new development areas (DW.Com , 2009).

A further cause of negative perspectives is that the first-generation low-flow toilets (mid-1990s), mainly used in the USA, lacked the necessary pressure to clear the internal trap and drain, meaning that blockages often develop (The Spruce (Weaver, 2020)). This was resolved through the U.S. EPS's WaterSense program that render it easy for consumers to identify high-efficiency toilets in the marketplace. Toilets that are certified by independent, third-party testing to meet EPA's rigorous criteria for both efficiency and performance, earn the WaterSense label (EPA WaterSense, 2017). Likewise, older pipelines such as cast-iron, are lesser inclined to deal with the reduced flow, due to friction problems, when compared to newer PVC pipes that are often located at better slopes (Graham,S, 2011) (AHS, 2020).

A further cause for blockages appears to be more linked to consumer habits of abusing the sewer disposal system with non-sanitary products (cd, guns, non-toilet paper material, rags, etc.), than the actual technology itself. There is limited research available on design requirements and its link to downstream sewer management and treatment processing under conditions of low-flow of high solids/materials wastewater.

In developing new low-flush toilet guidelines, it is recommended that these downstream aspects are investigated, specifically in terms of the South African situation as it relates to older sewers and excessive or undesirable "toilet paper" usage. It is likely that challenges may point to consumer education, awareness, and social responsibility, than just correction of design error.

Consumer based comparatives and information sharing:

International best practice and consumer forums dictate the publishing of comparative guides or purchase guidelines on the various toilets available in the market. Most of the testing is consumer-based or based on research websites, consulting experts and personal real-world experiences to narrow down superior toilet products. Although these guidelines cannot claim scientific testing methods, they provide the consumer with a start to understanding the market diversity and consumer demand potential. The products tested would appear to be those readily available in the market and who have met required standards approval relevant to the country.

Examples of these web-based consumer guides are:

- *Thoroughly Reviewed's Best Toilet* (ThoroughlyReviewed; Lytle,S, 2020) – this review considers 34 products and reviewed 15 of them, including comparative concepts such as:
    - Identifying the Best Overall (#cat1)
    - Identifying the Best Water Saving (#cat2)
    - Identifying the Best Flushing (#cat3)
    - Comparison(#comparison) – Providing a comparison table showing top 10 products against 14 criteria, including flush volume, flush type, flush technology, bowl type, style and warranty
    - Buying Guide(#guide) – including aspects such as identifying water savings / high efficiency types, flush options through to electrical requirements;

- *Architizer Editors' How to Choose the Ultimate Water-Saving Toilet* – A guide to choose high-efficiency toilets that "help save the Earth, gallon by gallon" (Architizer Editors, n.d.). This blog is mainly geared to architects, manufacturers and consultants;
- *TheToiletZone's 9 Different Types of Toilet Flush Systems* (Tank Fill Valve, Flapper-Flush Valve, etc.): The web article discusses several toilet flushing systems, their function and application as well as providing examples of some of the toilet flushing systems currently available in the market (TheToiletZone, n.d.);
- *Ceramic Ninja Web page*: Sanitaryware Technical Article – 12 Types of Toilets: Different types of Toilet – covers ten types of toilets available around the world (Mani,V, 2019a). The article listed types of toilets according to the shape and function of the toilets, including European or Western Water Closets, also known as WC/EWC and Squatting Pan, but also looked at water efficient toilets;
- *Ceramic Ninja Web page*: Sanitaryware Technical Article – Water Efficient Toilets: Claim to save up to 90% water. The article focusses on the different type of water saving toilets and how this toilet works better compared to traditional toilets (Mani,V, 2019b); and
- *Home Worthy List's Best Low-flow Water-Saving Toilets Review* (updated 2020) – The article is a Best Low-Flow Toilet Review dealing with aspects such as Top Low-Flush, Water-Saving, Energy Efficient Picks (HomeWorthyList; Stevens, L, 2020).

The above web site guides are found in the international marketplace and more particularly, the American market. South Africa does not appear to have similar, easily accessible consumer guides and information sites pertaining to local products.

By comparing the international best practice with that of South Africa, the following recommendations are made to address some of the shortcomings identified from the literature, that would assist in the uptake of low-flush technologies:

- South Africa will benefit from a nationally sponsored public education campaign regarding water efficient devices;
- Information on water efficient devices must be easily obtainable;
- South Africa needs a labelling system for water efficient devices;
- Municipal by-laws must include provisions relating to water efficiency and water conservation, and ideally there should be convergence across municipalities;
- Building codes and by-laws must converge;
- Informative billing;
- Financial incentive to consumers that adopt water efficient devices; although many municipalities mention the concept, there appear to be no practical information of actual rebates in practice;
- Consumer forums should be encouraged and actively encouraged to liaise with Standards testing outcomes, manufactures and building policy and regulations developers;
- Case studies and lesson learnt on successes and impact on the use of low-flush type toilet systems.

The launch (Oct 2020) of the "WRC/SALGA Technology & Innovation Forum" focus on 7 integrated technology and innovation platforms, as indicated below (Moraka, 2020):

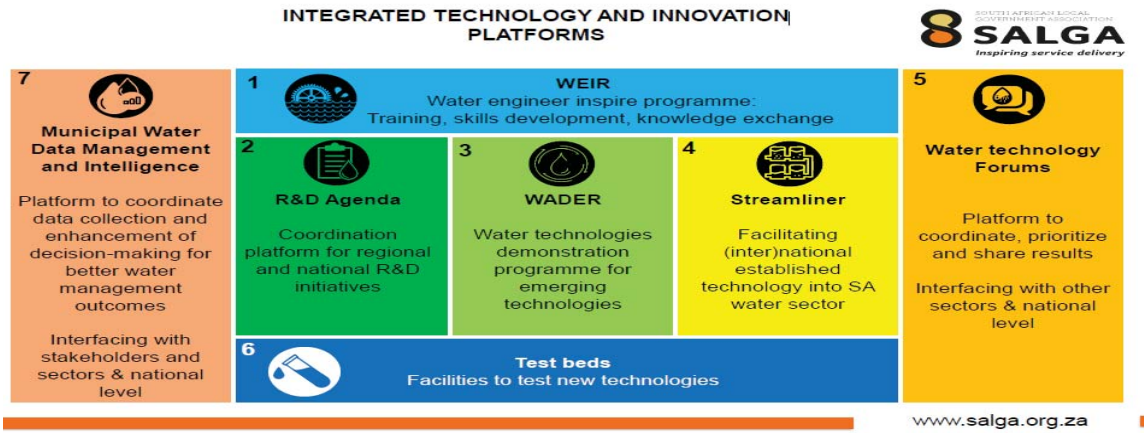

Figure 7: WRC/SALGA Tech & Innovation Forum's 7 integrated technology and innovation platforms (Moraka, 2020)

These platforms could be the ideal vehicles to facilitate and address some of the shortcomings identified in this study, in promoting the uptake of low-flush technologies. This is specifically relevant in terms of the commitment of SALGA to ensure political collaboration with Departments of Human Settlements, Water and Sanitation- and Cooperative Governance and Traditional Affairs, and National Treasury. The launch further identified that SALGA will approach National Treasury to explore an innovative procurement dispensation in implementing the 7 platforms and integrate their approach in alignment with the District Development Model (Moraka, 2020). Specific platforms envisaged to facilitate uptake of low-flush technologies are:

- Platform 2 – R&D Agenda – Coordination platform for regional and national R&D initiatives
- Platform3 – WADER – Water technologies demonstration programme for emerging technologies
- Platform 4 – Streamliner – Facilitating (inter)national established technology into SA water sector
- Platform 5 – Water technology Forums – Platform to coordinate, prioritise and share results Interfacing with other sectors & national level
- Platform 6 **–** Test beds – Facilities to test new technologies.

2.2 Policy Review

2.2.1 Overview of the policy environment of South Africa

South Africa has as obligation to meet the international Sustainable Development Goals (SDG) and in terms of sanitation, specifically *Goal 6: Ensure access to water and sanitation for all by 2030*. In terms of water efficient toilets, there are specific aims within the Goal 6 that translate to water efficiency and by default, to water efficient toilets. These are:

- substantially increasing water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity;
- expanding international cooperation and capacity-building support to developing countries in water- and sanitation related activities and programmes, including water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies;
- supporting and strengthening the participation of local communities in improving water and sanitation management.

Likewise, South Africa has created an enabling environment for sanitation innovation and economy through policy and legislative framework. Provision of sanitation services is guided by the following legislation and policy:

- *The Constitution of the Republic of South Africa, 108 of 1996:*
    - everyone has the right to an environment that is not harmful to their health or well-being; and to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that:
        - promotes conservation; and
        - secures ecologically sustainable development and use of natural resources while promoting justifiable economic and social development.

- *National Water Act, 36 of 1998:*
    - Provides for the protection, development, conservation, usage, management and control of water resources in a manner that supports justifiable and ecologically sustainable economic and social development.

- *Water Services Act, 108 of 1997* (DWS, 1997):
    - Sect 2a – the right of access to basic water supply and the right to basic sanitation necessary to secure sufficient water and an environment not harmful to human health or well-being;
    - Sect 2b – the setting of national standards and norms and standards for tariffs in respect of water services;
    - Sect 2j – the promotion of effective water resource management and conservation;
    - Sect 4.2.c.(vi) – Water Services Providers (WSP) to provide for measures to promote water conservation and demand management;
    - Sect 10.2.d – norms and standards may provide for tariffs to be used to promote or achieve water conservation; and
    - Sect 34.1.i – Water Boards to take reasonable measures to promote water conservation and water demand management, including promoting public awareness.

- *National Sanitation Policy (2016)* (DWS, 2016)
    - SA has made a major policy shift through the development of National Sanitation Policy which was developed through the review of the White Paper on Basic Household Sanitation (2001), adopting many of the strategic policy positions outlined by the Strategic Framework for Water Services (SFWS) of 2003, endorsing the national sanitation targets, as outlined in the National Development Plan (NDP) and Medium-Term Strategic Framework (MTSF) and by giving effect to the SDGs of 2015;
    - It encourages new thinking around sanitation management, new innovation, more appropriate ways of treating human waste/effluent, and use of sanitation as a resource;
    - Recognises the economic value of sanitation;
    - It provides policy positions on the entire sanitation value chain;
    - Defines Appropriate Technology (AT) as the sustainable application or operation of a technology (process, tool and/ or device) to meet national imperatives within the local institutional, financial, social, cultural, ethical, economic and environmental requirements and constraints experienced by the authority or consumer responsible for the technology;
    - Provides for Appropriate Sanitation Technologies, including aspects such as;
        - Criteria for appropriate sanitation technology will be developed,

        - Encouraging human settlement appropriate sanitation technologies which minimise natural resource use and negative impacts,
        - Limited water resource availability should inform appropriate technology selection.
        - Implementation of alternative, appropriate technology will be within social, environmental and economic constraints,
        - Formalise a process for certification and accreditation of appropriate sanitation technologies,
        - The Minister will, in concurrence with National Treasury, provide incentives to encourage utilisation of resource efficient sanitation infrastructure in human settlement areas.

- *Green Building Policy (2011)* (DPW, 2013)*:*
    - This Policy by the Department of Public Works (DPW) aims to provide leadership in sustainable building sector; efficient energy, water and waste management, indoor environmental quality and comfort, sustainable product and materials management, etc.;
    - It comments on the concept of Water Performance Certificates (WPCs) (not yet available in SA), which focusses on water efficiency, benchmarking water usage performance and establishing a register of information on water-usage of buildings to support policy development by government and to support retrofitting programmes by building owners and operators;
    - It comments that the Green Building Council of South Africa (GBCSA) has introduced a Water and Energy Benchmarking Tool which provides a comparison of buildings water usage to measured benchmarks.

In terms of sanitation-related plans, the following make provision for inclusion of water efficient technologies:

- *National Development Plan (NDP) 2030: Our future – make it work* (NPC, 2014)*:*
    - NDP has set a target that all South Africans should have full, affordable and reliable access to sufficient water and sanitation by 2030;
    - A dedicated national water-conservation and demand-management programme, with clear national and local targets for 2017 and 2022, and subprogrammes focused on municipalities, industry and agriculture;
    - Emphasis on the construction of houses and buildings that are more energy and water efficient.

- *National Water and Sanitation Master Plan* (DWS, 2018)*:*
    - South Africa will need to reduce water demand, as well as increase supply for a growing population and economy;
    - As a target, average domestic consumption must be reduced to 175 litres/person/day by 2025;
    - Further actions linked to reducing demand are addressed in the section on regulation, including a focus on water use efficiency, the quality of water and sanitation fittings (to ensure low-flow, robust fittings which prevent premature leakages), and the potential for rainwater harvesting in low-income areas;
    - Targets an average reduction in water demand of 15% below baseline levels in urban areas by 2030 (baseline is taken as year 2012);
    - Use of technologies that minimises use of water resources, encourages recycling and reuse;
    - South Africa must adopt water-less sanitation technology where appropriate;

- Include water use efficiency and water loss reduction targets in the KPIs of municipal managers and municipal water supply and sanitation managers, and in municipal implementation plans;
- Establish Water Efficiency Labelling and Standards (WELS) Scheme.

- *Industrial Policy Action Plan (IPAP)* (DTI, 2018)*:*
  - Promotes new standard development by NMISA, SABS for water efficiency in buildings. This standard aims to increase the efficient use of water in buildings, thereby reducing total potable water demand in South Africa. Its introduction will also support building regulations to ensure water efficiency in new constructions;
  - The Industrial Water Efficiency Project aims to support South African industry to transform water use patterns in a bid to improve efficiency of water management by industrial companies;
  - Promotes development of off-grid sanitation technologies to lower water requirements for sanitation.

- *National Sanitation Integrated Plan* (DWS & WRC, 2019)*:*
  - A 10-year road map, practical actions per province and settlement types, uptake of sanitation innovation and Industrialisation, faecal sludge management for beneficial use;
  - Proposes change in the current binary sanitation engineering paradigm through the introduction and the use of innovative and technological advances that brings about benefits at every step of the sanitation value chain. The disruption of the paradigm is not solely technological, it requires a change in the ecosystem of sanitation service provision which includes policy and regulatory enablers for alternate options, community involvement and education, skills transfer and development, and stimulation of localised commercialisation and industrialisation of the sanitation hardware;
  - Comments on "Appropriate Solutions" to match with sustainable sanitation which is related to 3-interconnected factors;
    - Technology (toilet type, constraints under which it can operate), e.g. WRC pour-flush and low-flush,
    - Management (planning, budgeting, financial and human resources), and
    - People-centred consideration (user preferences, behaviour, health & hygiene, community participation).

National Faecal Sludge Management Strategy (DWS: Sanitation Macro Planning, 2020)*:*
  - To encourage innovation in sanitation technologies and smart new concepts for the preparedness for the climate change effects ensuring resilient sanitation services in human settlements;
  - To ensure stakeholder participation in regulation, monitoring and evaluation of the performance of Faecal Sludge Management (FSM) systems in municipalities;
  - The strategy will support the initiatives by other institutions like DST, WRC and CSIR in technological uptake and new concepts in sanitation services. Technology will not be considered in isolation, there are planning and management aspects that need to be taken into consideration when selecting appropriate technologies in sanitation services chain;
  - Regulations must be in place to guide FSM systems. These regulations need to be enforced throughout the sanitation service chain, ensuring that management concerns are incorporated in the technological options. For an example, the use of locally designed technologies to facilitate operation and local repairs to fast-track breakdown resolutions.

In addition to national policy and plans, the following National Regulations and institutions/bodies relating to Norms and Standards pertaining to water efficient technologies, are noting:

- *Compulsory National Standards and Measures to Conserve Water (GNR.509 – June 2001):*

  Regulation 2 states the minimum standard for basic sanitation services and that toilets should, amongst other criteria, be safe, reliable, environmentally sound, easy to keep clean, provides privacy and protection against the weather, is well ventilated, keeps smells to a minimum and prevents the entry of flies and other disease-carrying pest (Colvin, et al., 2016). The regulation specifies that every consumer installation must comply with SABS 0252: Water Supply and Drainage for Buildings (DWS, 2001);

- *Department of Science and Technology (DST)* (SPIH, 2019)*:*

  DST (currently known as Department of Science and Innovation – DSI) defines its role from the approved National Sanitation Policy which has challenged the sector to become innovative in light of limited water resources. DST is mandated to facilitate sanitation technology innovations at a level of initial introduction and testing and supporting interested municipalities in acquiring funding to deploy the new technologies. Current municipal financing does not typically provide for expenditure on research and development using grant finance. DST is thereby in process to create two funds – the Innovation Risk Fund and Technology Innovation Fund. These will be utilised to fund pilot projects for new technologies within the public sector. An important condition by DST is that regulation of new technologies must be in line with existing regulatory frameworks and institutions. The establishment of Agrément Board is meant to close the gap related to certification of construction technology systems. Likewise, when introducing a new technology, DST considers the full system development, e.g. logistics, packaging, commercialisation, selling, manufacturing, scaling, market development, industry development, enterprise development, partnerships with vendors, end-user support and development of an active research and development system for sanitation technologies. The introduction of new technologies must therefore, trigger a full-scale re-engineering of existing value chains and develop platforms for continuous innovation involving research institutions. DST is also of the opinion that various institutions, such as National Home Builders Registration Council, Plumbing regulatory bodies, Department of Human Settlement, Water and Sanitation, etc. must come on board in the roll-out of new technologies.

- *Joint Acceptance Scheme for Water Services Installation Components* (JASWIC, 2008) (JASWIC, 2017)*:*

  JASWIC, initially formed by Water Engineers of the major municipalities, was created under the Water Services Act (108 of 1997), its mission is to promote the use of acceptable components in water and sanitation installations in the interest of water conservation, health, safety and the prevention of water pollution, to the mutual benefit of consumers, suppliers, water service authorities and water service providers and the promotion of efficiency in service delivery by co-operation and the exchange of information. Its membership represents:

  - Water Service Providers (mainly Metros)
    - Tshwane (Pretoria), Ekurhuleni (East Joburg), Joburg Water, eThekwini (Durban), Buffalo City (East London), Nelson Mandela (Port Elizabeth) and Cape Town;
  - Associations and Government Bodies
    - South African Bureau of Standards (SABS)
    - Water Research Commission (WRC)
    - Institute of Plumbing of South Africa (IOPSA);

The committee primarily has as focus:

- to establish and maintain the acceptance list based on product compliance to the relevant SABS specification (now referred to as the South African National Standards – SANS), and where there were no current SABS/SANS standards, compliance would be to an interim JASWIC "requirement" specification;
- to create and maintain these JASWIC "R" requirement specifications from drafts submitted by applicants along with other supporting and similar national or international standards as reference guides to the committee;
- to advise the SABS technical- and sub-committees of shortcomings in current standards, and on the development of the interim JASWIC "R" standards into full SANS standards in terms of the Standards Act, 2008 (Act No. 29 of 2008);
- to serve as a forum to discuss other matters that impact upon product and installation standards.

Part of JASWIC's objectives are to assist in the setting and maintaining of national standards for water supply and sanitation that prevent wastage of water and that facilitate the efficient use of water. The concept of assisting in highlighting policy development requirements and the setting and maintaining of national standards for low-flush toilet thus falls within JASWIC's domain.

- *Agrément South Africa (ASA)* (SPIH, 2019)*:*
  ASA's is a South African public entity under the Department of Public Works and Infrastructure (DPWI), taking the form of a Technical Assessment Agency. Agrément certification establishes fitness-for-purpose of innovative and non-standard building systems/techniques for the erection of buildings of any height and occupancy classification, as well as of construction products that are not fully covered by the NBR standard specifications or codes of practice of the SABS.

  Based at the Built Environment Division of the CSIR, the Agency draws on the necessary expertise within the CSIR, SABS, and universities or elsewhere as is appropriate when preparing evaluation programmes, draft certificates for approval, etc.

  Agrément certification is normally required by local municipalities and approval authorities, as well as financial institutions and specifiers, as a pre-requisite for using innovative techniques. The National Home Builders Registration Council (NHBRC) also requires Agrément certification of innovative building systems.

  Subjects evaluated for Agrément certification are required to satisfy technical requirements and meet relevant performance criteria. In the case of building systems, the certificate indicates which of the South African NBRs are deemed to be satisfied, thereby facilitating acceptance and approval by building control authorities. A description of the system or product and any special limitations or conditions is also given.

2.2.2 Inclusion, gaps and challenges of water efficient toilets in national policy

South African policy, as it relates to the principles of water use and conservation is extensive. However, specific reference to water efficiency measures and technologies is limited, in particular to technologies such as water efficient toilets. The table following provides a summary of some of the national policy inclusion, gaps and challenges as relating to low-flush / water efficient technologies.

Table 2-4: A summary of National Policy inclusion, gaps and challenges relating to water efficient toilets

Legislative or Policy Reference	Applicable sections referencing water conservation initiatives	Challenges or gaps in policy
The Constitution of the Republic of South Africa, 108 of 1996	• Sect 24 provides for the right of all people in South Africa to an environment that is not harmful to their health and well-being	No specific focus to water conservation Not relevant at this level
National Water Act, 36 of 1998	• Provides for the protection, development, conservation, usage, management and control of water resources	No specific refence to water efficient water services Not relevant at this level
Water Services Act, 108 of 1997	• Allows for the promotion of effective water resource management and conservation • WSP must provide for measures to promote water conservation and demand management • The norms and standards may provide for tariffs to be used to promote or achieve water conservation • Water Boards to taking reasonable measures to promote water conservation and water demand management, including promoting public awareness of these matters	No specific refence to water efficient water services, but de facto included under water conservation concept.
National Sanitation Policy (2016)	Provides for Appropriate Sanitation Technologies, including aspects such as: • To develop criteria for appropriate sanitation technology • Encouraging Human settlement appropriate sanitation technologies which minimise natural resource use and negative impacts • Limited water resource availability should inform appropriate technology selection • Implementation of alternative, appropriate technology ito social, environmental and economic constraints • Establish formal process for certification and accreditation of appropriate sanitation technologies. • The Minister will, in concurrence with National Treasury, provide incentives to encourage utilisation of resource efficient sanitation infrastructure in human settlement areas	No obvious gaps or challenges as: Water efficient technology included in AT; Certification provided for; and Potential created for rebates covered in the resource efficient incentives
National Development Plan 2030, Our future – make it work	• NDP has set a target that all South Africans should have full, affordable and reliable access to sufficient water and sanitation by 2030 • A dedicated national water-conservation and demand-management programme, with clear national and local targets for 2017 and 2022, and subprogrammes focused on municipalities, industry and agriculture • More emphasis on the construction of houses and buildings that are more energy and water efficient	No obvious gaps or challenges as mention is made of water efficient buildings and water conservation sub-programmes in municipalities
National Water and Sanitation Master Plan	• South Africa will need to reduce water demand, as well as increase supply for a growing population and economy. • As a target, average domestic consumption must be reduced to 175 litres/person/day by 2025 • Further actions linked to reducing demand are addressed in the section on regulation. This must include a focus on water use efficiency, the quality of water and sanitation fittings (to ensure that they are low-flow fittings and that they are robust and do	No obvious gaps or challenges as mention is made of need for water use efficiency and water loss reduction targets at municipal level and water conservation including establishing a Water

Legislative or Policy Reference	Applicable sections referencing water conservation initiatives	Challenges or gaps in policy
	not result in premature leakages), and the potential for rainwater harvesting in low income areas • The National Development Plan targets an average reduction in water demand of 15% below baseline levels in urban areas by 2030, where the baseline is taken as year 2012 • Use of technologies that minimises use of water resources, encourages recycling and reuse • South Africa must adopt water-less sanitation technology where appropriate • Include water use efficiency and water loss reduction targets in the KPIs of municipal managers and municipal water supply and sanitation managers, and in municipal implementation plans • Establish WELS Scheme	Efficiency Labelling and Standards (WELS) Scheme
Industrial Policy Action Plan (IPAP)	• Promotes new standard development by NMISA, SABS for water efficiency in buildings. This standard aims to increase the efficient use of water in buildings, thereby reducing total potable water demand in South Africa. Its introduction will also support building regulations to ensure water efficiency in new constructions • The Industrial Water Efficiency Project aims to support South African industry to transform water use patterns in a bid to improve efficiency of water management by industrial companies • Promotes development of off-grid sanitation technologies to lower water requirements for sanitation.	No obvious gaps or challenges Need to ensure low-flush will be included in new water efficient building standard
National Sanitation Integrated Plan	• 10-year road map, practical actions per province and settlement types, uptake of sanitation innovation and Industrialisation, faecal sludge management for beneficial use • Proposes change in the current binary sanitation engineering paradigm through the introduction and the use of innovative and technological advances that brings about benefits at every step of the sanitation value chain. • The disruption of the paradigm in not solely technological; it requires a change in the ecosystem of sanitation service provision which includes policy and regulatory enablers for alternate options, community involvement and education, skills transfer and development, and stimulation of localised commercialisation and industrialisation of the sanitation hardware. • Comments on “Appropriate Solutions” to match with sustainable sanitation which is related to 3-interconnected factors: o Technology (toilet type, constraints under which it can operate), e.g. WRC pour- low-flush o Management (planning, budgeting, financial and human resources); o People-centred consideration (user preferences, behaviour, health & hygiene, community participation).	No obvious gaps or challenges Potential to comment more in-depth on water efficient technologies at an urban residential, commercial and institutional level.

Legislative or Policy Reference	Applicable sections referencing water conservation initiatives	Challenges or gaps in policy
National Faecal Sludge Management Strategy	• Encourages innovation in sanitation technologies and smart new concepts for the preparedness for the climate change effects ensuring resilient sanitation services in human settlements • Requires stakeholder participation in regulation, monitoring and evaluation of the performance of FSM systems in municipalities • The strategy supports initiatives by institutions like DST, WRC and CSIR in technological uptake and new concepts in sanitation services. Technology will not be considered in isolation, planning and management aspects to be taken into consideration when selecting appropriate technologies in sanitation services chain • Confirms need for regulations to guide FSM system. These regulations need to be enforced throughout the sanitation service chain, ensuring that management concerns are incorporated in the technological options. For an example, the use of locally designed technologies to facilitate operation and local repairs to fast track breakdown resolutions.	No obvious gaps or challenges as Water efficient technology is covered under encouraging innovation

Despite the extensive inclusion of water conservation and identifying the need to water efficiencies in various policy documents, there may be a need to extend these to specific sectors or to be more explicit in their recommendations and guidelines. For example, literature indicates that further policies and guidelines on green management need to be put in place for the hotel sector and those that have been formulated need to be implemented in order to meet the tourist demand for more environmentally-friendly accommodation (Mbasera, 2016).

2.2.3 Provision for incentives and rebates

EU and Britain:

EU and Britain use Economic Policy Instruments (EPIs) to effect behavioural changes. EPIS are incentives designed and implemented with the aim of adapting individual decisions to collectively agreed goals, such as:

- pricing incentives are usually introduced via tariffs, charges or fees, taxes or subsidies;
- trading schemes relies on the exchange of rights or entitlements for abstracting or using ··water, or polluting the water environment;
- cooperation, voluntary adoption of new practices leads to reduced pressure on the water environment – e.g. payment motivated (subsidies) for environmental services or voluntary agreements (self-motivated); and
- risk management schemes.

EPIs may significantly improve an existing policy framework by incentivising, rather than commanding, behavioural changes that may lead to environmental quality improvements. Additional or ancillary benefits of EPIs include, but are not limited to (Delacámara, et al., 2013):

- creating a permanent incentive for technological innovation;
- stimulating the efficient allocation of water resources;
- raising revenues to maintain and upgrade the provision of water services; and

- promoting water use efficiency.

Table 2-5: The main characteristics of the four main types of EPIs relevant to water management. (Delacámara, et al., 2013)

Instrument		Definition	What can EPI deliver for water policy?
Pricing	*Tariffs*	Price to be paid for a given quantity of water or sanitation service, either by households, irrigators, retailers, industries, or other users.	Encouraging technological improvements or changes in behaviour leading to a reduction in water consumption or in the discharge of pollutants. In addition, they generate revenues for water services or infrastructures.
	Taxes	Compulsory payment to the fiscal authority for a behaviour that leads to the degradation of the water environment.	Encouraging alternative behaviour to the one targeted by the tax, for example the use of less-polluting techniques and products.
	Charges (fees)	Compulsory payment to the competent body (environmental or water services regulator) for a service directly or indirectly associated with the degradation of the water environment.	Discouraging the use of a service. For example, using charges in a licensing scheme may discourage users to apply for a permit.
	Subsidies on products	Payments from government bodies to producers with the objective of influencing their levels of production, their prices or other factors.	Leading to a reduction in the price of more water-friendly products, resulting in a competitive advantage with comparable products.
	Subsidies on practices	Payments from government bodies to producers to encourage the adoption of specific production processes.	Leading to the adoption of production methods that limit negative impacts, or produce positive impacts, on the water environment.
Trading	*Trading of permits for using water*	The exchange of rights or entitlements to consume, abstract and discharge water.	Encouraging the adoption of more water efficient technologies. May improve the allocation of water amongst water users.
	Trading of permits for polluting water	The exchange of rights or entitlements to pollute the water environment through the discharge of pollutants or wastewater.	Encouraging the adoption of less water polluting technologies. Improve the allocation of abatement costs amongst water users.
Cooperation		Negotiated voluntary arrangement between parties to adopt agreed practices often linked to subsidies or offset schemes.	Encouraging the adoption of more water-friendly practices.
Risk mgt. schemes	*Insurance*	Payment of a premium in order to be protected in the event of a loss.	Water users' aversion to risk and willingness to pay for income stabilisation. When proper designed, insurance premiums signal risk and discourage behaviours that increase risk or exposure.
	Liability	Offsetting schemes where liability for environmental degradation leads to payments of compensation for environmental damage.	Liability as a means to incentivise long-term investments in water efficient devices.

Notably, the EPIs provide the opportunity for improving technical efficiency, for example when a substantial amount of water is used in low productive or low efficient ways, e.g. commercial (hotels & offices), residential, institutional (schools, hospitals), etc.

EPIs such as incentive pricing, can encourage rapid adoption of new and more efficient technologies to reduce water consumption and achieve water saving, through discouraging non-essential uses and inducing the use of more water-efficient infrastructures and appliances. The incentive pricing is defined per unit of water consumed. Tariffs might consist in a price per unit of water consumed, a combination of a fix price plus a variable one, a multi-part tariff, a subsidy over discernible (and certified) amounts of saved water or even deposit rebate systems (Delacámara, et al., 2013). Further gains from incentive pricing, other than a reduction in water demand, include (Delacámara, et al., 2013):

- the potential of optimising installed capacities by making them more profitable in the short term and by improving their financial sustainability in the longer term;
- contributing to cost recovery through penalising excess consumption;
- reducing the bill paid by low-consumption users making water more affordable for low-income households (cross-subsidisation); and
- allowing for water efficient business, whilst contributing to the equity and fairness objectives of water policy.

US EPA WaterSense Program:

The USA's EPA, through the WaterSense Programme, partners with several organisations, such as (WaterSense, 2020):

- Manufacturers;
- Retailers and distributors;
- Local and state governments;
- Utilities;
- Water districts;
- Trade associations;
- Non-profits;
- Irrigation professionals;
- Professional certifying organisations;
- Licensed certification providers;
- Builders.

Incentives are offered through a number of rebate programmes that form part of the overarching US EPA WaterSense program and are taken up and implemented by the various Counties or state water providers. Incentives and rebates are offered by the WaterSense partners, with WaterSense providing the information as to rebates types, availability and access to these. The types and of rebates differ from partner to partner, with some generic formats/combinations. Rebates are typically provided by local WSPs, who comprise of any of the authorities, i.e. a local municipality, national authority or water utility. Some of the various rebate types and their applicable building types include:

Rebate Type:

- Bathroom Sink Faucets;
- Faucet Accessories;
- Flushometer-Valve Toilets;
- Irrigation Professional Services;
- Pre-Rinse Spray Valves;
- Showerheads;
- Spray Sprinkler Bodies;
- Tank-Type Toilets;
- Urinals;
- Weather-Based Irrigation Controllers.

Building Type:

- Commercial/Institutional;
- Residential;
- Multi-family.

Examples of some toilet-focussed rebate programmes within the WaterSense programme include:

- Miami-Dade County:
    - Miami-Dade County have multiple water conservation programmes such as, the senior and low-income family full retrofit program (SLIFR), high efficiency showerhead (SH) exchange program, high efficiency toilet (HET), and high efficiency cloth washer (HEW) rebate programs.
    - The participants in the REBATE programs (i.e., SH, HET, HEW) were required to purchase eligible high efficiency appliances approved by the US EPA WaterSense program and submitted their receipts to MDWASD for rebate redemption;
    - Participants in the REBATE programs were not limited form applying for multiple rebates within the water conservation program in MDWASD (Lee, et al., 2013).
- City of Plano: Water Rebate Program: Residential High Efficiency Toilet (HET) (City of Plano, 2020):
    - Eligibility is limited to residential homes only; commercial properties are not eligible;
    - Applicant must currently own a home built in 1994 or earlier and have a City of Plano water utility account in good financial standing for the property where the toilet(s) were installed;
    - All purchases must be made from a retailer located within the City of Plano;
    - Only new, WaterSense® labelled high efficiency (1.28 gpf or less) toilets are eligible for a rebate. The list of WaterSense® labelled high efficiency toilets is available online at www.epa.gov/watersense/products/toilets.html;
    - The City of Plano will issue a credit to the water utility account in the following amounts:
        - - $100 credit for the 1st high efficiency toilet
        - - $75 credit for the 2nd high efficiency toilet
        - - $50 credit for the 3rd high efficiency toilet
    - Old toilets may be disposed through Bulky Waste Collection by placing item adjacent to waste collection point by 7:00 am on scheduled bulky waste collection day. Each household is assigned a specific collection day.
- Seattle and King County' Saving Water Partnership – multiple rebate programmes, including (Saving Water Partnership, 2020):
    - Residential and multifamily toilet rebates:
        - A $100 rebate towards replacing an old toilet with a Premium 1.1 gpf (or less) toilet;
        - Rebates are available on qualifying Premium 1.1 gpf (or less) toilets on the Eligible Toilet List (pdf);
        - Maximum of two (2) rebates per household;
        - Existing toilets must be pre-2004 and have not previously received a rebate.
    - Commercial, industrial, and institutional rebates: 2 options:
        - Flush valve toilets and Urinals Rebate – $100 per fixture for replacing older flush-valve toilets and urinals (both porcelain and valve must be replaced) with high-efficiency toilets (HET) and WaterSense-approved urinals. New toilets must be 1.28 gpf or less WaterSense HET toilets. Existing toilets must be 3 gpf or greater. In the case of replacing older code-compliant (1.6 gpf) fixtures with WaterSense-certified and/or HET fixtures, rebates are determined on a case-by-case basis and subject to available funding. New urinals must be WaterSense-certified models. Existing urinals must be 1.0 gpf or greater;
        - Tank toilet Rebate – obtain a $100 rebate towards replacing old toilets with Premium 1.1 gpf (or less) toilets.
- City of Tucson, Arizona offers multiple rebate programmes, including:
    - Residential Rebates (Tucsonaz(b), 2020):

        - High Efficiency Toilet (HET) Rebate – Receive a $75 rebate per toilet for replacing up to two high-efficiency toilets;
        - Low-Income Toilet Replacement – Low-income individuals and families can receive free replacement of older toilets;
        - Clothes Washer Rebate – Receive a $200 rebate for purchasing a qualifying high-efficiency clothes washer;
        - Gray Water Rebate – Receive a rebate up to $1,000 for installing a permanent grey-water irrigation system;
        - Rainwater Harvesting Rebate – Receive a rebate up to $2,000 per property for qualifying rainwater harvesting system costs;
        - Rainwater Harvesting Grant for Low-Income Customers – Grants of up to $400 and loans of up to $2,000 are available to qualifying households.
    - Commercial and Multifamily Rebates (Tucsonaz(a), 2020):
        - High Efficiency Toilet (HET) Rebate – Receive rebates for replacing tank-type toilets and flushometer valve/bowl combinations with high-efficiency models;
        - High Efficiency Urinal (HEU) Rebate – Tucson Water offers a high efficiency urinal rebate program for its commercial and industrial customers;
        - Tucson Audit Program (TAP) – The Tucson Audit Program engages Tucson Water business customers through free Water Savings Audits and customized incentive packages.

A large portion of the American cities' and counties' rebate programmes follow a similar concept to that of Plano.

Likewise, in Australia's New South Wales area, the Rous Water's "Blue and Green Business Program" is a rebate programme available to business supplied from the Rous Water source in Ballina, Byron, Lismore and Richmond Valley local government areas. The programme promotes efficient use of potable water and provides financial assistance to businesses to undertake water savings and water efficiency projects. The rebates vary for the various per item, e.g. Toilets & Urinals – $150 per toilet, up to a max of $3 500/Mℓ/a saved for water recycling, leak repairs and other savings projects. Each organisation has an upper limit of $25 000 per organisation. More than 40 businesses have accessed this programme and have achieved a combined saving of 60 million ℓ each year (Rous Water, n.d.).

Current SA situation:

Price policies (PP) and non-price policies (NPP) have both been used as part of demand-side policy and offer separate advantages and disadvantages.

- Price policies refer to water price increases, including higher residential water tariffs, use of block rate pricing or peak pricing, etc.;
- Non-price policies refer to:
    - Use of water restrictions, either in volume or time of use, to control the manner in which activities such as car washing and garden irrigation occur. This includes, but is not limited to aspects such as recycled water use at car washes, not allowing sprinkler irrigation, only drip or micro, only allowing night-time irrigation, etc.;
    - Information and education campaigns to encourage water conservation; and
    - Rebates for adoption of water efficient technologies.

Priced policies (higher residential water tariffs) place a larger burden on poorer households, noting that water is considered a basic need and water demand usually being price inelastic (Millock & Nauges, 2010). Likewise, considering the low water price elasticity (price-elasticity typically varying between −0.1 and −1.0), pricing schemes may not always be effective tools for inducing water conservation by modifying household water behaviours. Increasing the water price is still viewed by public authorities as the most direct economic tool for inducing water conservation behaviour. However, additional measures associated with the use of PP (water price increases, block rate pricing, peak pricing, etc.) is then required to shape residential water use (Reynaud & Romano, 2018). More recently, it has been argued that NPP, such as water conservation programs, education campaigns, or smart metering, could find impact with residential consumers. NPP are based on the idea that residential water users can implement strategies that will result in water savings via changing their individual behaviour. Likewise, the adoption of water-efficient equipment is strongly affected by housing ownership status, by being water-metered and charged with a volumetric price on water consumption, as well as by behavioural factors (Millock & Nauges, 2010). Attitudinal characteristics and environmental concerns increase the likelihood for households of undertaking specific and self-reported water-saving behaviour and therefore, need to be considered when designing NPPs (Reynaud & Romano, 2018).

Literature indicates that many municipalities are moving towards water-efficient technologies, however, that there has not been a substantial uptake of "game-changing" alternative systems. Many of the municipal tariffs are based on usage, however, few incentive-based schemes are evident, other than the rising block tariff, to actively discourage excessive water use and promote more efficient water appliances. It may be necessary to revisit the generic tariff models to ensure that the tariff components are relevant to the actual costs, including aspects such as O&M, recurring vandalism/damage, capital replacement (measured against a formal replacement programme), etc.

International studies have shown that installing water-efficient devices is viewed as being an effective manner of inducing water conservation for several reasons, including (Millock & Nauges, 2010):

- Domestic water consumed through both indoor and outdoor appliances (e.g., showers, toilets, washing machine, sprinklers) represents a significant share of households' daily water use in developed countries;
- The reduction potential of water saving fixtures is well acknowledged, e.g. a water-efficient washing machine (uses 1/3rd the water of an inefficient model, an old-style single-flush toilet use up to 12 ℓpf, while a standard dual flush toilet uses a quarter of this on a half-flush, and a standard showerhead use up to 25 ℓ/minute whereas a water-efficient showerhead might use as little as 7 ℓ/minute);
- Policies to promote installation of water-efficient devices are likely to be more politically acceptable than price increases or policies imposing water restrictions.

There is a lack of solid incentives for the uptake of alternative technologies especially where household responsibilities increase in the operation and maintenance of the system (SPIH, 2019). Some municipalities, such CoCT, prompted by the urgency of their drought situation, embarked on an extensive campaign of encouraging water-efficient technologies. It is recommended that CoCT's concepts be investigated and collated into a comprehensive guideline document or a WIN-SA Lesson Series that can be replicated and upscaled nationally to assist municipalities in actively making water efficiency part of the water demand and management programme.

Existing policy and plans with future outlook make mention of the potential for development and inclusion of incentives and rebates (Sanitation Policy, DWS Master Plan, IPAP 2018).

2.3 Standards & Regulatory Review

2.3.1 International standards and regulations that govern low-flush toilets

Unites States of America (USA):

Severe droughts between 1985 and 1992 prompted California to call for continued water conservation, resulting in measures undertaken by local water agencies, which included low-flow toilet rebate programs and distribution of free plumbing retrofit kits. As such, California also became the first US state to mandate the installation of high efficiency toilets (dual or single flush), a requirement that has been phased in from January 2010 (Millock & Nauges, 2010).

The US have a number of standards dealing with toilets in general, the most commonly used ones for water efficiency being (EPA WaterSense, 2014):

- American Society of Mechanical Engineers (ASME) A112.19.2/Canadian Standards Association (CSA) B45.1 "Ceramic Plumbing Fixtures" standard – includes for the waste media extraction test, fill valve integrity test, and tank trim adjustability test protocols established in the WaterSense Specification for Tank-Type Toilets;
- ASME A112.19.14 "Six-Liter Water Closets Equipped with a Dual Flushing Device".

In addition, the WaterSense program has provided specifications for a tank-type high-efficiency toilet. The WaterSense label is a certification that confirms that manufacturer's tank-type toilets meet the EPA's efficiency and performance criteria (EPA WaterSense, 2014). The specifications are applicable to:

- Single-flush, tank-type gravity toilets;
- Dual-flush, tank-type gravity toilets;
- Dual-flush, tank-type flushometer tank (pressure-assist) toilets;
- Tank-type, flushometer tank (pressure-assist) toilets;
- Tank-type electrohydraulic toilets; and
- Any other tank-type technologies that meet these performance specifications.

EU and UK:

Studies across 10 OECD countries (Australia, Canada, Czech Republic, France, Italy, Korea, Mexico, Netherlands, Norway and Sweden) reported that households that were individually metered and charged for their water had a higher probability to invest in water-efficient equipment compared to households that paid a flat fee (Millock & Nauges, 2010).

In 2013, the European Commission adopted new ecological standards regulating toilets and urinals to reduce their environmental impact. The average toilet uses about 11 ℓpf (2.9 gpf). The new guidelines are expected to specify a maximum urinal flush volume of 1 ℓ, and maximum toilet flush volumes of 3.5-5 ℓ. By way of comparison, the 1992 US Energy Policy Act set the American standard for toilet flush volume at just over 6 ℓ (Stephenson, PA, 2013).

Flushing systems have to comply with the requirements of the respective European Standard listed in Table below in terms of water efficiency and product performance (EUR-Lex, 2013):

Table 2-6: EN standard compliance for the flushing system (EUR-Lex, 2013)

Flushing system	Standard	Standard description	Application
Toilet suites and toilet receptacles	EN 997	WC pans and WC suites with integral trap	EN standards for measuring the reduced flush volume of flushing toilet equipment on Class 1 and Class 2 WC
Toilet and urinal flushing cisterns	EN 14055	WC and urinal flushing cisterns	EN standards for measuring the reduced flush volume of flushing toilet equipment and EN standard compliance for the flushing system
Toilet and urinal manual pressure flush valves	EN 12541	Sanitary tapware – Pressure flushing valves and automatic closing urinal valves PN 10	EN standard compliance for the flushing system
Toilet and urinal contact-free pressure flush valves	EN 15091	Sanitary tapware — Electronic opening and closing sanitary tapware	EN standard compliance for the flushing system

Note: Flushing toilet and urinal equipment of type Class 1 generally refer to Continental Europe market while flushing toilet and urinal equipment of type Class 2 generally refer to UK markets (Gentry, et al., 2013).

Similar to the US EPA's certified WaterSense products labelling, the EU Ecolabel (EU Ecolabel, n.d.) certification provides the guarantee that the product complies with the following criteria:

- Water efficient products which contribute to reducing water consumption;
- Save water and money; and
- Reduced end-of-life impacts – includes aspects such as durability and recycle to allow reducing environmental impacts.

As mentioned previously, Australia introduced the WELS scheme in 2005 to compare the water efficiency of a range of appliances and fixtures. Each product label indicate the Standard against which they were tested, e.g. AS/NZS 6400. The relevant legislative and regulatory requirements and certifications that are applicable for labelling are:

- Australian Standard 6400:2016 for Water efficient products – Rating and labelling; and
- WaterMark certification – Requirement for all plumbing products and administered by the Australian Building Codes Board (ABCB).

2.3.2 South African standards and regulations that govern low-flush toilets

2.3.2.1 South African National Standards (SANS):

There are several SANS that apply to toilets and flushing systems from a volume perspective, these being:

- SANS 1733:2011 Edition 1.3: WC flushing systems (low-flushing capacity) that operate with flushing cisterns – ISBN 978-0-626-34649-2. The standard specifies the requirements for the components, assembly and combined performance of WC flushing systems that operate in conjunction with cisterns that have stored water capacities of 6 ℓ and less;
- SANS 497:2011 Edition 4.3: Glazed ceramic sanitaryware – ISBN 978-0-626-34422-1: The standard covers wash-hand basins, pedestals, sinks, water-closet pans, bidets, urinals and flushing cisterns made of ceramic materials. The standard also prescribes toilet flushing performance and is referenced in

numerous other related SANS standards for toilet materials, flushing devices and the water supply and drainage standards. It has however been commented that it is not often included in reports of "new" toilets, flushing devices, cisterns and installation requirements (Coetzee, 2020);

- SANS 10400-Q:2017 Edition 3.1: The application of the NBR's Part Q: Non-water-borne means of sanitary disposal – ISBN 978-0-626-34156-5. The standard specifies deemed-to-satisfy requirements for compliance with part Q (Non-Water-Borne Means of Sanitary Disposal) of the National Building Regulations;
- SANS 821:2007 Edition 3.1: WC flushing cisterns – ISBN 978-0-626-27944-8. The standard covers the requirements for hand-operated high-level, low-level, near-level and close-coupled cisterns of various flushing capacities and that are designed for a single-flush operation, a dual-flush operation or an interruptible-flush operation;
- SANS 1509:2017 Edition 2.2: Flush valves for WC flushing cisterns – ISBN 978-0-626-35087-1. The standard covers the requirements for the construction and performance of four types and three sizes of flush valves for WC flushing cisterns;
- SANS 1240:2016 Edition 2.3: Automatic shut-off flush valves for water closets and urinals – ISBN 978-0-626-33563-2. The standard covers the requirements for automatic shut-off flush valves for water closets and urinals that are intended for supplying a pre-set amount of water;
- SANS 752:2007 Edition 2.06: Float valves – ISBN 978-0-626-31514-6. The standard covers the requirements for two classes, two designs and three types of float valve of nominal size not exceeding 50 mm and water temperature not exceeding 50°C;
- SANS 1887- Part 2:2015 Edition 1.03: Tissue paper Part 2: Toilet paper – ISBN 978-0-626-31587-0. The standard covers four grades of creped toilet paper supplied in rolls, and their material and dimensional requirements, inspection, packaging and marking requirements, and methods of test;
- SANS 10252 Part 1: 2018: Edition 3.2: Water supply and drainage for buildings Part 1: Water supply installations for buildings – ISBN 978-0-626-35904-1. The standard establishes the general principles for the design, installation and testing of water installations for buildings. Specific refence is made to terminal water fittings for flushing and toilets in section 5.3.2, including referring the user back to requirements of SANS 1733 for low-flush toilets;
- SANS 10252 Part2: Edition1: Water supply and drainage for buildings Part 2: Drainage installations for buildings – ISBN 0-626-09622-7. The standard establishes general principles for the design, installation and testing of sanitary drainage installations. It does not cover any special requirements for drainage installations in health care, laboratory, or industrial buildings. It does refer to sewerage design flows in section 4.4 and comments on sanitary fixture requirements in section 5.2;
- SANS 10400-Part P: Drainage, Plumbing, Sanitation and Water Disposal. This SANS, which has a strong similarity to SANS 10252 Part2, is in the process of being reviewed. One of the reasons being that flushing of toilets and the grey water from other fixtures are affecting the municipal drainage systems. Likewise, most of the "Tables" in both documents are outdated, mostly because the quantities of effluent from the fixtures are calculated in terms of "discharge units" (du's) per fixture, based on flow rates which have drastically changed. The outdated du's for a toilet was based on a flush of 12 ℓ whereas the modern cisterns flush with 6 ℓ, 3 ℓ or less (D.S., 2020).

SANS 1733 specifically refers to low-flush systems and defines it as being "*a WC flushing system that is designed to operate on flushing capacities of 6 ℓ or less*". In addition, the standard states that individual components of the system need to comply with other standards listed above (SABS, 2011). Critical aspects covered in this SANS are:

- The individual components of the system shall be:

a) marked to indicate that they form part of a specific combined system (comply to marking format), and
b) so designed that, when the system components are assembled and installed in accordance with the manufacturer's instruction leaflet, the system operates as intended;

- The flushing device shall be of the single full-flushing type or dual-flushing type, as appropriate, with discharge capacities of 4,5 ℓ or 6 ℓ for a full flush and not less than 3 ℓ for a part flush;
- Identification marking for low-flush pans include identifying:
    - close-coupled systems, low-flush pans shall bear numbers "4,5", "6" or "4,5/6", that identify the flushing capacity of the pan as 4,5 ℓ, 6 ℓ, or 4,5 ℓ or 6 ℓ, and the letters "CC", that identify a close-coupled pan
    - near-level systems, low-flush pans identified by letters ”NL”.
    - low-level and high-level systems identified by the letters "LL" or "HL". Low level toilets consist of a floor standing ceramic toilet pan and an exposed ceramic cistern, connected by a metal flush pipe. The cistern is installed at a mid to low height on the wall with brackets. High level toilets are mostly historical in design, where the high cistern is fixed to the wall and connects to the toilet pan via an exposed flush pipe;
- The standard stipulates “full-flush” performance requirements, as well as additional flush performance requirements to be met at part-flush performance, as follows:
    - Surface wash performance (as given in 4.5.1(a) of SANS 497),
    - Type 1 paper removal performance (see 4.5.1(b) of SANS 497),
    - Dye test performance (relates to reducing colour intensity of the dye solution drawn from the water seal of the pan).

Potential future standards to investigate include:

- Flush standards related to flushing with 0.75-3 ℓ will need to define flush performance;
- Other existing standards to be met or new standards to be defined for aspects such as surface wash performance, paper removal performance and dye test.

There are several testing bodies and accreditation facilities which are associated with the plumbing industry in South Africa, including SAPCS, SABS, IAS, Omega Test House, Bureau Veritas, AENOR, Agrément, SATAS, as well as SA Watermark and JASWIC. Only a few of these companies are local and include for a specific focus on toilet technologies, these being SABS, Agrément and JASWIC. In addition, some challenges have been identified with the industry bodies. An article in Plumbing Africa indicated that IOPSA and other industry bodies identified the following problems in relation to SABS (Macnamara,M, 2017):

- expiry of the SABS permit, before being renewed in time;
- invoicing for renewals without delivering testing or certification of products; and
- no new products tested or delay in getting tested, despite having been paid for and this has led to loss of contracts, which had required SABS certification.

As result of these problems, a number of the industry bodies have investigated and used alternative certification services, e.g. South African Technical Auditing Services (Pty) Ltd. (SATAS), which is accredited by South African National Accreditation Systems (SANAS) to certify manufacturers, producing products within the scope of their accreditation, to the requirements of ISO 17065. The scope of their accreditation is covered on the Accreditation Certificate.

2.3.2.2 Review of the National Building Regulation regarding water conservancy and water efficient design at the household level

For purposes of this study, the review of the NBR will focus on the topic of water conservancy and more specifically its relationship to water efficient design at household level.

The National Regulator for Compulsory Specifications (NRCS) reports to the Department of Trade and Industry (the dti). Its mandate includes promoting public health and safety, environmental protection and ensuring fair trade, and is closely involved in the development and administration of technical regulations and compulsory specifications, as well as market surveillance to ensure compliance with the requirements of the compulsory specifications and technical regulations. The NRCS is also tasked to provide a regulatory function for the building industry to ensure building safety, health, structural stability and uniform interpretation of the NBR & BS Act and Regulations. The National Building Regulation Unit is responsible for ensuring uniform understanding and implementation of the NBR and Building Standards Act (BS Act), No 103 of 1977 (NRCS, 2014).

In the absence of suitable standards, either nationally or internationally, the NRCS initiates the drafting of the standard or develops a compulsory specification or technical regulation incorporating the necessary technical requirements in accordance with legislative prescripts. In the case of building regulations, the NRCS develops technical regulations that establish the minimum technical requirements for the built environment (NRCS, 2016). The SANS 10400 range of documents explains how designers (including architects and engineers) and builders should interpret the regulations.

Based on the literature available, the following comments apply:

- SANS 10400-Q, deals with "Non-water-borne means of sanitary disposal", but does not cover actual waterborne systems or flushing systems. There is limited comment about the need to obtain local authority permission before constructing any form of pit toilet;
- SANS 10400-S deals with toilet facilities for persons with disabilities, but does not relate the actual functioning of the toilet system;
- Although provision is made in SANS 10400-X and XA for sustainable buildings and energy efficiency in buildings, no similar provision has been made for water efficiency in buildings;
- Likewise, no Compulsory Specifications exist that relate to water efficiency, water conservation, environmentally sustainable toilets, low-flush toilets, etc.

The NRCS Strategic Plan (2016) comments on its involvement in the DTI's IPAP, including the aspect of "*Energy and water efficient household appliances*". The IPAP guides the strategic imperatives and priorities of the NRCS which includes the development of new compulsory specifications/ technical regulations, regulatory activities, effective and efficient enforcement strategies, improving technical infrastructure to allow for greater integration of technology and an improved service to stakeholders (NRCS, 2016).

2.3.2.3 Guidelines for Human Settlement Planning and Design (Red Book) (CSIR, 2001) and The Neighbourhood Planning and Design Guide (DHS, CSIR, 2019)

The Department of Human Settlements has developed Norms and Standards for housing which includes service packages – water, storm water, roads, lighting, sanitation and electricity. The Norms and Standards for housing require that systems must meet National Housing Regulations and that sanitation technologies must carry an Agrément SA certificate.

In Chapter 10 of the Guidelines for Human Settlement Planning and Design, what was commonly refer to as the "Red Book", refers to "Normal flush volumes" being around 8-9 ℓ, with the range being from 6-10 ℓ. In addition, refence is made to various pedestals, including ultra-low-flush / highly water efficient options, these being:

- Low-volume flush pans (ultra-low-flush / highly water efficient), have been developed that require only three litres per flush. These low-volume flush toilets do not have any negative effects on the self-cleaning capacity of waterborne sewerage systems;
- Various tipping-tray designs are also available, with flush requirements varying from 0,75-2 ℓ, depending on the design. These appliances have a shallow pan or tray that holds the water necessary for the seal. After use, the tray is cleared by tipping it, allowing the waste matter to fall into the pit below. Thus, the water is used solely for maintaining the seal, not for clearing the pan;
- Pour-flush bowls can also be used to maintain a water seal. These pans are flushed by hand, using a bucket, and generally require about two litres per flush. The biggest disadvantage of this appliance is that the effectiveness of the flush depends on the human element (highly variable) and there is no control over the amount of water used per flush.

In the newer Red Book version (2019), *The Neighbourhood Planning and Design Guide*, Section K: Sanitation, makes refence to utilising an urban water management approach called Water Sensitive Urban Design (WSUD). Within the South African context, WSUD is also referred to as Water Sensitive Design (WSD) to acknowledge the fact that the approach could be applied to settlements in general, not only to those in an urban setting. Part of the approach is to implement "Appropriate sanitation and wastewater systems", referring to technologies that reduce water use, allow for the use of treated wastewater or recycled water, and minimise wastewater (DHS, CSIR, 2019). The guide includes mention of various option of sanitation technologies, including low-flush, pour-flush and water recycling toilets. However, this version does not make reference to flush volumes, and specifically low flush volumes.

Other problems identified by IOPSA and other industry bodies in the Plumbing Africa article were:

- The confusion created by water regulation falling under the Water Services Act and not NBR – sector requires more simplified and consolidated regulation;
- Local plumbing standards should be more inclusive of international standards and requirements – prevent effective importing;
- The plumbing industry's manufacturers' forum has stipulated that it does not want to be put at risk again by relying on government or a single commercial entity for certification. The manufacturers' forum has approved IOPSA to facilitate an alternative advisory scheme. This advisory mark scheme, driven and sustained by industry, will have the primary objective to create equality and oversight (Macnamara,M, 2017).

On the positive side, three elements seem to determine the success of water-supply and sanitation projects namely:

i. Involvement of the community in all aspects of the projects;
ii. Use of appropriate technology; and
iii. The need for institution-building and -training activities in conjunction with the project.

The SA Municipal Report comments that the South African regulatory system is maturing, with established processes and systems to ensure that technologies are designed according to acceptable standards and are fit for purpose. Key issues with regard to Norms and Standards are (SPIH, 2019):

- The need to follow national building regulations and to obtain Agrément SA certification;

- Applicable levels of service for different localities;
- Ratios to guide different conditions (urban, rural, high density, etc.); and
- New technology systems must adhere to the applicable norms and standards in terms of designs and follow approved certification processes.

In addition to the above, it is also recommended the full value chain be developed for new technologies. Consideration should include aspects such as logistics, packaging, commercialisation, selling, manufacturing, scaling, market development, industry development, enterprise development, partnerships with vendors, end-user support and development of an active research and development system for sanitation technologies. Likewise, the concept of a new technology introduction triggering a full-scale re-engineering of existing value chains and develop platforms for continuous innovation involving research institutions, is supported.

2.3.3 Recommendations for NBR inclusion

At time of this study, water efficient toilets are seemingly not covered in the NBR. It is recommended that similarly to SANS 10400- XA, the concept of encouraging water efficiency in buildings (including flushing systems) should form a separate and additional part to Part X, e.g. Part XB Efficient Water Usage in Buildings. These regulations can then be further defined by either updating the existing SANS, or by providing additional SANS. This will protect municipalities and the user from insurance and performance claims and risks. If the technology is only prescribed in by-laws, then the municipalities carry the risk and responsibility on quality and performance of the technology, which is financially unfeasible. Also, it could lead to discrepancies in standards and performance criteria across municipalities, thereby reducing the efficacy of the low-flush concept.

In terms of improving water efficiency measures, PID recommended the need for an amendment to SANS 10400 and the NBR, outlining the need for discussion between plumbing industry stakeholders and government before ratification. The table following identifies recommended amendments to SANS 10400 and NBR in terms of improving water efficiency measures (Still, et al., 2008).

Table 2-7: Recommended amendments to SANS 10400 and the NBR in terms of improving water efficiency measures

Item Description	Specification regarding water efficiency	Notes
Cistern and pan – single flush	No cistern and pan for a new building should require more than 9 ℓ to clear	More efficient systems requiring 6 ℓ or less should be encouraged using a labelling system
Cistern and pan – dual flush	No cistern and pan with a dual flush mechanism should require more than 6 ℓ to clear on the full flush setting	
Cistern and pan – Interruptible flush	Cisterns and pans with interruptible flush mechanisms are an acceptable alternative to low-flush and dual flush options	The pan should be able to clear with not more than 9 ℓ
Shower	Shower roses should not deliver more than 18 ℓ/s at 4 bar pressure	Showers should be aerated to improve efficiency. More efficient showers delivering 10 ℓ or less should be encouraged using a labelling system
Bath	Baths should not hold more than 250 ℓ to the overflow level.	More efficient bath designs should be encouraged using a labelling system
Basin	Washroom – limit to 5 ℓ; Bathroom – limit to 10 ℓ; Kitchen – limit to 20 ℓ	More efficient basin and sink designs should be encouraged using a labelling system
Urinal	Automatic flushing urinals should be illegal. Urinal flushing should be user activated (either manually or with sensors), and should use no more than 2 ℓ of water per flush	
Tap – bath	Flows should not exceed 10 ℓ/m for single taps and 18 ℓ/m for mixer taps at 4 bars pressure	

Item Description	Specification regarding water efficiency	Notes
Tap – basin	Flows should not exceed 6 ℓ/m for single taps and 10 ℓ/m for mixer taps at 4 bars pressure. Taps over basins without plugs should not exceed 4 ℓ/m flow.	Tap flows should be aerated.
Tap – external	Flows should not exceed 20 ℓ/m at 4 bar pressure.	Taps located in public places which are not used for irrigation should be self-closing after a set time has passed or volume of water has been delivered, according to context
Hosepipe	Use of hosepipes for washing paved surfaces should be illegal. Hosepipes should be fitted with shutoff valves at the user end	
Irrigation system	Garden irrigation systems should be switched off using timers and/or soil moisture gauges	
Pressure reduction	Domestic water pressure should be limited to 4 bars and hot and cold-water pressures must be balanced	
Waterless toilets	Information regarding well tested designs of waterless toilet should be made available and these should be allowed for within the building codes	
Waterless urinals	Information regarding well tested designs of waterless urinal should be made available and these should be allowed for within the building codes.	
Water Efficient Dishwashers	More efficient models should be promoted through use of labelling	
Water Efficient Washing Machines	More water efficient models should be encouraged through use of labelling	
Greywater recycling systems	National standards for domestic greywater recycling systems should be developed and certified designs should be promoted.	

2.4 Municipal By-Law Review

Municipalities have by-laws available as one of the measures to promote, instil and regulate a water conservation approach amongst consumers. Some the larger municipalities had updated their water by-laws, and some, such as Ekurhuleni, Cape Town and Tshwane, had included sections on water efficiency. Municipalities need to reach consensus on by-laws, particularly those within large conurbations (e.g. Gauteng) which spans several municipal jurisdictions (Still, et al., 2008).

Other than eThekwini, City of Cape Town and City of Ekurhuleni, few municipalities encourage and facilitate low-flush technology or water efficient toilets. City of Cape Town, and to a lesser extent eThekwini Metro, would appear to have the most comprehensive information relating to water saving and water efficient technology option and choices.

2.4.1 City of Cape Town (CoCT):

The City of Cape Town developed a water by-law in 2010, as amended in 2018 (CoCT, 2011) (CoCT, 2018). For ease of reference to the public, the City issued an easy-to-read Summary Guide of the by-law and an unofficial combined version which includes the 2018 amendments (CoCT, 2019) (CoCT: Water and Sanitation Department, 2018). The by-law informed residents, property owners, plumbers, builders and built environment professionals about their actions in water use, the use of certified materials and measures that apply under certain circumstances.

There is a strong focus on water conservation and demand management within the by-laws and its amendments and specific reference to these aspects with regard to toilet installations. Example of some of the references are:

- Plan Approval section: Where renovations to an existing building triggers a building plan approval process, full details of any water conservation and demand management system or alternative water systems (e.g. grey water re-use, groundwater or rain water harvesting) for systems for non-drinking purposes like flushing toilets, irrigation, swimming pool filling or top-up or other non – domestic purposes must accompany the building plans;
- Schedule 1: Water conservation and demand management:
    - 13 - New or replaced water closet cisterns may not exceed 6 ℓ in capacity,
    - 14 - No automatic cistern or tipping tank may be used for flushing a urinal,
    - 15 - All automatic flushing cisterns fitted to urinals, must be replaced with either manually operated systems or non-manual apparatus which causes the flushing device to operate only after each use of such urinal or waterless systems that must be properly maintained.

In addition to the by-laws, CoCT have other plans and strategies to promote efficient water use and that specifically reference toilets and low-flush toilets. Examples of low-flush references are:

- Cape Town Water Strategy 2018 (CoCT: DWS, 2018):
    - The City will use pricing to promote wise water use. As such, water will be priced with reference to the cost of providing additional supply;
    - Regulations and other incentives will be subject to a cost-benefit analysis to ensure that the benefits exceed the costs. Key areas include low-flush toilets, low-flow taps and showers, management and use of greywater, and night-flow monitoring for large users. reuse of groundwater, stormwater and wastewater. This will be in support of the City's Municipal Spatial Development Framework, which seeks to improve the efficiency of the urban form through densification.
- CoCT's Development Management Information Guideline Series: Resource Efficiency for Development Guideline: Nov 2019 (CoCT: DSPEECC, 2019):
    - This booklet gives a summary of the regulations, policies, best practice and outlines the process to be followed to facilitate resource efficient developments;
    - The City recommends that all toilets be fitted with a close coupled or low-level cistern. All toilets must be fitted with a dual flush mechanism consisting of a maximum of 3 ℓpf on the low-flush setting and a maximum of 6 ℓpf on the high-flush setting;
    - The City promotes the installation of greywater systems in new developments for garden and landscaping irrigation (where appropriate) and toilet flushing.

Developing a similar concept to the CoCT's Development Management Information Guideline Series: "Resource Efficiency for Development Guideline" will form an ideal component to this study's Toolbox, pending national agreement on the resource efficiency criteria.

2.4.2 eThekwini Municipality:

The eThekwini Municipality's Water and Sanitation Department (EWS) by-laws comment as follows with regard to toilet and flushing volumes (EWS, 2015):

- Chapter 10: Prevention of Undue Consumption of Water: Clause 70: Flushing of Water-closet Pans and Urinals:
    - (1) A flushing device serving a water-closet pan or urinal shall be actuated -
        - a) manually, by a person using such pan or urinal; or

        - b) non-manually, by means of an approved apparatus which causes the flushing device to operate after each use of such pan or urinal;
    - (2) A flushing device serving a water-closet pan shall not be capable of discharging more than 9,50 ℓ or less than 8,50 ℓ of water during one complete flush under normal operating conditions, and such a device shall be connected to a water-closet pan which is so designed that its trap will be cleared in one such complete flush;
    - (3) A non-manually operated flushing device shall be so designed that if it malfunctions no flush will take place;
    - (4) No automatic cistern or tipping tank shall be used for flushing a urinal;
    - (5) A separate flushing device shall serve each –
        - a) wall-mounted urinal;
        - b) stall urinal; and
        - c) 1,8 metre length of slab urinal;
    - (6) A flushing device serving a urinal shall not be capable of discharging more than 2 ℓ or less than 1 ℓ of water during one complete flush.

Similar to other major municipalities, eThekwini has also developed a number of strategies which promote water conservation / efficient water use and that specifically reference toilets and low-flush toilets. Examples of low-flush references are:

- Water Conservation Guideline (eThekwini Municipality, 2009):
    - This guide was developed as part of the "Greening Durban 2010" programme, led by eThekwini Municipality's Environmental Planning and Climate Protection Department and includes installing water efficient technologies and products as part of the water saving methods open to residential, business and institutional consumers. It recommends the undertaking of a water audit by the consumer to assist in prioritising the areas of most water use. By targeting these areas first, the biggest savings can be achieved, mentioning savings in water use of up to 40%. It also identifies 3 cost intervention categories and identifies water use areas and technologies and actions could be applicable;
    - Toilets are covered under the "Medium Cost Interventions" and recommends replacing the older 10-13 ℓ single flush toilet and cisterns with 9 ℓ single flush toilets and 3-6 ℓ dual flush toilets have become common place. Dual flush toilets have two handles or buttons, one to activate the full flush (for solids) and second to activate a half flush (for liquids). A dual flush toilet can consequently use significantly less water.
    - Technology options identified include:
        - Installing a cistern displacement device in the larger cisterns;
        - Convert an existing single flush toilet into a dual flush toilet by installing a toilet stop. It is a device that can be installed in existing single flush ("supa flush") toilets;
        - Install a leak free toilet cistern. The leak free toilet cistern does not fill until the flush button is depressed. The cistern then fills and flushes;
        - Installing Interruptible Flush Mechanism which is a retrofit device for toilets which allows the user to control how long it flushes through the use of the handle. It fits most front lever operated cisterns;
        - Installing a waterless toilet system (e.g. Ecosan) – to include composting toilets and waterless urinals;
        - It also provides an example of the water & cost savings of a Dual Flush Toilet (cistern and pan, max 6 ℓ), showing a 65% potential saving (4 kℓ/month equating to R33.35/month – 2009/2010 tariff);

- Benefit: Given that a dual flush toilet costs the same as a standard toilet – the payback period is 0 months if installed new, with a saving of R33.35/month on the water bill.

2.4.3 City of Johannesburg (CoJ):

CoJ have existing Water Services By-Laws, which refer to toilets in terms of the following (CoJ, 2019):

- General conditions of supply:
    - The Council does not undertake to maintain sufficient pressure in the water supply system to ensure the operation of manually actuated toilet flushing valves which require a specified minimum pressure to operate.

CoJ have issued a number of other documentations related to water saving campaigns that include a focus on toilet water use, including:

- CoJ's Save Water Campaign;
- CoJ's Water and Sanitation: Tariffs page comments on consumers need conserve water by reducing their usage in order to reduce their charges. The comment reminds consumer that they use between 10-12 ℓ of water with each flush (CoJ, 2018);
- CoJ Newsroom 2016 Article: "City launches low-flush cistern to conserve water" (CoJ, 2016):
    - Whereby CoJ launched an innovative low-flush system (4.5 ℓ low-flush cistern) that will significantly reduce water consumption and demand and forms part of the City's ongoing Soweto Infrastructure and Rehabilitation Project;
- CoJ Newsroom 2015 Article: "Innovative Investments Will Ensure 'A Better Tomorrow' For City Residents, Says Mayor Tau" (CoJ, 2015).
    - The City's new Blue Economy strategy includes incentives will be given to households, office buildings and commercial sites to install low-flush toilets and water-saving urinals to encourage behaviour that will lead to savings on this scarce natural resource.

However, no other mention is made with regard to size and flush volumes, actual available incentives, etc.

CoJ's Green Building Policy (Reference: personal interview and draft Policy):
CoJ are in the process of drafting a Green Building Policy focus to New Buildings. It is expected that part of the policy goals will be to lower water consumption and is envisaged to include:

- Reducing water consumption through water-sensitive design, construction and operation of buildings; and
- Reducing operational building use water demand through the installation of efficient water harvesting and reuse systems, and water efficient appliances.

The Green Building Policy will be applicable to all new buildings, including major refurbishments that require building plan approvals. The policy will include for incentives, mainly focussed toward the developer, but it's not clear on how the individual residential consumer will be incentivised to change their designs, or even for commercial entities (hotels, etc.) to retrofit their systems to more water efficient technologies, other than potentially gaining access to municipal negotiated discounts on specific sustainable technologies and assistance in applying for grants or tax incentives.

2.4.4 City of Tshwane Metropolitan Municipality (CTMM):

CTMM's Water Supply By-laws (2014) does not mention low-flush toilets, but refers to toilets in terms of (CTMM, 2014):

- Part 5: Installation of work: Water Demand management: Clause 35(2) – No cistern and related pan designed to operate with the cistern may be installed if the cistern has a capacity more than 9 ℓ.

However, CTMM issued the "City of Tshwane Green Building Development By-Law" in 2013, which provides a legislative means to ensure the development of a more sustainable built environment for developments as part of the CTMM approval process. Water efficient standards and low-flush toilets are provided for in these by-laws (CTMM, 2013):

- Where flush toilets are installed, they must have dual-flush capability. Flush rates must not exceed 4,5 ℓ (half flush) and 9 ℓ (full flush).

The by-laws also make specific mention of potential incentives that CTMM may provide with regard to Green Building Development applications, which may include the following:

- Fast-tracked application procedures;
- Reduced application costs;
- Reduced bulk services contribution;
- Relaxation of specific planning requirements such as parking provision;
- Access to reduced cost of free green building technical training and seminars;
- Access to municipal negotiated discounts for energy-efficient/sustainable technologies;
- Access to municipal negotiated interest rate reductions from financial institutions;
- Assistance in applying for grants or tax incentives for investments in energy-efficient / sustainable technologies; and
- Formal recognition of performance through certification;

CTMM's Civil Specifications of 2005 identify the following with regards to water closets (CTMM: Water & Sanitation, 2005):

- Plumbing: Material Clause 07.01 (b)- Water closet (WC) suites
    - WC suites shall consist of a white glazed vitreous china closet with an S or P trap and seat lugs, a 14 ℓ low-level matching flat-bottomed flushing cistern placed and fixed on the closet, or a suspended enamelled cast-iron cistern with the flush pipe connected to the flushing rim of the closet with rubber cone joints, and a solid heavy-duty plastic seat with cover, hinges and buffers.

CTMM have also issued information brochures relating to water conservation and water restrictions. The publication "Water restrictions and how it affects you" references toilet water use and in specific low-flush toilets in the various section where restriction may impact (CTMM: Water and Sanitation, 2014):

- Section: Restrictions applicable to residential customers – All taps, shower heads and other plumbing components should be replaced with water-efficient parts or technologies;
- Section: Restrictions applicable to businesses (commercial and industrial), institutions and government departments – All taps, shower heads and other plumbing components in public places must be replaced with water-efficient parts or technologies; and
- Section: Water efficient plumbing it states that where flush toilets are installed, they must have a dual-flush capability. Flush rates must not exceed 4,5 ℓ (half flush) and 9 ℓ (full flush).

2.4.5 City of Ekurhuleni Metropolitan Municipality (CEMM):

The City of Ekurhuleni Metropolitan Municipality's by-laws make the following comment with regard to low-flush toilets and flushing volumes (CEMM, 2002):

- Chapter 4: Prevention of Undue Water Consumption: Requirements in relation to flushing devices Clause 38.1:
    - (a) no type of flushing device shall be used to serve a water closet pan or urinal other than a flushing device, which is actuated:
        - (i) manually by a person using such pan or urinal; or
        - (ii) automatically by means of an approved apparatus which causes the flushing device to operate after each use of such pan or urinal;
    - (b) a flushing device installed in a cistern serving a water closet pan shall not be capable of discharging:
        - (i) in the case of a single flush unit, more than 6 ℓ of water during one complete flush; or
        - (ii) in the case of a dual flush unit, more than 6 ℓ of water during one complete flush when the full-flush level is actuated, and more than 3 ℓ of water during one complete flush when the low-flush lever is actuated and such a device shall only be connected to a type of water closet pan in which the trap is cleared in one flush;
    - (c) an automatically operated flushing device shall be of such a design that no flush will take place if it malfunctions;
    - (d) every wall mounted urinal or stall urinal shall be served by a separate flushing device and where any slab urinal installed on any premises exceeds 1,8 metre in length, a sufficient number of flushing devices shall be used so as to ensure that a single flushing device will not serve any part of such urinal exceeding 1,8 metre in length;
    - (e) no flushing device used to serve any urinal shall be capable of discharging more than 2 ℓ or less than 1 ℓ of water during one complete flush;
    - (f) no automatic cistern or tipping tank shall be used for flushing a urinal.

2.4.6 Nelson Mandela Bay Metropolitan Municipality (NMBM)

Nelson Mandela Bay Metropolitan Municipality's Water Services By-law (2010) make the following comment with regard to water efficiencies, water efficient toilets and low-flush toilets and flushing volumes: (NMBM, 2010):

- No water fitting may be used/installed unless it has been included on the JASWIC List of Accepted Water Components;
- Consumer to ensure that equipment connected to water installation uses water in an efficient manner.
- Overflow from cisterns must discharge outside to ensure visibility;
- Flushing of water-closet pans and urinals:
    - Flushing device serving a water-closet or urinal must be actuated manually or non-manually by means of an approved device that causes flushing after each use,
    - Flushing device may not discharge more than 9.5 ℓ during a complete flush and must be connected to wate-closet pan with a trap that is cleared in one flush,
    - When a non-manual flushing device malfunctions, the design must ensure no flush occurs.
    - No automatic cistern or tipping tank may be used for flushing a urinal,
    - A flushing device serving a urinal may not discharge more than 2 ℓ or less than 1 ℓ during a complete flush.

NMBM identifies the need to use water resources and provide water supply sustainably, which include aspects such as minimising all forms of water wastage so as to ensure water use efficiency is maximised. A strong focus is to ensure that decisions consider Best Practical Environmental Option (BPEO) (NMBM, 2012) (NMBM, 2017). NMBM's Green Procurement Implementation Strategy of 2011 makes specific reference to the need to support and encourage green technologies and products.

Some of the aspects covered that could impact on the concept of water efficient technologies are (NMBM, 2011):

- Policy change identified is the need to include the following principle in NMBM's Environmental Policy Statement: "Implementation of green procurement practices into the supply chain management and to promote environmental responsibility and performance of suppliers";
- Incentives Potential: The implementation plan also recognises the various funding mechanisms that are available to suppliers in order to meet "green targets". An example would be the provision of waste collection services which involve a materials recovery facility to minimise waste but which has the opportunity to access incentive funding from the dti as part of the new SMME Development Programme for the Recycling Industry; and
- Suppliers will need to be included in NMBM's Green Procurement Register, which includes being awarded a Green Certificate by NMBM. Existing certifications such as ISO14001 certification or EMS recognised certification, e.g. EMAS, will ensure automatic Green certification.

2.4.7 Drakenstein Local Municipality (DLM):

Drakenstein Local Municipality's Water Services By-law (2014) make the following comment with regard to water efficiencies, water efficient toilets and low-flush toilets and flushing volumes (Drakenstein Municipality, 2014):

- A consumer must elect the available level of services to be provided to him and the Municipality will in its discretion decide upon the size of the connection and the use of pressure- and flow control but no sub-meter will be provided or installed on a private residential property;
- Service level 2: Restricted the water flow to Service Level 2 consumers to 10kℓ per month. Includes for a water borne connection connected to either a municipal sewer or a shallow communal sewer system; and a pour-flush toilet which must not be directly connected to the water installation;
- Service level 3: a full pressure metered water connection to each stand; and a conventional water borne drainage installation connected to the Municipality's sewer;
- Under Water Conservation and Prevention of Pollution, consumer must ensure the following;
    - Any equipment or plant connected to his water installation uses water in an efficient manner,
    - No cistern that exceeds a capacity of 9 ℓ and its related pan shall be installed,
    - Only flushing urinals that are user activated may be installed and preferably these should have a dual flush functionality.

Due to the prolonged drought in the Western Cape, water efficiency and water saving measures have been highlighted with the consumers through various means. Examples of these and how it impacts on water efficiency and in particular, to water supply fittings such as toilets and urinals are:

- Water Restriction measures: Save Water webpage: Notice of new Level 1 Water Restrictions (Drakenstein Municipality, 2019):
    - All automatic flushing urinals shall be turned off in buildings during times when such buildings are normally vacated;

- All properties where alternative, non-potable water resources are used (e.g. rain water harvesting, grey water re-use, treated effluent water, spring water, well points and boreholes), must display the appropriate signage to this effect clearly visible from a public thoroughfare and water users are strongly encouraged to follow the same watering times as applicable to municipal drinking water use detailed above;
- Customers are strongly encouraged to install water efficient parts, fittings and technologies to minimise water use at all taps, showerheads and other plumbing components;
- Consumers are encouraged to flush toilets with greywater, rainwater or other non-drinking water;

- Top Ways to Save Water Brochure (Drakenstein Municipality, 2017):
  - Upgrade to a multi-flush toilet and/or put a water displacement item in the cistern which can halve your water use per flush.

2.4.8 Dawid Kruiper Municipality (incorporating Khara Hais Municipality):

The Dawid Kruiper Municipality (DKM) is located in the Northern Cape area which is a water scarce area. The Water Services By-Law, 2012 as amended by the Water Services Amendment By-Law, 2017, comment on water efficient installation, including toilets, as follows (DKM, 2017):

- A consumer shall ensure that any equipment or plant connected to his or her water installation uses water in an efficient manner;
- The Municipality may, by written notice, prohibit the use by a consumer of any equipment in a water installation if, in its opinion, its use of water is inefficient and such equipment shall not be returned to use until its efficiency has been restored and a written application to do so has been approved by the Municipality.

In addition to the by-laws, the municipality refer to efficient water use in their water and sanitation policy, although no specific comment is made with regard to low-flush or water efficient toilets. An example is as follows:

- Water & Sanitation Services Standard Policy (2016) comments on consumers having to be made aware of their responsibilities regarding water conservation conscious and making saving water a way of life and not to flush foreign objects, used oil and materials into the sewer system.

2.4.9 Moqhaka Local Municipality (MLM):

Moqhaka Local Municipality is located in the Free State and include Kroonstad. The Water Services By-law (2015) make the following comment with regard to water efficiencies, water efficient toilets and low-flush toilets and flushing volumes (MLM, 2015) – under the Water Demand Management section:

- No flushing urinal that is not user-activated must be installed or continue to operate in any water installation. All flushing urinals that are not user-activated installed prior to the commencement of these regulations must be converted to user-activated urinals within two years of the commencement of these by-laws;
- No cistern, and related pan designed to operate with such cistern, must be installed with a cistern capacity of greater than 9 ℓ and all cisterns not intended for public use must be fitted with flushing devices allowing interruptible or multiple flushes, provided that such flushing device is not required in cisterns with a capacity of 4.5 ℓ or less.

2.4.10 Ugu District Municipality (UGU):

Ugu District Municipality's Water and Sanitation Services By-Laws (2009) is located in KZN and comment as follows with regard to water efficiencies, water efficient toilets and low-flush toilets and flushing volumes (Ugu, 2009):

- Only water fittings from the Schedule of Approved Pipes and Fittings (not readily available) as complied by the authority may be used without prior approval;
- Under the "Waste of water unlawful" section a consumer is to ensure that any equipment or plant connected to their water installation uses water in an efficient manner.

In addition to the by-laws, the municipality also refers to efficient water use and specifically low-flush or water efficient toilets in their Climate Change Response Strategy, which encourages use of water conservation technologies such as low-flush toilets and low-flow showerheads (Aurecon, 2016).

2.4.11 Amathole District Municipality (ADM):

Amathole District Municipality's Water Supply and Sanitation Services By-Law comment as follows with regard to water efficiencies, water efficient toilets and low-flush toilets and flushing volumes (ADM, n.d.):

- No cistern, and related pan designed to operate with such cistern, must be installed with a cistern capacity of greater than 9 ℓ and all cisterns not intended for public use must be fitted with flushing devices allowing interruptible or multiple flushes, provided that such flushing device is not required in cisterns with a capacity of 4.5 ℓ or less;
- No flushing urinal that is not user-activated must be installed or continue to operate in any water installation. All flushing urinals that are not user-activated installed prior to the commencement of these regulations must be converted to user-activated urinals within two years of the commencement of these by-laws.

2.4.12 Joe Gqabi District Municipality (JGDM):

Joe Gqabi District Municipality is one of the seven districts of Eastern Cape province of South Africa, seated in Barkly East. The Water Supply and Sanitation Services By-Law comments as follows with regard to water efficiencies, water efficient toilets and low-flush toilets and flushing volumes (JGDM, 2015):

- No flushing urinal that is not user-activated must be installed or continue to operate in any water installation. All flushing urinals that are not user-activated installed prior to the commencement of these regulations must be converted to user-activated urinals within two years of the commencement of these by-laws;
- No cistern, and related pan designed to operate with such cistern, must be installed with a cistern capacity of greater than 9 ℓ and all cisterns not intended for public use must be fitted with flushing devices allowing interruptible or multiple flushes, provided that such flushing device is not required in cisterns with a capacity of 4.5 ℓ or less
- A consumer shall ensure that any equipment or plant connected to his or her water installation uses water in an efficient manner.

In addition to the by-laws, the municipality refers to key water supply and sanitation services strategies that focus on efficient water use in their WSDP documentation. Some examples of this are (JGDM, 2019):

- Included in their 4 WCDM strategic pillars, under Social Pillar provision is made for the promotion of water use efficiency, through the design and implementation of a comprehensive consumer education and awareness programme with a focus on water use efficiency;
- The 'intermediate service level' makes provision for a pour-flush toilet pan (not connected to any water installation), wash-through and suitable toilet top structure connected to the municipality's sanitation system.

2.4.13 General comment on Municipal By-laws related documentation:

From the sample by-laws analysis, it appears as if few of the smaller municipalities and a limited number of the Metros have made specific provision or directives with regard to defining water efficient measures (6 ℓ or less flushing), particularly in relation to water fittings such as toilets flushing systems. The table below summarises municipalities' by-laws that were considered in this study review, with specific comment on maximum flush volume (cistern capacity for single flush or dual flush).

Table 2-8: Summary of selected municipalities water efficient toilet directives

Mun Cat	Municipality	Geographic location	Flush std	Low-flush	Comments from various water conservation related documentation
Metro	CoCT	Western Cape	Max 6 ℓ	Yes - dual flush 3 ℓ & 6 ℓ	• Incentives for low-flush toilets, greywater re-use, etc. • No automatic cistern or tipping tank may be used for flushing a urinal • Recommend toilets be fitted with a close coupled or low-level cistern. • All toilets must be fitted with a dual flush mechanism consisting of a maximum of 3 ℓ per flush on the low-flush setting and a maximum of 6 ℓ per flush on the high-flush setting
Metro	eThekwini EWS	Kwa-Zulu Natal	Max 9 ℓ	Yes - dual flush 3 ℓ & 6 ℓ	• No automatic cistern or tipping tank shall be used for flushing a urinal • Recommends replacing the older 10-13 ℓ single flush toilet and cisterns with 9 ℓ single flush toilets and 3-6 ℓ dual flush toilets.
Metro	CoJ	Gauteng	No flush limit provided	low-flush system programme = 4.5 ℓ low-flush cistern in Soweto	• 10-12 ℓ identified in Tariff documentation. • The City will incentivise and regulate the installation of low-flush toilets and water-saving urinals as a standard feature in Joburg homes, offices and commercial sites
Metro	CTMM	Gauteng	Max 9 ℓ		• Recommending a dual-flush capability. Flush rates must not exceed 4,5 ℓ (half flush) and 9 ℓ (full flush)
Metro	CEMM	Gauteng	Max 6 ℓ	Yes - dual flush 3 ℓ & 6 ℓ	• No automatic cistern or tipping tank for flushing a urinal • Urinal single complete flush 2 ℓ but not less than 1 ℓ
Metro	NMBM	Eastern Cape	Max 9.5 ℓ		• No automatic cistern or tipping tank for flushing a urinal

Mun Cat	Municipality	Geographic location	Flush std	Low-flush	Comments from various water conservation related documentation
					• Urinal single complete flush 2 ℓ but not less than 1 ℓ
Local Municipality	DLM	Western Cape	Max 9 ℓ		• No automatic urinal flushing and recommend dual flush functionality for urinals • Consumer can elect lower Serv Level, e.g. Level 2 - pour-flush toilet (not connect to water system) with water borne connection connected to either a municipal sewer or a shallow communal sewer system • Consumers are encouraged to flush toilets with greywater, rainwater or other non-drinking water
Local Municipality	DKM	Northern Cape	No flush limit provided		• Water installation are to use water in an efficient manner
Local Municipality	MLM	Free State	Max 9 ℓ	Yes - multiple/interruptible flush option with max flush 4.5 ℓ	• All cisterns not intended for public use must be fitted with flushing devices allowing interruptible or multiple flushes, provided that such flushing device is not required in cisterns with a capacity of 4.5 ℓ or less
District Municipality	UGU	Kwa-Zulu Natal	No flush limit provided		• Only water fittings from the Schedule of Approved Pipes and Fittings - (Schedule not readily available on web and this no clear directive)
District Municipality	ADM	Eastern Cape	Max 9 ℓ	Yes - multiple/interruptible flush option with max flush 4.5 ℓ	• All cisterns not intended for public use must be fitted with flushing devices allowing interruptible or multiple flushes, provided that such flushing device is not required in cisterns with a capacity of 4.5 ℓ or less
District Municipality	JGDM	Eastern Cape	Max 9 ℓ	Yes - multiple/interruptible flush option with max flush 4.5 ℓ	• All cisterns not intended for public use must be fitted with flushing devices allowing interruptible or multiple flushes, provided that such flushing device is not required in cisterns with a capacity of 4.5 ℓ or less

Most of the metros have specific directives, e.g. CoCT, whereas others ascribed to environmentally sustainable policies and "Green" principles without actively defining the extent of the technologies. Of note is NMBM, which has a directive that stipulate that all water services fittings need to be included on the JASWIC List of Accepted Water Components.

Many of the municipalities use the DWS' Model Water Services By-Laws (2005), which explain the consistency in the standards applied with regard to toilet capacity (DWS: WSSD, 2005):

- No flushing urinal that is not user-activated must be installed or continue to operate in any water installation. All flushing urinals that are not user-activated installed prior to the commencement of these regulations must be converted to user-activated urinals within two years of the commencement of these by-laws;

- No cistern, and related pan designed to operate with such cistern, must be installed with a cistern capacity of greater than 9 ℓ and all cisterns not intended for public use must be fitted with flushing devices allowing interruptible or multiple flushes, provided that such flushing device is not required in cisterns with a capacity of 4.5 ℓ or less;
- No person shall, without the prior written authority of the engineer, install or use a pipe or water fitting in a water installation within the municipality's area of jurisdiction unless it is included in the Schedule of Approved Pipes and Fittings as compiled by the municipality. (The municipality may charge for making copies of these Schedules available);
- A consumer shall ensure that any equipment or plant connected to his or her water installation uses water in an efficient manner.

Considering that most municipalities adopted the Model By-laws with no/limited personalisation or additional specification, the following is recommended:

- The Models By-laws need to be updated to encourage water efficiency, including for water efficient fittings and equipment, potentially identifying a range of water efficient option, e.g. low-flush, ultra-flush to pour-flush, etc.;
- Provide a generic/national Schedule of Approved Pipes and Fittings, which municipalities can change as per their SCM processes and relevance to their area;
- Noting that charging for Schedules will discourage people accessing it, specifically if needing to check on water efficient fittings and equipment – it is recommended that this information be freely available (pdf format) from the Municipalities website with a period applicability indicated to ensure that the latest version is being accessed.

3 CHAPTER 3: SECTOR CONSULTATION ON LITERATURE REVIEW FINDINGS

3.1 The Review Outcomes

The most critical gaps and outcomes from the literature review were collated as a summary and used to design a Questionnaire to attain the input from selected industry experts. The feedback from these stakeholders is summarised in the sections following.

3.1.1 Technology Review Outcomes:

There is a need to standardise the low-flush terminology as per the 3 major categories for common use in South Africa, being:

Low-flush toilet (also termed low-flow toilet, water-efficiency toilet or water closet):

Defined as flushing system that is designed to operate on **flushing capacities of 6 ℓ or less**, through either one of the following:

- a single-flush water closet with an average water consumption of 6 ℓpf (1.6 gpf) or less when tested in accordance with the Standard; or
- a dual-flush water closet with an effective flush volume defined as the composite, average flush volume of two reduced flushes and one full flush

Ultra-low-flush toilet (also termed a super flush, high-efficiency toilet or water closet):

Defined as flushing system that is designed to operate on **flushing capacities of 4.8** ℓ or less, through either one of the following:

- a single-flush water closet with an average water consumption of 4.8 ℓpf (1.28 gpf) or less when tested in accordance with the Standard; or
- a dual-flush water closet with an effective flush volume defined as the composite, average flush volume of two reduced flushes and one full flush

Microflush toilets:

Defined as flushing system, as well as, a urine diverting flushing system that is designed to operate on **flushing capacities of 3 ℓ or less** of either grey/rain/river/potable water, through either one of the following:

- a single-main flush water closet, or pour flush, with an average water consumption of 3 ℓ per flush (0.8 gpf) or less when tested in accordance with the Standard; or
- a dual-flush water closet with an effective flush volume defined as the composite, average flush volume of two reduced flushes and one full flush, may also include a urine diversion option with a flush volume of 1 ℓ or less.

It is recommended that a similar rating system as the WELS system for water efficient appliances, which includes toilets, is adopted in South Africa. This makes provision for a labelling system which can provide consumer guidance on three critical aspects, being:

- Star Rating – overall water efficiency of product;
- Rate of consumption (for toilets it's the flush volume);
- Registration and product details.

SA has an extensive array of water efficient toilet systems available to residential, commercial and institutional market. These range from low-flush options through to micro-flush options and each as some advantages and disadvantages. Disadvantages that will most likely prevent the effective uptake of the technology include:

- Toilet and Flushing system;
    - Requiring more than 1 flush to clear the bowl
    - Noise (commercial environment with pressure assist type systems)
    - High installation costs & in some cases high maintenance costs
    - Lack of readily available part at more rural out flung areas and local hardware (building ware) suppliers.
- General Sewer impact;
    - Risk of clogging, stagnation in sewer lines and coating due to inadequate flush volume and low incline not allowing for adequate flush speed/flow to be maintained. (SA networks designed for high flush volumes and flat areas, also to cater for SA's disposal habits)
    - Impact on wastewater plants due to chemicals used for disinfection of blockages/stagnant sections and low-flow causing a high-strength influent quality that will deter effective processing (e.g. drought situation in Cape Town).

Other aspects which are seen to impact on slow uptake of technology are:

- Manufacturers and suppliers:
    - Lack of exposure to such devices and their SANS accreditation;
    - Lack of incentivisation, normally brought on by municipal building regulations (contained in planning regulations and by-laws), supported by NBR and Red Book requirements (designing with a focus on sustainable water use by utilising water efficient technologies).
- Lack of public exposure to the technology, compounded by:
    - lack of familiarity with water efficient devices/technologies;
    - lack of home ownership (i.e. they are renting);
    - financial challenges either in terms of affordability or recouping the investment;
    - reluctance to make any changes, due to disinterest, not understanding the need or urgency, or lack of change management; and
    - lack of effective incentives.

There is ample evidence that the concept water efficient appliances, including low-flush technologies, can lead to substantial savings in both water consumption, as well as financial savings at a residential, commercial and institutional level. Water efficiency must be addressed as a whole within the various premises, rather than just individual aspect such as replacing toilet or faucets, etc. Likewise, starting at utilising water efficient toilets is a good beginning point as toilet flushing accounts for about 25-30% of total domestic water use.

Critical gaps in literature or limited research were identified and recommendations for further investigation and studies are:

- Technical research required;
    - Residential water use attitudes and household behaviour, specifically with regard to water efficient systems,
    - Design requirements to ensure that the downstream sewer system is able to manage a low-flow high solids situation – e.g. specifically in dealing with relates to older sewers and excessive or undesirable "toilet paper" usage,
    - Low-flush toilet guidelines to encourage designers, engineers and plumbers to utilise this technology (Best Practice),

- Research to prove the savings and cost effectivity of low-flush toilet to encourage consumers, policymakers, designers, engineers and plumbers to engage with this technology more efficiently.

- Easily accessible consumer guide information, such as Best Toilet review websites showcasing;
  - (#cat1) Identifying the Best Overall,
  - (#cat2) Identifying the Best Water Saving,
  - (#cat3) Identifying the Best Flushing,
  - Comparison – Providing a comparison table showing top 10 products against set criteria, including flush volume, flush type, flush technology, bowl type, style and warranty,
  - Buying Guide – this should include aspects such as identifying water savings / high efficiency types, flush options, costs comparisons through to electrical requirements,
  - How to Choose your Water-Saving Toilet,
  - Best Low-flow Water-Saving Toilets Reviews.

3.1.2 Policy Review Outcomes:

Various policy documents highlight- and make reference to the need for water conservation and water efficiencies. However, whilst the principles are well instilled, there is a need to extend policies to specific sectors or be more explicit in their recommendations, guidelines, and plans, e.g. on green management for the hotel sector (commercial sector), institutional and residential sectors.

3.1.3 Standards & Regulatory Review Outcomes:

Due to water efficient toilets currently not covered in the NBR, it is recommended that similar to SANS 10400-XA, a separate and additional part to Part X, e.g. Part XB (Efficient water usage in buildings…) – include water efficient flushing systems and toilet systems. These regulations can then be further defined through the SANS programme, by either updating the existing SANS or by providing additional SANS.

Recommended amendments to SANS 10400, in particular the NBR in terms of improving water efficiency measures for toilets, include:

- Cistern and pan – single flush;
  - No cistern and pan for a new building should require more than 9 ℓ to clear
  - More efficient systems requiring 6 litres or less should be encouraged by using a labelling system
- Cistern and pan – dual flush;
  - No cistern and pan with a dual flush mechanism should require more than 6 ℓ to clear on the full flush setting
- Cistern and pan – Interruptible flush;
  - Cisterns and pans with interruptible flush mechanisms are an acceptable alternative to low-flush and dual flush options. The pan should be able to clear with not more than 9 ℓ
- Waterless toilets;
  - Information regarding well tested designs of waterless toilet should be made available and these should be allowed for within the building codes
- Waterless urinals;
  - Information regarding well tested designs of waterless urinal should be made available and these should be allowed for within the building codes.

Alignment between the Dept of Human Settlements' Guidelines for Human Settlement Planning and Design, the various municipal design requirements and the NBR are crucial, to ensure that the norms and standards for Housing meet those of the National Housing Regulations. To achieve this, it is recommended that:

- The "Red Book" and Municipal norms and standards needs to follow national building regulations;
- Certification of sanitation technologies must be consistent and possibly achieved through another acceptable means than SANS (due to delays), for example, an Agrément SA certificate or a future organisation if a national rating and labelling system is accepted;
- Identify clear ratios to guide different conditions (urban, rural, high density, etc.) and their technology implications; and
- New technology systems must adhere to the applicable norms and standards in terms of designs and follow approved certification processes.

3.1.4 Municipal By-Law Review Outcomes:

In lieu of many municipalities using the DWS model by-laws, the following is recommended:

- The Model By-laws need to be updated to make allowances for and encourage water efficiency, including for water efficient fittings and equipment, potentially identifying a range of water efficient option, e.g. low-flush, ultra-flush to pour-flush, etc.;
- Provide a generic/national Schedule of Approved Pipes and Fittings, which municipalities can change as per their SCM processes and relevance to their area, – for example, improve and build on the JASWIC approved suppliers and fittings;
- Information, specifically related to design requirements, standards and by-laws must be freely available (pdf format) from the municipalities website with a period applicability indicated to ensure that the latest version is being accessed;

3.1.5 Summary of Recommendations:

Based on the critical gaps identified from the literature review, and considering lessons from international best practice in comparing with South African procedures, the following recommendations would potentially assist in the enhanced uptake of low-flush technologies:

i. South Africa needs a labelling system for water efficient devices;
ii. South Africa will benefit from a nationally sponsored public education campaign regarding water efficient devices;
iii. Information on water efficient devices must be easily obtainable;
iv. Building codes and by-laws must converge in terms of using water efficient technology;
v. Municipal by-laws must include provisions relating to water efficiency and water conservation, and ideally there should be convergence across municipalities;
vi. Informative billing to identify high water consumption;
vii. Financial incentive to consumers that adopt water efficient devices;
viii. Consumer forums should be established and actively encouraged to liaise with Standards testing outcomes, manufactures and building policy and regulations developers to ensure synergy; and
ix. Case studies and lesson learnt on successes and impact on the use of low-flush type toilet systems.

3.2 Questionnaire format and process followed

The literature review outcomes were summarised and used to obtain input from selected stakeholders, to include:

- Local government who are implementing low-flush systems; as well as who are not implementing low-flush systems;
- Academic and research institutions with know-how in this field;
- CSIR and DSI in terms of technology development and implementation;
- National or provincial institutions responsible for low-flush systems regulations and legislation;
- National institutions mandated to in terms of technology development and implementation, e.g. JASWIC and Agrément South Africa (Technical Services);
- Industry and industry related media, e.g. Institute of Plumbing Sa (IOPSA) & Plumbing Industry Registration Board; and digital magazine: Plumbing Africa;
- SASTEP specialist.

Table 3-1: Selected specialist groups and sector representation interviewed during the study:

Sector	**Organisation**
Government - National	DWS
Government - National / NDPW&I Support	Agrément South Africa (Technical Services)
Industry Publication	Author & Editor: Interact Media - Includes digital magazine: Plumbing Africa
JASWIC EXCO / Government - Local	Nelson Mandela Bay Metro
	City of Cape Town (plumbing compliance)
	City of Tshwane: Water & Sanitation Division
	Ekurhuleni Metro Municipality: Water Services Alberton - Deputy Director: Water Loss
	eThekwini Municipality
JASWIC EXCO / SA Bureau of Standards	SABS
JASWIC EXCO / Sector expert / Research	WRC
JASWIC EXCO /Industry	Institute of Plumbing SA (IOPSA) & Plumbing Industry Registration Board
Local Government	eThekwini Water & Sanitation: EWS - Strategic Executive and Deputy Head: Engineering Services
Local Government	City of Johannesburg
NCRS and NBR	NCRS (NBR Specialist)
Sector expert / Research	Individual & Consultant Group
Sector expert / Research	University of Stellenbosch
Sector expert / Research	CSIR
Sector expert / Research	UKZN - PRG
Sector expert /Built Environment	University Pretoria

The questionnaire was developed in spreadsheet format, with the following sections per worksheet:

- Definitions;
- SA Water Efficient Toilet Types;
- Critical Gaps in Literature;
- Policy Gaps;
- Standards & Regulations;
- Municipal By-Laws.

Each section stated the outcome of the review, followed by a set of questions pertaining to the subject. A total of 22 respondents were requested to study the finding and provide their perspective on the gaps that were identified and to make recommendations to resolve these gaps.

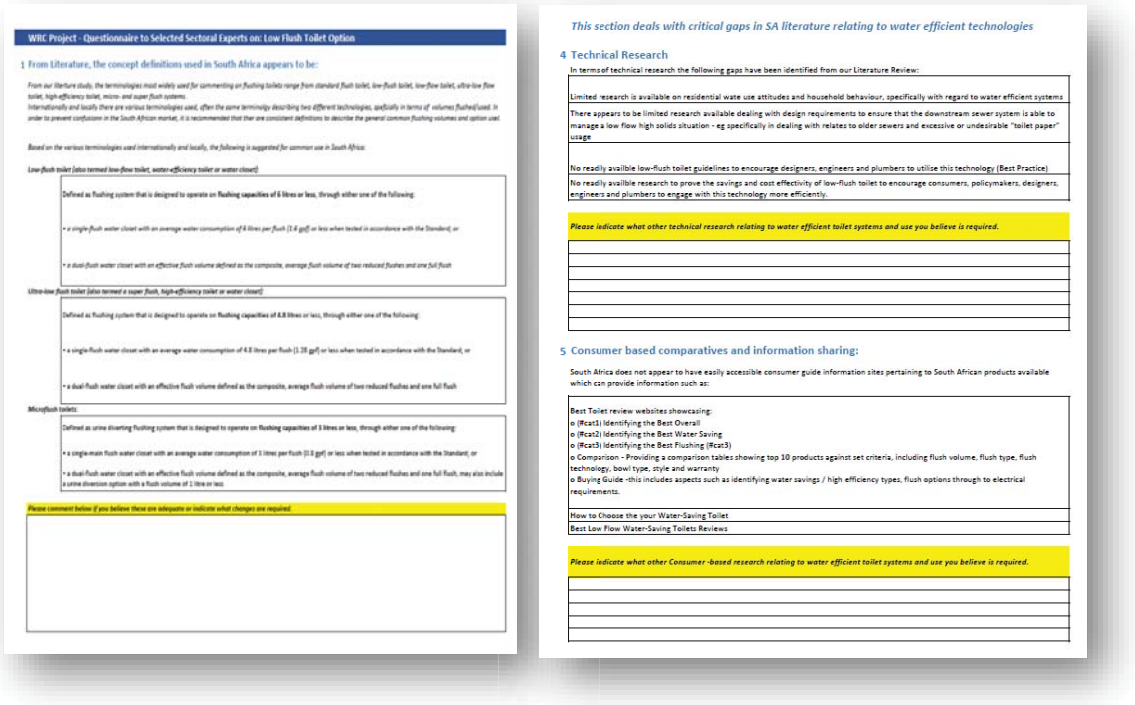

Figure 8: Questionnaire format

A statistical satisfactory response was received, with 68% of the sector experts responding, which represents 5 of the 6 main sectoral groups. It is to be noted that some of the respondents represent more than one main sector.

Figure 9: Responses to Questionnaire

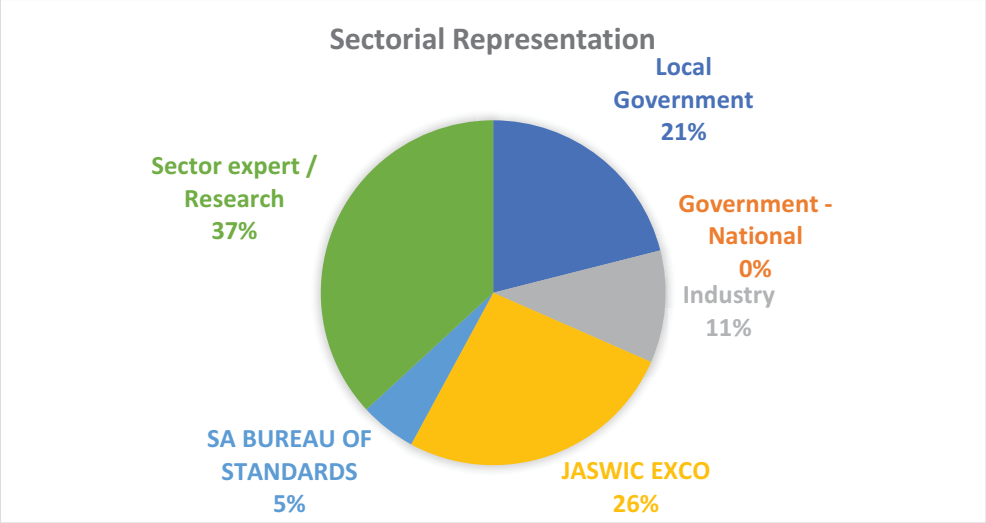

Figure 10: Sectoral Representation in Responses to the Questionnaire

3.3 Feedback on outcomes of sector consultation

A general comment was made by a respondent, that "…low flush toilets are definitely the way to go, but the plumbing industry, their specific consumer clients and the general public have in the past borne the brunt of good energy and water efficient innovations and regulations, which have failed and lost support because..." The reason for this is that the concept and technologies were not introduced and enforced in an inclusive, systematic and organised manner (Coetzee, 2020).

3.3.1 Industry perspective on the technology review

The following comments relating to the technology review aspects, are pertinent:

- Concept of multiple definitions:
    - Regarding the Microflush toilets definition, it was suggested the reading: "Defined as *flushing system as well as urine diverting flushing system* that are designed to operate on flushing capacities of 3 ℓ or less, through either one of the following:"
    - This to also include the option of pour flush with 3 ℓ or less of either grey/rain/river/potable water.
    - A suggestion was to consider perceived categories towards finalising terminologies in the South African context, i.e.:
        - 4.9-6 ℓ = Standard Flush;
        - 3-4.8 ℓ = Low Flush (as per Wikipedia definition);
        - 3 ℓ or less Ultra-low flush (whereby the term "Microflush" refers to an off-grid sustainable eco-friendly low-cost odour free private toilet that re-uses a few ml of grey water from a previous user's hand wash to isolate waste and flush – according to globalsustainableaid.org).
    - Multiple definitions vs single water efficient rating:
        - Use a "star rating", similar to WELS, to indicate efficiency rather individual definitions and accept all toilets with a <9 ℓ single flush as being low-flush. Examples included: give toilets water efficiency ratings on a scale of 0 to 6, with anything >9 ℓ getting 0 points, 9 ℓ = 1 point, 6 ℓ = 2 points, 5 ℓ = 3 points, 4 ℓ = 4 points, 3 ℓ = 5 points, 2 ℓ = 6 points and 1 ℓ = 7 points, also use sticker label showing efficiency.

- It was recommended that a dual flush system with ratio 6 ℓ to 3 ℓ capacity be considered as the standard;
- Concerned was expressed about the 4.8 ℓ or less flush by the municipal sector, as this might have an impact on reduced flow of excrement in the municipal sewer reticulation system resulting in blockages. Some of SA's metro sewer infrastructure consists of aged earthenware piping reticulation, whereby low-flush systems <6 ℓ capacity could impact on the flow of excrement in the sewer, causing blockages.

- Sustainability / System robustness and O&M cost:
  - A water efficient system does not necessarily imply that the system is robust and reliable, as many overly complicated systems and valves fail (often sooner than expected). A case in point is leaking cistern beta valves – the capacity of the cistern (for example) is then immaterial as significantly more water will be lost due to a leaking outlet valve than would have been the case with a cistern with a larger capacity which remains watertight, even though the flush volume is greater than that of the lower capacity cistern;
  - A disadvantage of many "complex" flush types (e.g. dual flush) is the high maintenance requirement and related high maintenance costs, compared to a basic single-flush mechanism;
  - Disadvantage of Pressure assisted, or vacuum flush is the requirement for electricity.
- Flat Sewer gradient and solids:
  - Most existing sewer systems have flat gradients (with a slope unknown to the homeowner/customer and which cannot easily be ascertained without exposing the pipes), and have pipe diameters designed to cater for "higher" flow volume (both aspects impact on the internal flow velocity). Reducing the flush volumes to very low levels will thus negatively affect velocities and the capacity/ability of the system to scour the pipes of solid matter;
  - SA utilises a 110 mm Ø drainage system in our infra structure versus Europe which has a much smaller diameter, Hence, coupled with the lower the flushing capacities, there is higher potential for drainage blockages. The reason for the 9 ℓ and 11 ℓ flushes is to cater for effective removal of the solids, woman's toiletries and disposable nappies. Therefore, the load on the drainage must be supported by the amount of flush water as the costs on blocked drains is substantial;
  - Some comment was received that discounted the potential negative impacts of a low-flush system. It was based on the rationale that using the average inflow figures from a few representative wastewater treatment works and calculating the contribution per capita, it will be possible to show that dropping the flush volume from an average 9 ℓ to 6 ℓ, or from 6 to 4.5 ℓ per person will not make a substantial change in the total flows. This is due to toilet flushing only being one contributor and not necessarily the largest contributor to wastewater. Water wastage (leaks, bursts, etc.) is seen as the single largest contributor, with water losses and Non-Revenue Water accounting of around 40% in most towns. It was commented that a leaking toilet can waste as much as 5 000 ℓ in a day, with most towns having a number of running toilets on any given day.
  - It was recommended that municipal officials that are concerned about the impact of low flush toilets on their sewers, should pick one new housing project to install low flush systems, and compare if the sewers behave differently to the areas which are not fitted with low flush technology.
- System efficacy:
  - Lower flushes (<9 ℓ single flush) often require multiple flushes, not clearing bowl adequately;
  - Consumer understanding/knowledge to correctly operate the dual flush system is seen as problematic, where users are not always sure which flush button to use;

- It was commented that consumers will only care about how much flush water they use if they are paying for the water; or when they have to physically carry the water to the toilet or to a supply tank near the toilet. Consumers want is a flush that removes the waste and cleans the pan. As whole, if the flush clears the pan, they will be happy, often without concern for how much water was used. Whereas, if they have to re-flush too often, they will not be unsatisfied with the system;
- System abuse by flushing certain hard solids (tins, stones, etc.) causes damage to toilet system and additional discards (vegetable peels, food, bones, diapers, household waste, etc.) requires more water to flush down the sewer;
- Pour-flush pumping by vacuum tanker requires additional water to be in the pit;
- Pour flush with pits cannot be linked to sewer (though pour flush can link to sewer as evidenced by bucket flushing when the water is off);
- Pour flush toilets at their most simple are linked to a leach pit, which is essentially a lined pit with open joints. Depending on the surrounding soil this kind of pit can usually accept 100 to 300 ℓ/d of flush water without problems. It was commented that residents often subsequently add internal plumbing to their houses with showers, kitchen sinks, baths, etc., and through this they generate in the region of 300 to 2000 ℓ/d of effluent (size of family, leaks in fittings, etc. being factors). Once the absorption capacity of the leach pit is exceeded, a septic tank and a suitable soak pit or water borne connection is required.

- Cost viability impact on sewer system:
  - Expense is a major issue when one moves away from standard gravitational water borne systems to pressurised domestic systems, and at present these systems are potentially not financially viable in our country (at least in most – if not all – areas).
- Research Gaps:
  - Technical research:
    - Problems relating to low flows in sewers, specifically where the sewers were designed for larger flows, e.g. case of Germany;
    - The cost of the downstream sewer system, and its maintenance – is orders of magnitude more than the cost of water. The rationale is posed “Why try to save a few litres of water at the toilet when the impact on the downstream system is ignored?”;
    - In terms of the big picture, how does the cost of water compare to maintenance on the toilet types/mechanism and to the cost of unclogging downstream infrastructure;
    - A study to learn more about how South African communities use toilets and what items are discarded down the system. Then figure out what flush volume is really needed. Would it not perhaps make sense to rather send 20 ℓ of water down the pipe (instead of 5 ℓ)? The 15 ℓ of water would be much cheaper than sending out a team to unclog the pipe at regular intervals;
    - Further technical research required relating to innovation in pedestal design that evacuates waste without having to flush repeatedly – e.g. hydrophobic coating;
    - Further technical research required relating to O&M requirements for new flush toilets;
    - Further technical research required in terms of developing Guidelines for plumbers on the use of water efficient toilets and requirements;
    - Further technical research required relating to developing Training tools for plumbers on new toilets; and
    - Further technical research required relating to electric- and sensor-based flush systems, in particular the no-touch version.

- Consumer research:
  - Potential for introducing a national system to rate water use appliances in terms of efficiency (compare for example the Australian star ratings – WELS Scheme);
  - For the more technical consumer, what Agrément and/or SABS thinks of each technology (readily available Certification test / approval outcome and approved product list);
  - Effective cost comparisons also including aspects such as;
    - Initial installation cost and operation and maintenance cost,
    - Cost benefit analysis ROI to allow for water tariff increases on average 9-12 % /year.
  - Consumer-based information must be cascaded down to municipalities in order to inform customers and this information should incorporate the municipality regulations on sewers and allowable cistern flushing capacity;
  - Education campaign on water efficient devices needs to consider retrofits as well as buying new products;
  - The concept of having consumer-based research available was supported, but the practicality to make it happen was questioned. It was commented that DWS, COGTA, WRC, or someone similar, should take the lead and create a professional body that can provide such information on a regular, objective, professional, sustained and long-term basis, using a sound and replicable methodology;
- Potential Incentives for those who do not necessarily pay for services to utilise water efficient technologies.

- Cost viability:
  - Expense is a major issue to consider when moving away from standard gravitational water borne systems to pressurised domestic systems. At present, these systems may not be financially viable in most areas.

3.3.2 Industry perspective on existing current national policy

Sector experts commented on the literature review findings and challenges in existing national policy, with specific reference to water conservation as it relates to water efficient toilets, as follows:

- Potential inclusion of the Green Building Council Policy in legislation: The Green Building Council seems to be influential among architects, and is the profession that specifies much of the sanitation systems;
- Emerging challenge of open defaecation in cities homeless is a public health issue that requires new debates and new policy on dealing with the matter;
- It is observed that the implementation of the policy often falls short of the intention;
- Funding for basic sanitation should make installation of water efficient devices for flush toilet mandatory, however it is also coupled to a challenge which is the ability to enforce legislation;
- The DTIC to encourage local manufacture through incentives;
- Water efficient flush toilet should form part of green code for new buildings;
- Water efficient flush toilet should be compulsory installations public institutions, e.g. schools;
- There is a disconnect between the municipal officials, who make decisions on sanitation policy in their areas, and national level bodies, such as the WRC, CSIR, DWS, etc. It was commented that even the higher capacitated municipalities (e.g. Metros) are not effectively capacitated in terms of understanding all the issues and options. Most often, people tend to just copy what has been done before.

3.3.3 Industry perspective on Standards, Regulations and the NBR

The questionnaire responses indicated the selected specialists' perspectives with regard to Standards and Regulation as being:

- Although there are solutions, it is often necessary to have to navigate / change a broken regulatory / enforcement environment.
- There is a dearth of design information regarding the hydraulic design criteria for the drainage system to be able to introduce it into the SANS 10400-P (the application of the NBR through "deem-to-satisfy" rules) which would be the main driver for such a change, since it is the handbook used for building control officers. The municipal water by-laws only cover water supply. There is a disconnect between many municipal building control departments and water supply. It is one thing to be able to clear a WC pan with 1,5 ℓ water, but another to ensure that the discharge gets to the sewer, without increasing blockages, etc., which appears to have received little attention by the promotors (commercial and government) of low-flush and grey water re-use.
- The NBR part-P for drainage "deemed-to-satisfy" application standards SANS10400 -P and SANS10252 -2 drainage for buildings, were originally modelled around toilet soil water flushes of 12 ℓ or 9 ℓ, and integrated with fairly generous waste water from other sanitary fixtures (baths, showers, basins and sinks, etc.). However, it also still functions well enough hydraulically with the current 6 ℓ and 6/3 ℓ flushes (and SANS 1377 low flush 4,5 ℓ cistern/toilet combination systems in particular applications). Therefore, the specified minimum and maximum gradients, pipe sizes and lengths are still appropriate. However, if the flush volumes are further reduced and especially if grey water re-use is applied in the same installation, the hydraulic load units in the standards and regulations will no longer work. This is an area for urgent research and development, performance measurement and verification studies, at such a level that the regulations and national product and installation standards can be changed accordingly. This research can be undertaken by WRC. There also needs to be a top-level national transition / integration plan to adequately train the reticulation designers, manufacturers, installers, designers, artisan training and qualification, etc. to ensure that the "new norms" work and are correctly phased in and run in unison with the current systems;
- Regulations must be enforceable otherwise "people" will scorn them, and having scorned one law, the doors are open to ignore other, more justifiable and more enforceable, laws, as well;
- Water efficient toilets are not being enforced or regulated, likewise, because water efficient design is not regulated enforcing it thus becomes problematic/ difficult;
- It was questioned that in development of Efficiency Standards (connected to sewer or not connected), why persist with 9 ℓ flush for new toilets and not just work with 6 ℓ only;
- Automatic flushing urinals should be illegal. Urinal flushing should be user activated (either manually or with sensors) and should use no more than 2 litres of water per flush. Waterless urinals should be encouraged;
- A critical innovation is the "leak-free" cisterns that have been developed, which work on the principle of eliminating one or more of the standard seals where normal cisterns eventually start to leak. It was commented that it is a critically important concept, but there needs to be a standard or a means to certify that these will give reasonably trouble-free service over a reasonable life;
- There is no synergy in the municipalities in the implementation and enforcement of building regulation with Water services;
- The development of Efficiency Standards has been lacking / lagging behind and has not been incorporated in policies and by-laws;

- Recommend taking account of Agrément SA's tests conducted (pages 8-10) in terms of developing Efficiency Standards; and
- It was commented that many efficient products have not been promulgated in the Building Regulations. Likewise, it was recommended that the Green Building regulations are also targeted for inclusion of such products.

3.3.4 Industry perspective on Municipal By-Laws:

The questionnaire responses indicated the selected specialists' perspectives with regard to Municipal By-Laws:

- By-Laws should assimilate the current situation regarding water efficiency. Emphasis should be in the new developments whilst the existing developments should be voluntarily as authorities cannot expect consumers to drastically change to water efficient fittings, even-though this change over must be encouraged;
- Recommend engaging JASWIC to provide guidance to municipalities in selection of various plumbing materials;
- There appears to be a disconnect between the Building Control departments (applying the NBR and SANS 10400 – which does not include hot and cold water supply) and Water Supply /Engineering departments (that apply the municipal water supply bylaws). This disconnect is particularly experienced by the plumbing industry when it comes to enforcement on site, specifically where water supply and drainage combine at sanitary fixtures as a single system, but is treated as two separate systems. The toilet is a prime example of such disconnect. This organisational split creates a chasm that breeds poor quality control and bad practice. Some designs therefore result where the building "produce" more soil and wastewater discharge than the potable water supplied to it. Ensuring that water supply is adequately catered for in the NBR is a step in the right direction, noting the danger that the water bylaws and the specialised expertise that goes with it, may be negatively impacted – it was recommended by the plumbing sector this should not happen.
- Following on the above, is the need for the Building Control Departments and the Water Supply and Sanitation Departments to be integrated in a controlled way to allow for the successful introduction of more specialised drainage models as required by ultra-low flush toilets and grey water systems.

4 CHAPTER 4: POLICY AND REGULATORY TOOLBOX

The literature review and sector input provide an informative basis for the development of a *Policy and Regulatory Toolbox,* aimed at enhancing the adoption and uptake of low-flush / water efficient toilets, with specific inclusion of the categories reviewed during this study.

The purpose of the toolbox is to provide practical guidelines to assist cross-functional organisations, including government, to have access to structured and relevant information that will enhance the adoption and uptake of low-flush / water efficient toilets. The Policy and Regulatory Toolbox consist of the following tools, each being described in more detail in the sections following:

1) Establish and reference Water Efficient Toilets as part of the Sanitation Value Chain;
2) Policy Toolbox;
    a. Standardise low-flush terminology for SA,
    b. Develop a rating system,
    c. Develop incentives aligned with the value chain,
    d. Introduce a grant and rebate funding programme,
    e. Development policy concepts in more detail.
3) By-laws Toolbox;
4) Model Standard Toolbox.

4.1 Unpacking the Water Efficient Toilet Value Chain:

The Toilet Board Coalition (TBC) has identified a business paradigm named "The Sanitation Economy" which presents vast potential for economic growth by bringing business solutions for the toilet-water-energy-food nexus. Likewise, it will assist in addressing the challenge of achieving universal access to improved- and safely-managed sanitation (SDG6). Through new business models, it monetises toilet provision, products and services, biological resources (re-usable water and nutrients), data and information to provide new benefits across the economy and society (Akinsete, et al., 2019).

The Sanitation Economy links 3 distinct areas for business and societal benefit, these being (Akinsete, et al., 2019) (TBC, 2017):

- *The Toilet Economy: Human Rights*
  This concept entail toilet products and service innovation that provides toilets fit for purpose for all contexts and incomes, thereby contributing to human rights and business value. The economy spans centralised and decentralised, sewered and non-sewered, high water tables and low, low income to high, rural, urban and peri-urban, planned and unplanned (informal) settlements. Toilet designs apply the Circular Sanitation Economy principals to minimise waste and greenhouse gas (GHG), and capture data to feed the Smart Sanitation Economy
- *The Circular Sanitation Economy: Resources*
  This thinking incorporates Toilet Resources (TBC's preferred term for human waste) that feed into a system which replaces traditional waste management with a Circular Economy approach. This is achieved through new technologies which are creating more cost-efficient decentralised alternatives to the current capital-intensive waste management systems. It connects the Biocycle, using multiple forms of biological waste, recovering nutrients and water, creating value-adding products such as renewable energy, organic fertilisers, proteins, and more.
- *The Smart Sanitation Economy: Data*

This concept involves digitisation of sanitation systems that optimise data for operating efficiencies, maintenance, plus consumer use and health information insights. Sanitation is included in smart cities architecture monitoring public toilet usage, sewage treatment, health indicators, and detects needs for maintenance and repair throughout the system. In a Smart Sanitation Economy, sensoring technologies and earth observation via satellite technologies provide real-time monitoring of sanitation systems bringing about operational efficiencies and new insights about human health and consumer behaviour.

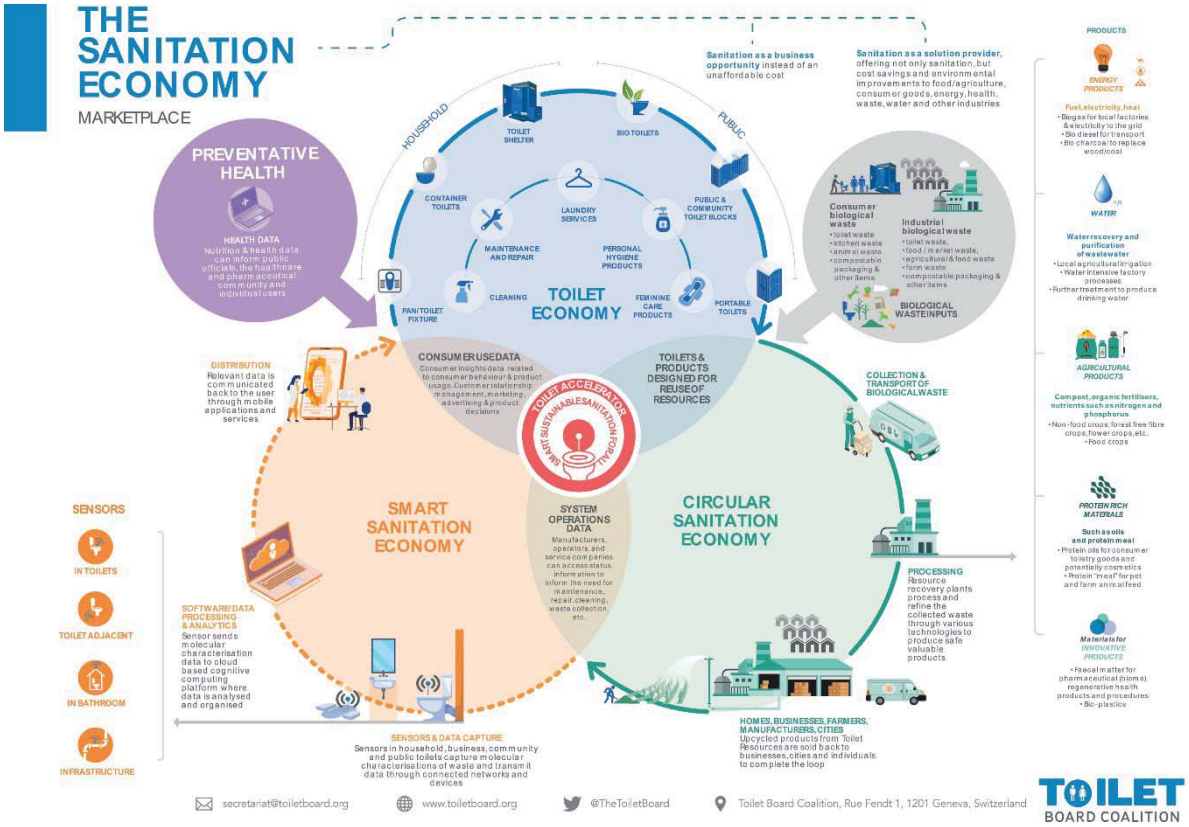

Figure 11: The Sanitation Economy (TBC, 2017)

In identifying the potential aspects that can facilitate or enhance the uptake of water efficient technology, consideration must be given to holistic system development for new technologies. This implies consideration of each of the components that form part of the value chain, including aspects such as logistics, packaging, commercialisation, selling, manufacturing, scaling, market development, industry development, enterprise development, partnerships with vendors, end-user support and development of an active research and development system for sanitation technologies (Interview: Dr Valerie Naidoo, WRC, 2020).

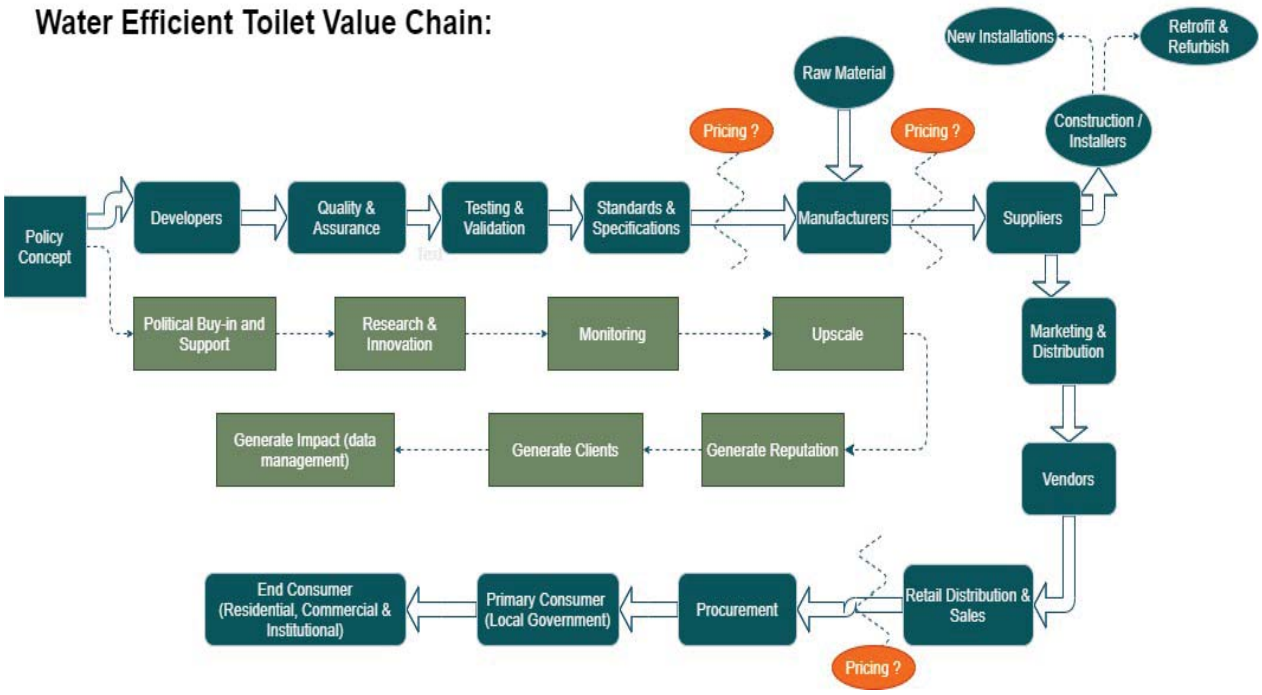

Figure 12: Concept Sanitation (Toilet) Value Chain featuring components that contribute to the uptake of water efficient toilets in the SA market space

Key participants in a water efficient toilet value chain include:

- Research, Development and Innovation;
    - Academic – WRC, CSIR and Tertiary Institutions
    - Manufacturer's R&D departments
    - National Programmes, e.g. WADER, SASTEP, SALGA Tech & Innovation, etc.
    - International Programmes.
- Supply chain;
    - Manufacturers
    - Importers
    - Wholesalers
    - Retailers
    - Builders, developers or real estate agents offering products in a new property or as part of a renovation
    - Plumbers or other trade professionals, when supplying and installing a product
    - Plumbers in their responsibility to ensure installed products meet certification requirements.
- Policy and Regulatory chain;
    - National Government Departments: DWS, DTIC, DEFF, DPWI, COGTA
    - Government Bodies: JASWIC, Agrément SA
    - Professional Bodies: IOPSA; PIRB
    - Standard and Regulatory Bodies: SABS, NCRS
    - *Envisaged "WELS Regulator".*
- User Chain;
    - Residential Sector (Households)
    - Commercial Sector (Hotels & Offices)
    - Institutional (Schools, Hospitals, Universities & Government Offices).

- *Future Envisaged Contributor to Value Added Chain;*
    - *Recycling Facilities / Recyclers – Commercial sector,*
    - *WELS Regulator,*
    - *WELS Inspectorate – Rebate Facilitator and Auditor – National Government (national grant rebate); Local Government (under building inspectorate section – similar to Green Policy Certification) or WSP or CMA.*

Linked to the Toilet Value Chain, several business options or job creation opportunities warrant further investigation:

- Recycling facilities: The development of Ceramic Recycling facilities present potential. In these facilities, old toilets (and other discharged ceramic items) can be disposed of via a recycling facility. Internationally, recycling facilities typically crush the porcelain and convert it into concrete for roads or sidewalks. An example of such a company is Waste Diversion in Toronto. (http://www.waste-diversion.com/toiletrecycling), which comments: *"A toilet can consist of many different materials such as ceramic, porcelain, plastic, brass and metal. All the materials can be separated and recycled when possible. Plastic, brass and metal can be melted down and recycled. Toilet recycling facilities typically crush the ceramic and porcelain so it can be added as a feedstock or dry aggregate for concrete, asphalt or other building materials. This process helps take these water wasting toilets out of circulation thus saving water in the process. It also keeps the toilets from being dumped in landfills and provides beneficial reuse of the materials."*
- Job Creation opportunities:
    - Recycling Facilities:
        - Collection of old toilets (ensure compliance with hazardous waste procedures);
        - Labour and administration duties at recycling facilities;
        - Transport of recycled material to next user, e.g. a feedstock or dry aggregate for concrete, asphalt or other building materials;
    - WELS Regulator- Regulatory function of managing and administering the envisaged SA WELS Scheme;
    - WELS Inspectorate – Rebate Facilitator and Auditor – National Government (National grant rebate); Local Government (under building inspectorate section – similar to Green Policy Certification), WSP or CMA
    - WELS Accredited Installers – installers of plumbing appliances and fixtures will need to be certified as WELS Accredited Installers. Effective synergy will be required between the WELS- and Municipal and Building regulatory programmes, which could be facilitated by ensuring that certification forms part of municipal approved plumber certification programmes.

4.2 Policy Toolbox

The Policy Toolbox comprise of changes, additions, incentives and/or rebates that could be used to enhance the uptake of low-flush toilet technology.

Policies to promote installation of water-efficient devices are likely to be more politically acceptable than price increases or policies imposing water restrictions, as it provides incentive as opposed to a penalty-based approach. The study indicated that there is a need to extend policies to specific sectors or be more explicit in their recommendations, guidelines, and plans. For example, green management for the hotel sector (commercial sector), institutional and residential sectors.

It is recommended that the existing position of the National Sanitation Policy (2016) regarding Appropriate Sanitation Technologies, needs to be enacted (DWS, 2016), with specific reference to the following activities:

- Develop criteria for appropriate sanitation technology and specifically, for low-flush water efficient toilets;
- Encoure the development of "Human settlement appropriate sanitation technologies" which minimise natural resource use and negative impacts;
- Ensure that the limited water resource availability informs appropriate technology selection;
- Ensure that the implementation of alternative, appropriate technology will be within social, environmental and economic constraints;
- Develop a formal process for certification and accreditation of appropriate sanitation technologies; and
- The Minister in concurrence with National Treasury, to facilitate the provision incentives to encourage utilisation of resource efficient sanitation infrastructure in human settlement areas.

To facilitate an incentive scheme, it is recommended that a national policy on water efficient technologies, including low-flush water efficient toilets, is developed that incorporates the following components:

- Confirms the terminology of water efficient technologies, including low-flush water efficient toilets;
- Provides guidelines for use of water efficient technologies in commercial and institutional buildings (e.g. hotels, schools, offices, etc.), new residential and commercial developments (green-field developments) and residential buildings;
- Provides guidelines on potential incentives for commercial and institutional buildings, new residential and commercial developments, and residential buildings, to encourage use of water efficient technologies;
- Facilitates the implementation of incentives to encourage use of resource efficient sanitation infrastructure through programmes, such as retrofitting of household toilet systems and possible rebates; and
- Undertakes awareness campaign, brochures distribution and marketing of the technology, its cost and benefits to users.

Concept tools within the Policy Toolbox are further described in the sections following.

4.2.1 Standardise low-flush terminology:

It is critical to reach consensus and agree on a standardised terminology for water efficient toilets. It is recommended to standardise the low-flush terminology according to 3 major categories, that would be suitable in the South African context:

Low-flush toilet (also termed low-flow toilet, water-efficient toilet or water closet):

Defined as flushing system that is designed to operate on **flushing capacities of 6 ℓ or less**, through either one of the following:

- a single-flush water closet with an average water consumption of 6 ℓpf (1.6 gpf) or less when tested in accordance with the Standard; or
- a dual-flush water closet with an effective flush volume defined as the composite, average flush volume of two reduced flushes and one full flush

Ultra-low-flush toilet (also termed a super flush, high-efficiency toilet or water closet):

Defined as flushing system that is designed to operate on **flushing capacities of 4.8** ℓ or less, through either one of the following:

- a single-flush water closet with an average water consumption of 4.8 ℓpf (1.28 gpf) or less when tested in accordance with the Standard; or
- a dual-flush water closet with an effective flush volume defined as the composite, average flush volume of two reduced flushes and one full flush

Microflush toilets:

Defined as flushing system, as well as, a urine diverting flushing system that is designed to operate on **flushing capacities of 3 ℓ or less** of either grey/rain/river/potable water, through either one of the following:

- a single-main flush water closet, or pour flush, with an average water consumption of 3 ℓ per flush (0.8 gpf) or less when tested in accordance with the Standard; or
- a dual-flush water closet with an effective flush volume defined as the composite, average flush volume of two reduced flushes and one full flush, may also include a urine diversion option with a flush volume of 1 ℓ or less.

4.2.2 Develop a Rating System:

It is recommended to adopt a South African version of the Australian WELS system for water efficient appliances and fixtures. The purpose of the WELS scheme is to:

- Conserve water supplies by reducing water consumption;
- Promote the adoption of efficient and effective water-using and water-saving technologies; and
- Provide information for purchasers of water-using and water-saving products.

These objectives can be achieved by specifying and enforcing standards for water efficiency and labelling for a range of regulated water-using appliances, fixtures, and fittings. Potential products such as washing machines, dishwashers, showers, toilet suites, urinals, taps and flow controllers can be included in a WELS-regulated system. This rating system makes provision for a labelling system, on the product, which can provide consumer guidance on four key indicators, being:

i. Star Rating on the overall water efficiency of product – recommending a 6-star system for South Africa (refer to table 4-1);
ii. Rate of consumption – to incorporate the toilets flush volume and ideally, the volume of water used in an average flush, half-flush and full-flush;
iii. Registration and product details, including the applicable compliance standard; and
iv. Referral point for additional information.

Table 4-1: Conceptual Stars Rating, based on performance for South African WELS products

Appliance	0 STARS	1 STARS *	2 STARS **	3 STARS ***	4 STARS ****	5 STARS *****	6 STARS ******
Tapware	>16 ℓ/min or fails requirements	12-16 ℓ/min	9-12 ℓ/min	7.5-9 ℓ/min	6-7.5 ℓ/min	4.5-6 ℓ/min	3-4.5 ℓ ℓ/min
Showers	>16 ℓ/min or fails requirements	12-16 ℓ/min	9-12 ℓ/min	7.5-9 ℓ/min	Not Applicable	Not Applicable	Not Applicable

Appliance	0 STARS	1 STARS *	2 STARS **	3 STARS ***	4 STARS ****	5 STARS *****	6 STARS ******
Toilets	Average flush >6 ℓ	Average flush ≤6 ℓ	Average flush ≤4.8 ℓ	Average flush ≤4 ℓ	Average flush ≤3.5 ℓ	Average flush ≤ 3 ℓ	Average flush ≤2.5 ℓ
	Standard toilet	***Low-flush toilet [LFT]***	***Ultra-low-flush toilet [ULFT]***	***Microflush toilets [MFT]***			
Urinals	>4 ℓ flush or fails requirements	≤4 ℓ flush	≤2.5 ℓ flush	≤2 ℓ flush	≤1.5 ℓ flush	≤1 ℓ flush	≤1 ℓ flush on sensor device

Note: Table derived from the Australian WELS products (Plumbline, n.d.)

Applicable laws and regulations will be required to implement the WELS scheme, in setting out the goals and regulatory functions of the scheme, including the powers to monitor, enforce scheme requirements and identify the role and responsibilities of a WELS Regulator.

Policies and procedures to support the laws and regulation may also be required such as:

- Standards Notice that identifies;
    - what a WELS product is,
    - what Standards apply to a WELS product,
    - which building codes the product needs to comply with,
    - details of registration processes and requirements, including periods of registration, and requirements for a product to remain registered,
    - instances when a registration can be cancelled or suspended,
    - requirement that the Regulator maintain a WELS product registration database.
- Regulations which identify or establishes the detail of who can register products, procedures for infringement notices, including for payment extensions and withdrawal of notices;
- Development and maintenance of a national Product Registration database, and regular updating and register maintenance by the custodian of the register;
- A web-enabled national register to include registration details of the product such as:
    - model name (for all product packaging and in displays when the registration number is not shown)
    - registration number
    - water consumption
    - star rating
    - image of product
    - product type
    - subtype of product.

Figure 13: Recommended format of the Water Efficiency Labelling and Standards (WELS) labels (BUILD, n.d.)

In Australia, the WELS scheme is managed by their Department of Agriculture, Water and Environment on a day-to-day basis on behalf of the Regulator. This arrangement may not be applicable in the South African context, in terms of day-to-day management. It is recommended that a specific organisation is identified and designated to support the WELS Regulator to undertake the management, operation and testing of the envisaged WELS scheme.

As identified during this study's gap analysis, there appears to be constraints in terms of the effectiveness of current industry testing bodies, these being SABS, Agrément and JASWIC. One scenario could lean towards the WELS Regulator not resorting under the SABS, in which case it is imperative that it retains close operational ties- and regular structured formal liaison with the SABS, and that the WELS standards are identified as a subset to existing National Standards. In order to achieve the main objectives of a WELS scheme, the following must be enacted by the WELS Regulator:

- ensuring standards underpinning the WELS scheme are current and appropriate;
- managing product registrations;
- working with industry to maintain high levels of compliance with registration and labelling requirements.

It is recommended that a joint task team, ideally including the DTIC, DWS, SABS, NCRS, DPWI, Agrément, JASWIC, IOPSA, PIRB and Green Building Council of South Africa (GBCSA), be convened to investigate and advise on the most suitable manager of the WELS scheme and under which legislation it will resort. The WELS scheme should link closely with the current DPW Green Building Policy to ensure synergy between the WELS type scheme and the Green Policy's Water Performance Certificates (WPCs). Likewise, the WELS programme should seek to take an inclusive partnership approach with different types of organisations (similar to USA's EPA WaterSense Programme), such as:

Table 4-2: Proposed WELS partner type and roles

Organisation Type	**WELS Partner Type in National Product Registration database**	**Partner Role**
Builders	Builder	Build new homes in accordance with the Green Policy specifications and Water Performance Certificates (still conceptual) and using WELS products to put into effect this certification.
Green Building Certification Organisations	Green Building Certification Organizations	Meet the requirements of the Green Home Certification System to oversee certification decisions for building to earn the Water Performance Certificates.
Manufacturers	Manufacturer	Manufacture products eligible to earn the WELS label.
Non-profit Organisations	Promotional	Promote WELS and water efficiency.
Retailers & Distributors	Retailers & Distributors	Sell, market, and encourage the use of WELS labelled products. Distribute WELS labelled products. Types of eligible organisations include, but are not limited to, home improvement stores, hardware stores, appliance retailers and distributors, plumbing supply houses, decorator showrooms/specialty stores, and commercial irrigation distributors. Note1
Trade Associations	Promotional	Support members that are eligible to join as a WELS partner.
Utilities or Water Service Provider (WSP) /Water Supply Authorities / Government Agencies (Water Boards, CMA's)	Promotional	Promote WELS and water efficiency in terms of products and consumer programmes. Include environmental departments, municipal programs, local governments, water agencies, water supply authorities, wholesalers, public utilities/ Municipal WSPs, private utilities (private WSPs), wastewater treatment facilities, water boards, and public utility commissions (WRC). Note2

Notes:

1. Retailers or distributors wishing to sell WELS labelled products under their own brand (private labelled products) agree to work with the manufacturer(s) of any labelled products to ensure that both the retailer/distributor's and the manufacturer's information are included in the WELS certification file and that the WELS Program mark guidelines are followed.
2. Promotional partners represent a diverse array of organisations who communicate directly with consumers

The partner advantages could include aspects such as, but not limited to, the following:

- Participate in a national water efficiency brand that symbolises the importance of water efficiency in SA;
- Reduce research costs and increase consumer confidence by promoting water-efficient products that meet or exceed the WELS scheme performance criteria;
- Gain access to materials that help you find out how other partners are promoting WELS and water efficiency and gain access to free collateral and media materials (e.g., public service announcements, fact sheets, brochures, press releases, and water-efficiency messages for utility customers);
- Support campaigns such as Fix a Leak or Water Week with tailored promotional materials;
- Distinguish a partner's organisation from others with the WELS partner logo and gain recognition from GBCSA;
- Exercise an option to have an annual competition which could allow a partner to participate in- and be able to win a WELS Partner of the Year award; and
- Participate in a national network of peers to share success stories, attend partner-only webinars, and receive regular program news and updates.

4.2.3 Develop Incentives Aligned with the Toilet Value Chain:

Incentives are positive measures that establish emotional bonds between the user and the incentive provider, change user behaviours and motivate all partners involved along the Toilet Value Chain. An incentive type will differ for different groups, i.e. an incentive that motivates the toilet manufacturer might not appeal to the plumber, etc. These will require further investigation in terms of feasibility and viability. The list following provides an indication of some incentives, but does not claim to represent a comprehensive list of all available options.

Table 4-3: Incentive options that link to different groups along the Toilet Value Chain

Value Chain Component	Potential Incentive to encourage uptake of water efficient, low-flush technology
Research, Development and Innovation Chain	
	• Annual competitions for various best R&D aspects related to water efficient toilets – possibly hosted via WISA, the DTI, etc. to facilitate ongoing product improvement • Acknowledge via recognised or prestigious forums, such as the SALGA Technology and Innovation Forum, academic platforms for research excellence, etc.
Supply Chain	
Manufacturers Importers Wholesalers	*Regulatory incentives:* • Changing building codes to only accommodate water efficient products *Voluntary Incentives:* • Product discount through guaranteed sales. Involves agreeing on a criteria/ product which is then used/promoted through other incentive programmes, e.g. Grant Funded Retrofit or Replacement programmes. (Either nationally or locally) • Subsidies aimed at new developing local manufacturers only, could include tax rebates, logistical support • Product improvement recognition/ awards linked to the R&D annual competition mentioned above

Value Chain Component	Potential Incentive to encourage uptake of water efficient, low-flush technology
	• Joint venture Marketing Campaigns and developing promotional materials to highlight the features, benefits and desirable lifestyle choice of low-flush technology
Retailers	• Following on from the Marketing Campaigns use promotional materials to re-enforce consumer awareness and desire • Offer products at discount prices / specials, etc., linked to the guaranteed sales discount • Commission from Manufacturers, Importers and Wholesalers for increased sales
Builders, developers or real estate agents offering products in a new property or as part of a renovation	• Joint venture Marketing Campaigns and developing promotional materials to highlight the features, benefits and desirable lifestyle choice of low-flush technology • Improved potential for Green Certification, which is a positive marketing feature for sales
Installers/ plumbers or other trade professionals, when supplying the product they are installing.	• Potential to purchase products at discount prices / specials • Specialised Certification and free training for plumbers, who are also responsible for ensuring products they install meet certification requirements / rebate requirements
Policy and Regulatory Chain	
National Government Depts: DWS, DTIC, DEFF; DPWI, COGTA	• Professional recognition by achieving targets as set out in the departmental masterplans, sector plans, country plans, SDG targets, etc.
Government Bodies: JASWIC, Agrément SA	• Professional and performance-based recognition from the sector regulator
Professional Bodies: IOPSA; PIRB	• Professional and performance-based recognition from the sector leader/s
User Chain	
Residential Sector (Households)	Grants and Rebate system – discussed in more detail in the section following
Commercial Sector (Hotels & Offices), as well as Institutional (Schools, Hospitals, Universities & Government Offices)	Rebate systems – discussed in more detail in the section following.

The section following expands the potential Consumer Incentive Scheme into more detail.

4.2.4 Potential Consumer Incentive Schemes:

The concept of a WELS scheme will reach far to raise consumer awareness in terms of water saving and water efficient appliances. In addition, incentive schemes such as rebate or grant systems, are recommended. Several examples and best practices are available, which are listed below but need to be further investigated and developed to be implementation ready.

Various types of rebates may be offered by the WELS partners, whereas WELS scheme will only provide the information as to what rebates are available and how to access the various rebates. It is expected that the rebate types will differ from partner to partner, although some generic formats or combinations may occur. Internationally, most rebates are provided by the local WSPs, and it is rerecommended that SA follow a similar

route. Rebate organisations can comprise of any of the following: national authorities, a local municipality or WSP, WSA, WMA or water utility. Some of the various rebate types and their applicable building types could include:

Rebate Type;

- Bathroom Sink Faucets
- Faucet Accessories
- Flushometer-Valve Toilets
- Pre-Rinse Spray Valves
- Showerheads
- Tank-Type Toilets
- Urinals:

Building Type;

- Commercial/Institutional
- Residential.

4.2.4.1 Residential Rebate System:

It is recommended that a full suite of rebates is investigated, and not be confined to water efficient toilets only. These rebates should ideally form part of a WSP's water conservation programme. Recommended residential rebate systems that require further investigation are:

- Low-Flush Toilet (LFT) Rebate – various potential options;
    - Issue a R450 credit to the water utility account *(estimated at 50% of cheapest water efficient toilet purchase price of R900)* rebate per toilet for replacing up to two high-efficiency toilets, or
    - Issue a credit to the water utility account in the following amounts:
        - - R600 credit for the 1st water efficient toilet [LFT] installation
        - - R450 credit for the 2nd water efficient toilet [LFT] installation
        - - R300 credit for the 3rd water efficient toilet [LFT] installation
    - Only new, WELS labelled LFT (water efficient toilets of 6 ℓ per flush or less) are eligible for a rebate. Proof of purchase- and of safe disposal of old appliances – either the recycle depot receipt or solid waste site receipt (if no recycler available in municipality).
    - Old toilets can be disposed of by recycling (potential business opportunity).
- Grant Funded Retrofit or Replacement programmes;
    - Pensioner and low-income family full retrofit programme (PLIFR) – this include changing toilet, taps and shower heads to the more efficient water saving technology (e.g. LFT), which will also assist household in saving water and water related costs/tariffs or
    - Low-Income Toilet Replacement programme (LITR) – Low-income individuals and families can receive free replacement of older toilets, with more efficient water saving technology (e.g. LFT).
    - Only new, WELS labelled LFT (water efficient toilets of 6 ℓ per flush or less) and related products (shower heads & taps) are eligible for a rebate and may not have previously received a rebate.
- Likewise, other rebate programmes that require further feasibility investigation include;
    - Clothes Washer Rebate – receive a rebate for purchasing a qualifying high-efficiency clothes washer
    - Grey Water Rebate – receive a rebate for installing a permanent grey-water irrigation system
    - Rainwater Harvesting Rebate – receive a rebate up to set limit per property for qualifying rainwater harvesting system costs

- Rainwater Harvesting Grant for Low-Income Customers – limited grant funding and or loans with a set limit to be made available to qualifying households (outside scope of this study).

In terms of funding such Rebate and Grant Programmes, it is recommended that the concepts discussed below are investigated further for viability and sustainability.

Rebate Funding:

- Municipal, CMA or WSP Rebate & Grant fund portion can potentially be achieved through a special tariff item on billed water sales (ideally levied against the residential water sales volume). Although all billed residential consumers contribute, the benefit is gained through cross-subsidisation from the larger users.
- Conditions:
  - Toilet installation to be removed in building must be more than 3 years old;
  - Proof of purchase of "approved" (e.g. WELS labelled) appliance and proof of installation by a certified municipal-approved "WELS installer / plumber" must be provided as part of portfolio of evidence when submitting the Rebate application form to the relevant rebate organisation;
  - Portfolio of evidence may not be older than 3 months;
  - Residence must have municipal water account and be paid up;
  - No prior rebate claims against residence.

Grant Funding:

- Municipal, CMA or WSP Rebate & Grant fund portion can potentially be achieved through a special tariff item on billed water sales (ideally levied against the residential water sales volume). Although all billed residential consumers contribute, the benefit is gained through cross-subsidisation from the larger users.
- A proportionally shared fund between the Local Municipality and National Government (50% basis) to service the following programmes:
  - Pensioner and low-income family full retrofit programme;
  - Low-Income Toilet Replacement programme;
  - Rainwater Harvesting Grant for Low-Income Customers.
- Conditions:
  - Toilet Installation to be removed in building must be more than 3 years old;
  - Residence must have municipal water account and be paid up;
  - No prior rebate claims against residence;
  - The provision of the fixtures, materials, fittings, toilet and labour will be undertaken through the Grant Fund Programme by a certified municipal-approved "WELS installer / plumber", to allow for maximum discounted cost benefit. This can either be achieved through a stock draw-down option with an approved panel of installers or through a different formal SCM agreement concept.

4.2.4.2 Commercial / Multi-family / Institutional Rebate System:

Several options may be explored for Commercial, Multifamily Residential, Industrial, and Institutional rebates, including:

- Flush valve toilets (flushometer valve/bowl) and high efficiency Urinals Rebate;

- Issue a R450 per fixture credit to the water utility account for replacing older flush-valve toilets and urinals (porcelain and valve must be replaced) with WELS-approved ultra-low-flush toilets (ULFT) and WELS-approved urinals
- New toilets must be classified as ULFT (4.8 ℓpf) or less, and must be a WELS-approved toilet. Existing toilets must be 11 ℓpf (or greater). In the case of replacing older code-compliant (6 ℓpf) fixtures with WELS-certified ULFT fixtures, rebates may be determined on a case-by-case basis and subject to available funding,
- New high efficiency urinals must be WELS-certified models. Existing urinals must be 3.8 ℓpf (1.0 gpf) or greater.

- Tank toilet rebate involves the issue of R450 (per fixture) credit to the water utility account, as a rebate towards replacing old 11 ℓpf (or greater) toilets with a dual-flush toilet with an effective flush volume of 6 ℓpf (or less) defined as the composite, average flush volume of two reduced flushes and one full flush (or less) toilets,
- Water Audit Programme (WAP) – The WAP engages business customers through free Water Savings Audits and customised incentive packages.

Rebate Funding:

- Municipal, CMA or WSP Rebate & Grant fund portion can potentially be achieved through a special tariff item on billed water sales (ideally levied against the commercial /bulk meter consumer (multi-family) / institutional water sales volume). Similar to the residential programme, although all billed consumers contribute, the benefit is gained through cross-subsidisation from the larger users.
- Conditions:
  - Prior approval through a WAP must be obtained, before proceeding with replacements – The WAP engages business customers through free Water Savings Audits and customised incentive packages;
  - Organisations applying for the rebate must have a municipal water account, must be billed as commercial / bulk meter consumer (multi-family) / institutional consumer and the account must be paid up;
  - No prior rebate claims in favour of the organisations;
  - Toilet Installations to be replaced in building must be more than 3 years old and 11 ℓ per flush or higher;
  - Proof of purchase of “approved” (e.g. WELS labelled) appliance and proof of installation by a certified municipal-approved “WELS installer / plumber” must be provided as part of portfolio of evidence when submitting the rebate application business motivation to the relevant rebate organisation;
  - Portfolio of evidence may not be older than 6 months or as agreed through WAP.

4.2.4.3 Introduce a Grant & Rebate Funding Programme for Low Flow Toilets:

Assuming a scenario where the Rebate/Grant fund is achieved with a special levy of 50c/kl water billed by the WSP and National Government co-fund contribution, noting that terms and conditions will apply to receiving the account rebate and/or the grant fund support. The funding can be broken down as follows (example following):

In Metro areas:

- The WSP's Rebate/Grant portion of funding is based on a 20:80 split;
- 20% is the funds available for the Rebate programmes for Commercial and Residential programmes with a 50% split to each ("Commercial" includes for Commercial / Multi-family / Institutional consumers);
- 80% forms the WSP's Grant fund portion which is then combined with an equal contribution from National Government.

In non-Metro areas:

In the example following, the available information provided the billed volume for commercial and residential as separate values. These values were then used to calculate the various Rebate and Grant fund portions:

- The WSP's rebate portion of the funds were calculated as:
    - For the Commercial Rebate, the fund was based on a 50c/kl contribution from the commercial billed volume;
    - For the Residential Rebate, the fund was based on a 20:80 split of a 50c/kl contribution from the residential billed volume. Thus, only 20% of the residential collected funds are available for the Residential Rebate programme;
- The remainder 80% of the residential collected funds forms the WSP's Grant fund portion which is then combined with an equal contribution from National Government.

In order to estimate the full potentially, an estimated "project cost per household" for the grant fund supporting the two scenarios needs to be done (table below). The Grant fund programmes are:

- Pensioner and low-income family full retrofit programme (PLIFR);
- Low-income Toilet Replacement programme (LITR) – just replacing toilet.

Table 4-4: Estimated Project cost per household (Budget figure)

Envisaged Project Cost per House	Shower head replacement	Toilet replacement	Taps Flow controller (4 taps/ bathroom)	Add Material Cost = R500 + including 10% for unforeseen expenses	Labour (Est)	Est Total Cost	Recommended Budget Cost
Cost per house retrofit	R200	R900	R200	R1,980.0	R2,000	R3,980	R4,000
Cost per toilet replacement		R900		R1,540.0	R1,200	R2,740	R2,800

Note:

- *Estimated Project cost per household (Budget figure): Rough appliance costs from web, e.g. CTM, Builders, etc. website prices for standard water efficient / water saving devices/items (Sept 2020)*

The section following illustrates the concept of rebating fixtures or household retrofits within a rebate programme in a typical metro and non-metro area. The detailed calculations are included under Appendix 3.

Metro Areas:

Total Grant fund available for a specific Metro Area: Calculation of anticipated portion of grant funding available from the WSP is based on 80% of their Annual Billed Water Sales of 180 446 Ml/a.

Table 4-5: Determination of WSP portion, National Government contribution and total grant funding available - Metro Area

Scenario Municipality	Annual Billed Water Sales (ML)	Annual "LFT" Rebate & Grant fund portion available from WSP (re 50c/kl billed vol)	Annual "LFT" Grant fund (80% of collected funds)	Annual Nat Gov Contribution "LFT" Grant fund	Total Combined Annual "LFT" Grant Fund Available *
Municipality / Metro X	180 446	R90,223,008	R72,178,406	R72,178,406	R162,401,414

**Round-up the available combined budget to R162.5 million/a to determine the number of households assisted*

Table 4-6: Envisaged household households assisted per annum – Metro Area

Combined Annual "LFT" Grant fund Available	PLIFR			LITR			Total households assisted/ annum
	PLIFRP (50% portion)	Est Cost per house retrofit	No of retrofit houses / annum	LITRP (50% portion)	Est Cost per toilet replacement	No of Toilet replacement/ annum	
R162,500,000	R81,250,000	R4,000	20 313	R81,250,000	R2,800	29018	**49 330**

From the calculations, the illustrative annual assistance achieved per Annual "LFT" Grant programme is:

- Pensioner and low-income family full retrofit programme – 20 313 households;
- Low-income Toilet Replacement programme – 29 018 households;
- Combined – 49 330 households served per annum.

Total Rebate (water account credit) fund available for a specific Metro Area: Calculation of anticipated portion of rebate funding available from the WSP is based on 20% of their Annual Billed Water Sales of 180 446 Ml/a. The rebate credit fund has two components, Commercial and Residential, with an equal budget split. The table below illustrate the available budget and the annual assistance achieved through annual rebates (credit) at R450/ fixture, for the two sectors.

Table 4-7: Total Annual Rebate fund available and potential annual replaced fixture achieved within a Metro Area

Scenario Municipality	Annual "LFT" Grant fund (50c/kl) Available from WSP	Annual "LFT" Rebate Portion Fund Available (based on 20% of collected funds)	"Commercial Portion (Based on 50% of Annual "LFT" Rebate Portion Fund Available) "	Commercial Sector: No of annually Rebated (credited) Fixtures	"Residential Portion (Based on 50% of Annual "LFT" Rebate Portion Fund Available)	Residential Sector: No of annually Rebated (credited) Fixtures
Municipality / Metro X	R90,223,008	R18,044,602	R9,022,301	20050	R9,022,301	20050

From the calculations, the illustrative annual Rebate credit assistance achieved per sector is:

- Commercial (including for Commercial / Multi-family / Institutional consumers) – 20 050 fixtures replaced.
- Residential (including for Commercial / Multi-family / Institutional consumers) – 20 050 fixtures replaced.

Local Municipality Area:

Total Grant fund available for a specific Local Municipality: Calculation of anticipated portion Grant funding available from the WSP based on 80% of the residential water sales.

Table 4-8: Grant fund available within a municipal area

Scenario Municipality	Annual Billed Water Sales (Ml/a)	Total Annual Residential "LFT" Rebate & Grant fund (50c/kl) Available from WSP	80% of Residential Billed Water Sales (Ml/a)	Annual "LFT" Grant fund (based on 80% of collected funds)	Annual Nat Gov Contribution "LFT" Grant fund	Combined Annual "LFT" Grant fund Available*
Municipality Z	6 930	R3,465,203	5544.324	R2,772,162	R2,772,162	**R5,544,324**

**Round-up the available combined budget to R5.5 million/a to determine the number of households assisted*

Table 4-9: Envisaged household households assisted per annum within a municipal area

Combined Annual "LFT" Grant fund Available	Pensioner and low-income family PLIFR			LITR			Total households assisted/ annum
	PLIFRP (50% portion)	Est Cost per house retrofit	No of retrofit houses / annum	LITRP (50% portion)	Est Cost per toilet replacement	No of Toilet replacement/ annum	
R5,500,000	R2,750,000	R4,000	688	R2,750,000	R2,800	982	**1670**

From the calculations, the illustrative annual assistance achieved per Annual "LFT" Grant programme is:

- Pensioner and low-income family full retrofit programme (PLIFR) – 688 households
- Low-income Toilet Replacement programme (LITR) – 982 households
- Combined – 1 670 households served per annum

Total Rebate (water account credit) fund available for a specific Local Municipality Area: The Rebate credit fund has two components, Commercial and Residential, the values of which are based on the sector's billed water volumes. The table following illustrate the potentially available budgets and annual assistance achieved through annual rebates (water account credits) @ R450/ fixture for the two sectors.

Table 4-10: Envisaged household households assisted per annum - Commercial Sector & Residential Sector

Scenario Municipality	Commercial Sector			Residential Sector		
	Annual Billed Commercial Water Sales (Ml/a) (2016/2017)	Annual "LFT" Rebate fund (50c/kl) Available from WSP	No of annual rebates (credit) @ R450/ fixture	Annual Billed Residential Water Sales (Ml/a) (2016/2017)	20% of the Annual "LFT" Rebate fund (50c/kl) Available from LM/CMA/WSP	No of annual Rebates (credit) @ R450/ fixture
Municipality Z	1 555.8503	R777,925	1 729	6 930.405	R693,041	1 540

From the calculations, the potential annual rebate credit assistance per sector is (includes Commercial, Multi-family, Institutional consumers):

- Commercial – 1 729 fixtures replaced;
- Residential – 1 540 fixtures replaced.

4.2.5 Policy concepts that require further comment or investigation:

Sector feedback also indicated that historically, SANS10400 -P and SANS10252 -2 drainage for buildings (originally modelled around toilet soil water flushes of 12 ℓ or 9 ℓ) and integrated with wastewater from other sanitary fixtures (baths, showers, basin, sinks), functions adequately hydraulically with 6 ℓ and 6/3 ℓ flushes, and with SANS 1377 low flush 4,5 ℓ cistern/toilet combination systems in particular applications. This implies that current specified minimum and maximum gradients, pipe sizes and lengths may still be appropriate. Concern has been expressed that if flush water volumes are further reduced and grey water re-use in the same installation, the hydraulic load units identified in the standards and regulations may become dysfunctional.

It is thus recommended that the following policy elements related to technical-engineering aspects be investigated:

- Research and development relating to performance measurement and verification studies, in order to facilitate the changes to the regulations and national product and installation standards;
- Sustainability / System robustness and O&M cost aspects of the various systems need to be established, including cost comparisons (e.g. cost of water compared to maintenance on the toilet types/mechanism and to the cost of unclogging downstream infrastructure);
- Research required relating to electric and sensor-based flush systems, specifically the no-touch version;
- Development of formal training guidelines and certification for artisan training, focussed on installing water efficient appliances, fixtures and equipment. This certification and training dovetails with that of existing municipal requirements as well as housing/building requirements and Green building requirements;
- Develop and enact a top-level national integration plan in order to adequately train reticulation designers, manufacturers, installers, designers and impact on artisan training and qualification. Transition planning is necessary to ensure that the “new norms” work and concepts are correctly phased in a synchronistic manner with the current systems;
- Policy and new debates on dealing with the emerging challenge of open defaecation in cities by the homeless which presents a public health issue.

It is recommended that the following policy concepts in relation to the consumer aspects be investigated:

- Consumer awareness campaigns focussed on system abuses related to the prevention of flushing certain hard solids (tins, stones, etc.) that causes damage to toilet system and flushing household discards (vegetable peels, food, bones, diapers, household waste) that requires more water to move these substances;
- Cost comparisons to include aspects such as;
    - Initial installation cost and operation and maintenance cost,
    - Cost benefit analysis return of investment (RoI) to allow for water tariff increases on average 9-12 % /year
- Cascading of consumer-based information to municipalities and to their consumers, to incorporate the municipal regulations on sewers and allowable cistern flushing capacity;
- Consumer awareness / education campaign on water efficient devices and retrofit requirements, as well as buying new products;
- Having consumer-based research available was supported, but the practicality of it happening was questioned. It was suggested that DWS, COGTA, WRC, et al. should create a professional body that provide information on a regular, objective, professional, sustained and long-term basis, using a sound and replicable methodology.

4.3 Regulations Toolbox

This toolbox responds to the regulatory gaps by presenting tools and ideas that will facilitate the uptake of low-flush technology, including aspects related to the NBR.

Considering that water efficient toilets are not covered in the NBR, it is recommended that similarly to SANS 10400- XA, that a separate and additional part to Part X, e.g. Part XB Efficient water usage in buildings to encourage water efficiency in buildings, and to include water efficient flushing systems and toilet systems. These regulations can then be further defined through the SANS programme, by either updating the existing SANS or by providing additional SANS.

Recommended amendments to SANS 10400, in particular the NBR, include:

- Cistern and pan – single flush;
  - No cistern and pan for a new building should require more than 9 ℓ to clear. More efficient systems requiring 6 ℓ or less should be encouraged by using a labelling system;
- Cistern and pan – dual flush;
  - No cistern and pan with a dual flush mechanism should require more than 6 ℓ to clear on the full flush setting;
- Cistern and pan – interruptible flush;
  - Cisterns and pans with interruptible flush mechanisms are an acceptable alternative to low-flush and dual flush options. The pan should be able to clear with not more than 9 ℓ
- Information regarding tested designs of waterless toilet should be made available and these should be allowed for within the building codes;
- Information regarding tested designs of waterless urinal should be made available and these should be allowed for within the building codes.

There needs to be a standard or a means to certify that "leak-free" cisterns will give reasonably trouble-free service over a reasonable life. The "leak-free" cisterns that have been developed and work on the principle of eliminating one or more of the standard seals, where normal cisterns eventually start to leak.

To ensure alignment between the Dept of Human Settlements' Guidelines for Human Settlement Planning and Design, the various municipal design requirements, and the NBR, it is recommended that:

- The "Red Book" and municipal norms and standards needs to follow national building regulations;
- Certification of sanitation technologies must be consistent and possibly achieved through another means than SANS (due to delays). As example, an Agrément SA certificate or alternative entity should a national rating and labelling system is accepted;
- Clear ratios must be established to guide different conditions (urban, rural, high density, etc.) and their technology implications;
- New technology systems must adhere to the applicable norms and standards in terms of design, and follow approved certification processes;
- Likewise, synergy is needed across municipalities in the implementation and enforcement of building regulation and water services.

In addition to the recommended changes to the NRB, the concept of a WELS rating system is already captured in legislation. This may require either an individualised Standard, similar to the "Australian Standard 6400:2016 Water efficient products – rating and labelling", or the concept of WELS can be incorporated into the

recommended SANS 10400- Part XB Efficient water usage in buildings. The WELS Standard must detail the criteria for:

- Testing;
- Rating; and
- Labelling products and display (star rating, water consumption, flow rates).

It is further recommended that the current SA range of product-specific standards that set technical specification for plumbing and drainage products and additional requirements for product testing, performance, labelling and display are revised to y accommodate a WELS system in terms of:

- showers;
- tap equipment;
- flow controllers;
- toilets, including for WC Pans, WC flushing devices, cistern inlet, outlet valves and technical specifications for flushing valves for water closets and urinals – for use with mains supply and with break tank supply;
- urinal equipment, including technical specification for urinal flushing cisterns;
- washing machines; and
- dishwashers.

4.4 By-laws Toolbox

The By-law Toolbox section outlines and recommends, based on the by-law analysis, the manner in which municipalities can amend or restructure water services by-laws to encourage and enhance the uptake of water efficient technology solutions, through either new development and or retrofitting actions.

Considering that most municipalities are using the DWS' Model Water Services By-Laws (2005) with limited personalisation, the following is recommended:

- The Model need to be updated to make allowances for- and to encourage water efficiency, including water efficient fittings and equipment, and identifies a range of water efficient options, e.g. low-flush, ultra-flush, pour-flush, etc.;
- Best practices from existing municipalities, such as CoCT, can be adopted into a nation-wide by-law. Aspects to ensure are included are:
    - Encouraging consumers to flush toilets with greywater, rainwater or other non-drinking water;
    - Incentives for low-flush toilets, alternative water source including grey-water for re-use, etc. It is recommended that for urban areas specifically that the cities will incentivise and regulate the installation of low-flush toilets and water-saving urinals as a standard feature in their rated residential properties, offices and commercial sites;
    - Banning use of automatic cistern or tipping tanks for flushing a urinal, specifically in public facilities;
    - Recommend that new installing toilets be fitted with a close coupled or low-level cistern. All new toilets must be fitted with a dual flush mechanism consisting of a maximum of 3 ℓ per flush on the low-flush setting and a maximum of 6 ℓ per flush on the high-flush setting;
    - Alternatively, all cisterns not intended for public use, must be fitted with flushing devices allowing interruptible or multiple flushes, provided that such flushing device is not required in cisterns with a capacity of 4.5 ℓ or less;

- Provide a generic/national Schedule of Approved Pipes and Fittings, which municipalities can change as per their SCM processes and relevance to their area. This schedule must be made available on the municipality's website;
- Charging for Schedules will discourage people accessing it, specifically if needing to check on water efficient fittings and equipment. This information should be freely available (pdf format) from the municipal website with a period applicability indicated to ensure that the latest version is being accessed;
- The by-laws typically cover water supply, leaving a disconnect between building control departments and water supply departments. (Example: clear a WC pan with 1,5 ℓ water versus ensuring the discharge reaches the sewer without causing blockages. etc.). Therefore, by-laws need to take into account the need for synergised design requirements between municipal design departments, i.e. Building Control Departments and Water Supply and Sanitation;
- Efficiency Standards should be incorporated into municipal policies and by-laws.

Municipalities who have developed their own by-Laws, should ensure inclusions of low-flush systems, taking the same considerations as for the Model By-laws.

4.5 Model Standard Toolbox (commentary only)

The technical aspects of the Model Standard are not covered as part of this research study, but does allow for commentary towards the development of Standards and Norms for Low-flush / Water Efficient Toilets.

Extensive comment has been made under the preceding sections relating design and performance aspects, aimed at a focussed water efficient toilet uptake. In addition, the envisaged changes to SANS 10400 and NBR, as well as the extent of testing and performance criteria related to the testing, are already recognised in South Africa.

Compliance with the SANS 10400 and NBR should be a prerequisite when applying building contracts, such as the GCC, FIDIC, NEC and other tender frameworks, related to the installation of plumbing fixtures, etc.

An educated user will empower the user to select their low-flush toilet model and avoid any surprises and disappointment, which will eventually result in poor uptake of the technology. The efficacy of toilet functioning can be demonstrated and uptake enhanced by demonstrating and using tools that provide insight into individual model performance, such as MaP ratings.

MaP of toilets was developed to identify how well popular toilet models flush, using a realistic test media, and to grade each toilet model based on this performance. The test results list numerous toilet fixtures and the flushing performance of each fixture. This is essential information for anyone buying a new toilet. (MaP, n.d.).

In North America, the MaP testing protocol is widely accepted as the de facto flushing performance test for toilets, and it is included in both the U.S. EPA's WaterSense program (voluntary program) and the ASMEA112.19.2/CSA B45.1 Standard for Ceramic Plumbing Fixtures (mandatory compliance). The difference between the programs and the MaP is that they only pass/fail test a toilet model at 350 grams, whereas the MaP is essentially a 'test to failure' up to a maximum of 1,000 grams. The MaP scores represent the number of grams of solid waste (soybean paste and toilet paper) that a particular toilet can between both programs and the MaP is that they only pass/fail test a toilet model at 350 grams, whereas the MaP is essentially a 'test to

failure' up to a maximum of 1,000 grams. The MaP scores represent the number of grams of solid waste (soybean paste and toilet paper) that a particular toilet can flush and remove completely from the fixture in a single flush.

Note: MaP deals mainly with USA toilet systems, but their testing protocols in MaP-qualified laboratories, are readily available (MaP, n.d.). MaP laboratories exist in North America (including Canada) and Asia (IAPMO R&T Labs). The various internationally located IAPMO R&T Labs provide product certification and testing (including MaP) for U.S., Canada, Mexican, Australian Indonesian and other markets. (IAPMO, n.d.)

Testing methods should incorporate and adjust the MaP concept or develop a similar publicly available platform to test South African toilets systems. For the South African version of the "MaP Testing" to be effective, it is recommended as an independent testing program, not affiliated with- or controlled by any manufacturer or group. This concept could fit well into the "WELS Regulator" concept and warrant further investigation and development as part of the regulatory toolbox.

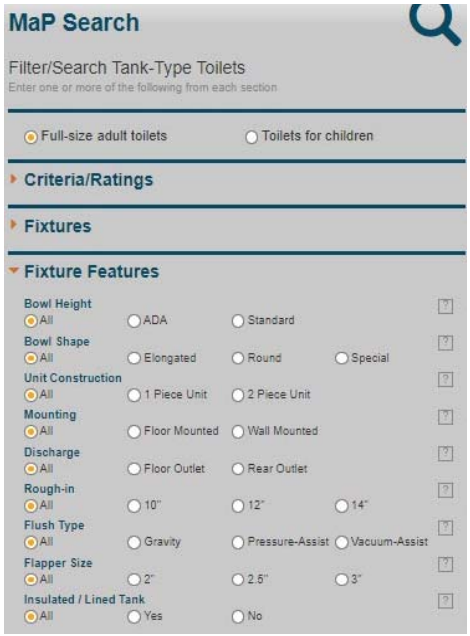

Figure 14: Comparative Fixture Features for selection using MaP. (MaP, n.d.)

5 CHAPTER 5: A POLICY BRIEF FOR LOW-FLUSH WATER EFFICIENT TOILETS FOR SOUTH AFRICA

A Policy Brief was developed to support national, provincial and local government to position, adopt, support and promote low-flush / water efficient toilets in the South African market space. Included are recommendations for potential incentives and rebates that would enhance uptake of the technology. The key focus areas in the Policy Brief were informed and developed based on a systematic and comprehensive review South African policies, regulations and standards that governing low-flush / water efficient toilets. International best practice was used to inform the Policy Brief, adopted to fit the South African context. Finally, input by stakeholders and industry experts were used to test and finalise the recommendations and draft the Policy Brief.

The Policy Brief aims to:

1. Identify gaps in policies, regulations and standards that deter the adoption and uptake of low-flush / water efficient toilets, specifically in terms of the South African context;
2. Make recommendations to allow for enabling South African policies, regulations and standards that encourage the adoption and uptake of low-flush / water efficient toilets;
3. Comment on mitigation concepts and actions for any other aspects that may deter the recommendation from being adopted and implemented; and
4. Make recommendations for incentives and rebates that could be utilised to enhance the uptake of the technology.

Table 5-1: The focal points of the brief

CATEGORY	RECOMMENDATIONS	
KEY DRIVERS TO FACILITATE UPTAKE & COLLABORATION	**1**	**Enact** water efficient accommodations in the **National Sanitation Policy** (2016) regarding Appropriate Sanitation Technologies
EXTEND EXISTING POLICIES	**2**	Develop a **national policy** on water efficient technologies
	3	Adopt and develop a **Water Efficiency Labelling and Standards** (WELS) rating system for water efficient appliances and fixtures
LEADERSHIP AND SYNERGY OF WATER EFFICIENT TECHNOLOGIES	**4**	Identify potential Water Efficiency Labelling and Standards (WELS) system for the **Regulator and its legislative home**
LEGISLATION DEVELOPMENT	**5**	**SANS 10400 amendments** and extending it with Part XB – Efficient water usage in buildings for water
	6	Ensure **synergy and alignment** between the Department of Human Settlements' Guidelines for Human Settlement Planning and Design, the various Municipal design requirements, and the NBR and to ensure that the norms and standards for Housing meet those of the National Housing Regulations
	7	**Legislation to allow the enactment** of a Water Efficiency Labelling and Standards (WELS) rating system for water efficient appliances and fixtures

CATEGORY	RECOMMENDATIONS	
POLICY CONCEPTS THAT REQUIRE FURTHER INVESTIGATION	**8**	Policy concepts relating to further **technical research**
	9	Policy concepts relating to further **consumer research**

The policy brief is aimed at national government, specifically departments mandated to address water, climate and trade, human settlements, water and sanitation strategy, trade and industry, as well as the National Regulator for Compulsory Specifications (NRCS). Each policy recommendation is attributed to a department that should own and implement the particular policy element. Where there are two or more departments that are deemed responsible for addressing a policy recommendation, one of them will be deemed the lead ("champion"). The policy brief will also benefit local government in terms of their mandate to locally regulate and implement these initiatives.

The Policy Brief is attached as an Appendix 4.

6 CONCLUSIONS

This study departed from the hypothesis that a better understanding of the policy and regulatory environment, as pertaining to low-flush toilets, will assist to identify and address the gaps that underly the seemingly poor uptake of low flush toilet technology in the South African market place.

Underlying reasons were identified for the low adoption of low-flush toilets, as rooted in policy, standards, bylaws and technology, and experts from the water and plumbing sectors were consulted to confirm and comment on the study findings, towards developing recommendations and a responsive toolbox.

Low-flush toilets are predominantly viewed to be part of sustainable water efficient toilet industry in SA that would contribute to protecting and conserving the scarce water resources of the country. However, a number of constraints, including negative perceptions, lack of an organised approach, and poor access to credible information, all led to a limited uptake of the technology – after a seemingly positive initial support and goodwill for water efficient innovations.

The study revealed that a mindset "reset" is required, which could be affected by:

- Reintroduce water efficient concepts – it is critical that these are shown to be inclusive, systematic, and organised;
- Ensure that information be easily obtainable, e.g. use labelling and rating regulatory system for water efficient devices;
- Establish consumer forums that can liaise with Standards testing outcomes, manufactures, building policy, regulations developers and ensure synergy is achieved;
- Implement a nationally sponsored public education campaign with regard to water efficient devices.
- This campaign can be extended to include for the concepts of a WELS rating system, retrofitting and rebate systems, once these concepts have been confirmed and developed.

The outcomes of this study provide recommendations that will:

- Enable SA policies, regulations & standards to facilitate and fast-track the adoption and uptake of low flush water efficient toilets;
- Assist in mitigating aspects that may deter effective implementation;
- Identify incentives & rebates that would enhance technology.

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APPENDIXES

APPENDIX 1: Examples of Different Toilet Technology and Structures

Examples of different Toilet Types: (Mani,V, 2019a)

Figure 15: Normal water closet - EWC or WC

Figure 16: WC health

Figure 17: Squatting type pan

Figure 18: Anglo Indian type toilet

Figure 19: Small size squatting pan toilet for kids

Figure 20: Smart toilet type

Figure 21: Squatty potty type toilet

Figure 22:Rimless Type toilet

Figure 23: Tornado Flush – Toto

APPENDIX 2: QUESTIONNAIRE

Refer to Questionnaire in *spreadsheet format*, designed to cover the following subjects per worksheet:

APPENDIX 3: Low Flow Toilet ("LFT") Grant & Rebate Funding (Example)

Scenario:
Assume a Rebate/Grant fund is achieved with a special levy of 50c/kl water billed by the WSP, with a National Government co-fund contribution (terms and conditions to be applied). The funding is broken down as follows:

In Metro areas:

- the WSP's Rebate/Grant portion of funding is based on a 20:80 split;
- 20% fund is available for the rebate programmes for Commercial and Residential programmes with a 50% split to each ("Commercial" includes for Commercial / Multi-family / Institutional consumers)
- 80% forms the WSP's grant fund portion, which is then combined with an equal contribution from National Government.

In non-Metro areas:
In this example, available information on billed volume for commercial and residential were applied as separate values, and used to calculate the various Rebate and Grant fund portions:

- The WSP's rebate portion of the funds were calculated as;
    - For the Commercial Rebate, the fund was based on a 50c/kl contribution from the commercial billed volume,
    - For the Residential Rebate, the fund was based on a 20:80 split of a 50c/kl contribution from the residential billed volume. Thus, only 20% of the residential collected funds are available for the Residential Rebate programme.
- The remainder 80% of the residential collected funds forms the WSP's grant fund portion which is then combined with an equal contribution from National Government.

In order to estimate "project cost per household" for the grant fund aspects of the two programmes, indicative costing for the programmes listed are applied in the table below. The grant fund programmes are:

- Pensioner and low-income family full retrofit programme (PLIFR);
- Low-income Toilet Replacement programme (LITR) – just replacing toilet.

Appendix Table 1: Estimated Project cost per household (Budget figure)

Envisaged Project Cost per House	Shower head replacement	Toilet replacement	Taps Flow controller (4 taps/ bathroom)	Add Material Cost = R500 + including 10% for unforeseen expenses	Labour (Est)	Est Total Cost	Recommended Budget Cost
Cost per house retrofit	R200	R900	R200	R1,980.0	R2,000	R3,980	R4,000
Cost per toilet replacement		R900		R1,540.0	R1,200	R2,740	R2,800

Note:

- *Estimated Project cost per household (Budget figure): Rough appliance costs from web, e.g. CTM, Builders, etc. website prices for standard water efficient / water saving devices/items (Sept 2020)*

These concepts are illustrated below by calculating the fixture rebates or household retrofits that can be achieved through the various programmes within a typical metro and non-metro area.

Metro Areas:

Determination of volume: this calculation was derived from an assumed % billed (58%) vs provided, based on KZN-Umgeni Water info (Umgeni Water, 2019) for eThekwini area:

Appendix Table 2: Assumption of % billed vs provided

Example: Municipal area	ML/d provided	ML/d billed	% bill vs provided
Within KZN Province	1857	1075	58%

Calculation of the anticipated portion of rebate/grant funding available from the WSP was based on eThekwini Municipality (Metro) info for 2017/2018 (Umgeni Water, 2019):

Appendix Table 3: Determination of LM/CMA/WSP portion of fund available -Metro Area

Example Municipality	ML/d provided (June 2018)	% bill vs provided	Annual Billed Water Sales (ML)	Annual "LFT" Rebate & Grant fund portion available from LM/CMA/WSP (re 50c/kl billed vol)	Annual "LFT" Rebate Portion Fund Available (20% of collected funds)	Annual "LFT" Grant fund (80% of collected funds)
Municipality / Metro X	854	58%	180446	R90,223,008	R18,044,602	R72,178,406

Determination of Total Grant fund available - Metro Area

Appendix Table 4: Determination of Total Grant fund available -Metro Area

Example Municipality	Annual "LFT" Rebate & Grant fund portion available from LM/CMA/WSP (re 50c/kl billed vol)	Annual "LFT" Grant fund portion for LM/CMA/WSP (80% of collected funds)	Annual Nat Gov Contribution "LFT" Grant fund	Total Combined Annual "LFT" Grant Fund Available *
Municipality / Metro X	R90,223,008	R72,178,406	R72,178,406	R162,401,414

**Round-up the available combined budget to R162.5 million/a to determine the number of households assisted:*

Appendix Table 5: Envisaged household households assisted per annum – Metro Area

Combined Annual "LFT" Grant fund Available	Pensioner and low-income family full retrofit programme (PLIFR)			Low-income Toilet Replacement programme (LITR)			Total households assisted/ annum
	PLIFRP (50% portion)	Est Cost per house retrofit	No of retrofit houses / annum	LITRP (50% portion)	Est Cost per toilet replacement	No of Toilet replacement/ annum	
R162,500,000	R81,250,000	R4,000	20313	R81,250,000	R2,800	29018	**49330**

From the calculations, the annual assistance achieved per Annual "LFT" Grant programme is:

- Pensioner and low-income family full retrofit programme (PLIFR) - 20 313 households;
- Low-income Toilet Replacement programme (LITR) - 29 018 households;
- Combined - 49 330 households served per annum.

Determination of Total Rebate (water credit) fund available -Metro Area:

The Rebate credit fund has two components, Commercial and Residential, with an equal budget split. The table below indicates the potentially available budget and annual assistance achieved through annual rebates (credit) @ R450/ fixture for the two sectors.

Appendix Table 6: Determination of Total Annual Rebate fund available and potential annual replaced fixture achieved -Metro Area

Example Municipality	Annual "LFT" Grant fund (50c/kl) Available from LM/CMA/WSP	Annual "LFT" Rebate Portion Fund Available (based on 20% of collected funds)	"Commercial Portion (Based on 50% of Annual ""LFT"" Rebate Portion Fund Available) "	Commercial Sector: No of annually Rebated (credited) Fixtures	"Residential Portion (Based on 50% of Annual ""LFT"" Rebate Portion Fund Available) "	Residential Sector: No of annually Rebated (credited) Fixtures
Municipality / Metro X	R90,223,008	R18,044,602	R9,022,301	20050	R9,022,301	20050

From the calculations, the illustrative annual Rebate credit assistance achieved per sector is (including Commercial / Multi-family / Institutional consumers):

- Commercial - 20 050 fixtures replaced;
- Residential - 20 050 fixtures replaced.

Local Municipality Area:

The example calculations were derived from Drakenstein LM's Paarl & Wellington figures (Drakenstein LM, 2018) & (Drakenstein LM, 2020), where Drakenstein is the WSP. The available municipal information provided separate billed volumes for the commercial and residential consumer sectors. These values were then used to calculate the various Rebate and Grant fund portions:

- The WSP's rebate portion of the funds were calculated as:
    - For the Commercial Rebate, the fund was based on the 50c/kl contribution from the commercial billed volume;
    - For the Residential Rebate, the fund was based on a 20:80 split of the 50c/kl contribution from the residential billed volume. Thus, only 20% of the residential collected funds are available for the Residential Rebate programme.
- The remainder 80% of the residential collected funds forms the WSP's Grant fund portion which is then combined with an equal contribution form National Government.

Applying data from both the Drakenstein Municipality's "Annexure A - Annual Report 2018-2019" (Drakenstein LM, 2020) and Water Conservation and Water Demand Management Strategy (Drakenstein LM, 2018), the breakdown of % Residential vs % Commercial billed water use was estimated as:

Appendix Table 7: Estimated breakdown of % Residential vs % Commercial billed water use

Drakenstein Local Municipality - Paarl / Wellington: (Municipality Z)		
Portion of System Volume (2016/17) (Ml/a)	Residential portion in Ml/a (based on 48.74%)	Commercial portion in Ml/a (based on 10.94%)
14 220.506	6 930.405	1 555.850

Determination of Grant fund available based on Municipality info for 2016/2017:

Calculation of anticipated portion grant funding available from the WSP was based on 80% of the Residential water sales.

Appendix Table 8: Determination of Grant fund available -LM Area

Example Municipality	Annual Billed Water Sales (Ml/a) (2016/2017)	Total Annual Residential "LFT" Rebate & Grant fund (50c/kl) Available from LM/CMA/WSP	80% of Residential Billed Water Sales (Ml/a) (2016/2017)	Annual "LFT" Grant fund (based on 80% of collected funds)	Annual Nat Gov Contribution "LFT" Grant fund	Combined Annual "LFT" Grant fund Available
Drakenstein LM - Paarl / Wellington Portion: (Municipality Z)	6 930	R3,465,203	5 544.324	R2,772,162	R2,772,162	**R5,544,324**

Using a rounded-up value of the available combined budget of R5.5 million/a, the potential annual number of households assisted that be assisted, can be determined as follows:

Appendix Table 9: Envisaged household households assisted per annum - LM Area

Combined Annual "LFT" Grant fund Available	Pensioner and low-income family full retrofit programme (PLIFR)			Low-income Toilet Replacement programme (LITR)			Total households assisted/ annum
	PLIFRP (50% portion)	Est Cost per house retrofit	No of retrofit houses / annum	LITRP (50% portion)	Est Cost per toilet replacement	No of Toilet replacement/ annum	
R5,500,000	R2,750,000	R4,000	688	R2,750,000	R2,800	982	**1 670**

From the calculations, the annual assistance achieved per Annual "LFT" Grant programme is:

- Pensioner and low-income family full retrofit programme (PLIFR) - 688 households;
- Low-income Toilet Replacement programme (LITR)- 982 households;
- Combined – 1 670 households served per annum.

Determination of Total Rebate (water account credit) fund available - Local Municipality Area:

The Rebate credit fund has two components, Commercial and Residential, the values of which are based on the sector's billed water volumes. The tables following provides an indication of the potentially available budgets and the illustrative annual assistance achieved through annual Rebates (water account credits) @ R450/ fixture for the two sectors.

Appendix Table 10: Envisaged household households assisted per annum - Commercial Sector

Example Municipality	Commercial Sector		
	Annual Billed Commercial Water Sales (Ml/a) (2016/2017)	Annual "LFT" Rebate fund (50c/kl) Available from LM/CMA/WSP	No of annual Rebates (credit) @ R450/ fixture
Drakenstein Local Municipality - Paarl / Wellington: (Municipality Z)	1555.8503	R777,925	1729

Appendix Table 11: Envisaged household households assisted per annum - Residential Sector

Example Municipality	Residential Sector		
	Annual Billed Residential Water Sales (Ml/a) (2016/2017)	20% of the Annual "LFT" Rebate fund (50c/kl) Available from LM/CMA/WSP	No of annual Rebates (credit) @ R450/ fixture
Drakenstein Local Municipality - Paarl / Wellington: (Municipality Z)	6930.4050	R693,041	1540

From the calculations, the illustrative annual Rebate credit assistance achieved per sector is (including Commercial / Multi-family / Institutional consumers):

- Commercial - 1 729 fixtures replaced;
- Residential - 1 540 fixtures replaced.

APPENDIX 4: Policy Brief

Refer to Policy Brief document: Promoting the effective uptake and implementation of low-flush / water efficient toilet technology in South Africa