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Domestic Water Saving Fixtures Report

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1. Introduction

1.1. Background - is South Africa facing the largest drought of the last century?

"South Africa is a 'water-stressed' country, bordering on water scarce… water may become a binding constraint on development, at least in some parts of the country" (National Planning Commission, 2011). 'In many parts of the country, we are fast approaching the point at which all of our easily accessible freshwater resources are fully utilised. All South Africans must recognise this situation so that necessary steps are taken to assess current and future demands for water.' – NWRS2, 2013, page 4.

It can be argued that South Africa as a whole is experiencing the worst drought of the last century. According to the South African Weather Service (see link for more information), South Africa received the lowest rainfall between January and December 2015 since the recording of rainfall began in 1904! Since 1904, rainfall in all nine provinces has averaged 608 mm per year, while in 2015 South Africa received only an average of 403 mm (66% of the annual average). Previously, the lowest rainfall received in a year was in 1945 when South Africa received 437 mm (72%).

The sustainable provision of water to South African citizens is becoming an increasing challenge. The demand on the potable water supply system could be alleviated by implementing water demand management strategies on a domestic and commercial scale. One such demand management strategy is to encourage the installation of water efficient fixtures in all homes and offices. Additionally, South African citizens have in recent years been exposed to considerable water tariff increases due to pressures on the water supply infrastructure. Identifying ways to reduce domestic and commercial water demand in a cost effective manner will help individuals and businesses reduce their water utility bills.

1.2. Report Aims

This report proposes a DIY water efficient fixture installation guide for domestic / commercial water users to reduce potable water consumption (and associated costs) in homes and offices. Proposed interventions are intended to be implemented without the need for professional assistance. The report is limited to three fixtures that consume large amount of potable water domestically / commercially namely, toilets, taps and showers. For more information on larger scale, complex commercial or industrial situations, please contact us directly – our details are provided on the JG Afrika website.

1.3. What are water efficient fixtures and why are they important?

In your home, the appliances and fixtures that use most water will usually be the washing machine, dishwasher, shower, basin taps and toilet. Fixtures that save water include low-flow shower heads, low-flow taps or taps with auto-shutoff mechanisms, and water-saving toilets and urinals. Equipment

that saves water includes dishwashers, clothes washers, other commercial kitchen equipment such as sprayers and steam cookers, as well as industrial process equipment. Water efficient fixtures are devices designed to reduce water consumption and can be installed or retrofitted in most domestic and commercial sites where inefficient fixtures exist.

Reducing water use from fixtures and equipment is perhaps the easiest method to reduce total potable water use. It does not require extensive design solutions, just specifying certain products. Water-efficient appliances and fixtures can save you a lot of water and money in the long term as well as make a big difference to the country's overall use of clean tap water. Replacing older water fixtures with low-flowing ones is a relatively low-cost and quick way for your home / workplace to conserve water and save money. Additionally, by reducing a facility's draw on public treated water supplies, tenants and building managers reduce the energy used by water utilities' to pump, treat, and dispose of water.

Toilets, taps and showers typically consume 40-60% of the total annual potable water use in domestic and commercial areas. Therefore these fixtures are a high impact target area to address when looking to reduce water consumption. They are also relatively easy and cost effective to retrofit with water saving fixtures. For this reason, toilets, taps and showers were selected as the focus of this study. Installing water efficient fixtures for these fixtures can considerably reduce water consumption (up to 50% reduction) and typically facilitates a payback period of less than a year.

However, there are many additional water saving measures that can be adopted to save water. One additional high water use area that can be optimised is laundry water use. By adjusting washing machine settings water consumption can be reduced from 15ℓ/kg washing to 7ℓ/kg washing. However, this requires professional assistance to ensure wash quality is not compromised and is not covered in detail in this report.

1.4. Benefits

The benefits of installing efficient water saving fixtures in toilet, taps and showers is as follows:

- Water saving from installing water efficient fixtures is typically 40-60% (if existing fixtures are standard inefficient fixtures), thereby decreasing demand on municipal water system
- Significant heating cost savings are possible due to reduced hot water use
- Greywater discharge (therefore sewage discharge costs) are significantly reduced, thereby decreasing demand on municipal wastewater plants
- Cost effective fixtures can be installed with no professional guidance

1.5. Disadvantages

The disadvantages of installing efficient water saving fixtures in toilet, taps and showers is as follows:

- Periodic maintenance to remove solids (i.e. sediment) from inlet mesh strainer of aerators and low-flow showerheads is required

- Behavioural change may be required to become accustomed to different water pressures / volumes

2. Water saving fixture selection and installation

2.1. Toilets: hold-flush mechanism

Most toilets in South Africa are installed with standard cisterns (see Figure 1). Older toilet cisterns with a syphon-flushing system hold between 9 litres and 15 litres of water. Modern toilet cisterns hold about 6 litres of water. These standard toilets drain the entire the cistern for each flush. Urine requires smaller flushing volumes than faecal solids and therefore using a full cistern flush for liquids is wasteful. Toilet flushing consumption easily can be optimised through a simple water saving initiative (and good maintenance).

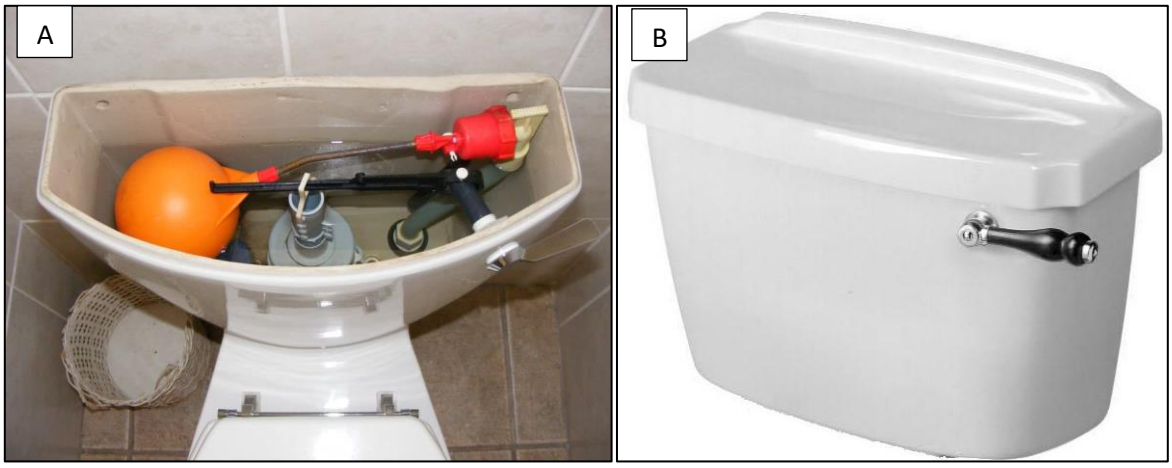

Figure 1: A: Standard flush mechanism, B: typical cistern

A simple, cost-effective, DIY water saving initiative that can be used is to convert standard toilets to a hold-flush (multi-flush or interruptible flush) system that flushes for as long as the handle is held down. Hold-flush systems can result in savings of up to 20% on your water bill. A hold-flush system is simple and lets you control the flush volume – as soon as you let go of the toilet handle it will stop flushing. This can save more than 50% of the flushing volume. Most existing standard toilet cisterns (except dual flush systems and some very old-fashioned mechanisms) can be retrofitted with a hold-flush system for approximately R50 (or less). Materials needed for this retrofit are as follows:

- 3 x lead fishing cup-sinkers (weight 3-4 oz or 85-100g) per toilet
- 1 x cable tie (4.8 x 200mm) per toilet

When the toilet handle is pushed down, the internal cistern lever arm (see Figure 2) is pulled up to initiate siphon action. A lead sinker can be attached to the end of the internal cistern lever arm (see Figure 2) to counterbalance the flush mechanism. The weight of the sinker forces the lever arm down

and prevents the entire cistern from draining each flush. Suitable fishing sinkers can be ordered online from the following online fishing store: http://www.fishingstore.co.za/cup-fishing-sinkers. This intervention can be implemented easily and cost effectively without making any structural changes to the cistern. The cistern should be checked for leaks after installation.

Figure 2: Fishing sinker attached to end of level arm inside toilet cistern to counter-balance siphon flush

There are alternative toilet saving options such as installing a dual-flush system (long and short flush) or reducing your cistern volume by placing a bottle or bag that displaces the water into your cistern. Installing a dual flush system requires replacing the entire cistern, which is be costly (roughly R1500), requires higher levels of maintenance than the hold-flush and is arguably less water efficient. Placing a plastic bottle or 'hippo bag' into your cistern will also reduces the amount of water per flush at little to no cost. A hippo bag costs approximately R17. The container, or bag, should ideally be placed under the ball. If using a plastic bottle container to reduce the water flow, you will need to make a drainage hole on either side of the container, mid-way up, so that the water stored in the container (that takes up space) does not become stagnant. The bottle will need to be weighted down to stop it floating. The use of this system often requires two flushes to flush solids down as the total flush volume has been reduced (Reference: http://www.capetowngreenmap.co.za/go-green/save-water-toilets).

2.2. Taps: low-flow aerators and restrictors

Businesses and homeowners pay for water three times – once to buy it from a utility, once to heat it using gas or electricity, and once to dispose of it as wastewater. That's why high-efficiency tap aerators (see Figure 3) attached to the spout of basin taps can save business owners and homeowners considerable amounts of water and money. These tap aerators are a simple insert for your existing tap fixtures and achieved an estimated basin water saving of 45-65% (and associated hot water costs) as they strict flow from 12-15 ℓ/min to 6-7 ℓ/min. However, not every situation is a good fit for tap aerators, so it's important to keep a few things in mind.

i. Flow Rate: If you already have a low-flow aerator, it may not be effective to replace it. Check this by reading the side of the aerator (the metal ring where the water comes out). If your flow rate is more than 10 ℓ/min you should replace it.

ii. Maintenance: Aerators occasionally need to be rinsed out since sand and particulate can build up, restricting the flow. Plan to replace them periodically (every 2-3 years) to maintain good performance.

iii. Task: Aerators may or may not be a good idea, depending what you're using water for. This guide gives a general rule to gauge your needs:

a) Volume-based tasks: If water is used to fill a container (e.g. pasta pots or dish-washing sinks) aerators will not save water or energy. Instead they will increase the amount of time it takes to complete the task. In this case, don't use an aerator.

b) Flow-based tasks: If running water is used for washing (e.g. hands, dishes or food) then an aerator is the perfect solution. In this case, use a 6ℓ/min aerator.

Figure 3: Low-flow tap aerators

These low-flow tap restrictors supply all outlets evenly with an aerated spray and are generally pressure compensating for constant flow from 0.8 to 6 bar. Aerators restricts the flow of water from your tap without reducing water pressure. They may also include an integrated anti-clogging dome screen to filter sediments and particles. Aerators fit any regular 'M22' or 'M24' aerator housing (22 to 24mm diameter).

To install a new water efficient tap aerator (see Figure 4), unscrew the existing aerator housing and remove your existing aerator (and washers). Assemble your new aerator by placing the insert and new washer into the housing. Clean the thread on your tap. Screw your new aerator on and hand-tighten. Here's a Vimeo video showing the above process (see link).

They can be purchased at various outlet stores. A reliable online shop to order water efficient fixtures is provided in the following link: http://www.sustainable.co.za/water-saving/water-saving-shower-heads.html.

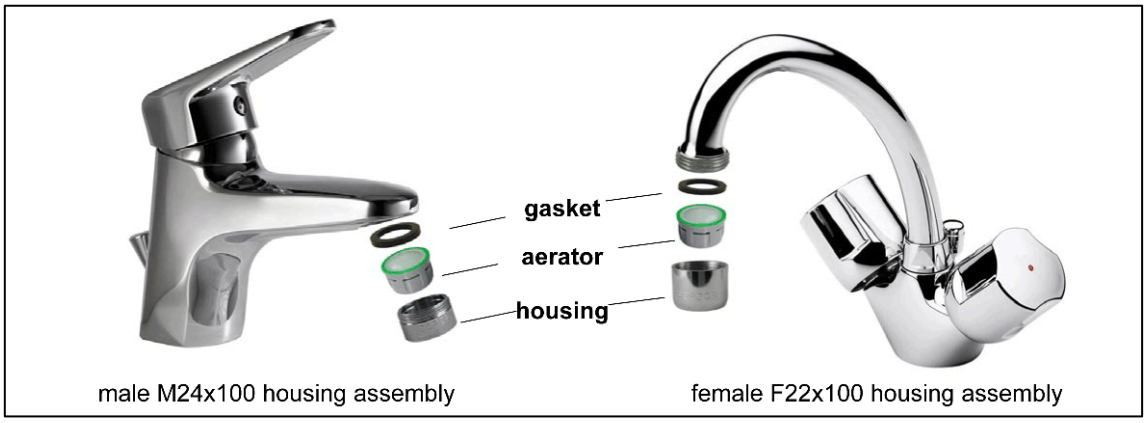

Figure 4: Low-flow tap aerator installation

Existing old-fashioned M22 oval spout (rather than internally threaded modern round taps) pillar taps (See Figure 5). These taps can be retrofitted with water saving internal low-flow tap restrictors. It is recommended that these old-fashioned taps are fitted with Ellies water flow restrictors (FSFR3) and Ellies tap re-seaters (FSFTH3) shown in and Figure 5, or suitable similar alternatives.

Figure 5: Oval spout pillar tap (M22) fitted with Ellies tap re-seater (FSFTH3) and slow restrictor (FSFR3)

These internal low-flow tap restrictors supply all outlets evenly with water and are pressure compensating for constant flow from 0.8 to 6 bar. They provide a non-aerated spray and include an integrated anti-clogging dome screen to filter sediments and particles. They are also very robust and hardy as a single piece insert that ensures a longer design life. These restrictors achieved an estimated basin water saving of 50-65% as they strict flow from 12-15 ℓ/min to 6-7 ℓ/min.

2.3. Showerhead: flow restrictors and aerators

Businesses and homeowners pay not only for water as a utility, but also pay for heating costs and wastewater discharge costs. Installing low-flow aerated showerheads (see Figure 6) can save business owners and homeowners substantial amounts of money and considerably reduce water consumption. These low-flow showerheads are simple to install and fit any regular shower attachment. They achieve

an estimated shower water saving of 45-65% (and associated water heating cost savings) as they strict flow from 12-15 ℓ/min to 6-7 ℓ/min.

These low-flow showerheads are pressure compensating for constant flow from 0.8 to 6 bar. They provide an aerated spray and some items include an integrated anti-clogging dome screen to filter sediments and particles. Effective aerators restrict the flow of water from your shower without drastically reducing water pressure.

Not all showerheads are made equal. Two locally available low-flow showerheads (see Figure 6 'A' and 'B') that have found favourable public appeal are the Oxygenics 'e-Shower' head available commercially for roughly R300 (see link for information) and the 'Value-Eco' showerhead available commercially for roughly R150 (see link information). The design of these shower heads create narrow and high velocity needle jets through the use of laminar flow technology. Each jet remains intact rather than breaking into droplets, thereby using the water saving low-flow efficiently. The result is a powerful spray that feels like a normal shower while saving water and energy (at supply pressures below around 5-7 litres per minute). The Oxygenics flow device is of single orifice design; the nozzle uses a Venturi system consisting of 16 air entrance ports which allow air to increase the spray force and increased oxygen (aeration) levels in the water. The Oxygenics body is chromed high-impact ABS plastic and the base is chromed brass. Both options include a ball joint is incorporated to allow for full adjustment and convenience. Both showerheads are designed to function appropriately at pressures no less than 200 kPa and constructed to withstand pressures of 1000 kPa. These two options are recommended above the Hansgrohe Crometta 85 Green jet overhead shower for roughly R200 (Figure 6 'C') due to their comfort.

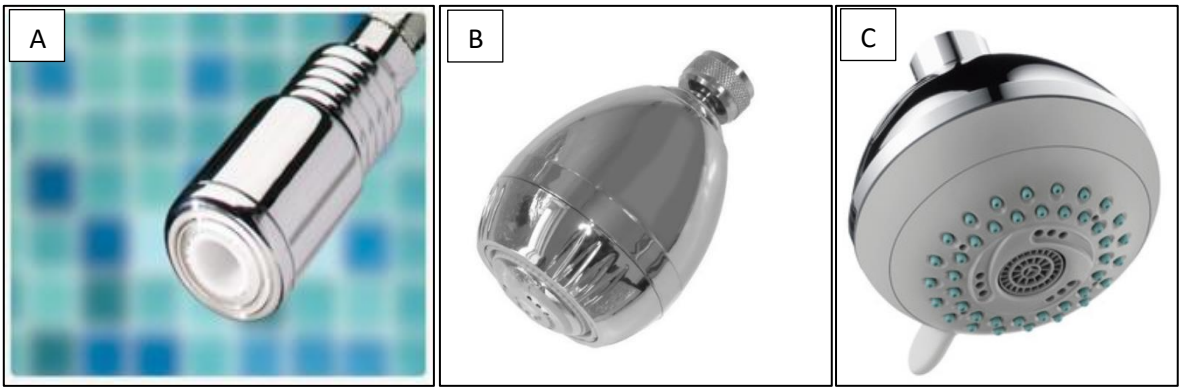

Figure 6: A: Oxygenics 'e-Shower' head; B: 'Value-Eco' showerhead; C: Hansgrohe Crometta 85 Green jet overhead shower

2.4. Domestic implementation - materials, costs and payback

This section provides an example of the required materials, cost estimates and payback for installing selected DIY water saving fixtures (for toilets, showers and taps) for a 4-person household comprising 2 toilets, 3 basins (2 taps each) and 2 showers (using e-Shower Oxygenics shower heads). Please note that these prices are estimates for each item and will vary for each outlet store. The tools required for the installation include a pair of water pump pliers, thread tape and a pair of scissors.

Table 1: List of materials and approximate cost of each item

Item/material	Quantity	Unit cost	Cost
3 oz lead fishing cup-sinker pack (10 weights)	1	R 65	R 65
Cable ties (4 x 250mm) pack (50 units)	1	R 30	R 30
Low-flow tap aerator and housing	4	R 100	R 400
e-Shower Oxygenics showerhead	2	R 300	R 600
Showerhead washer	2	R 10	R 20
Total			**R 1 115**

Cost and saving examples for each efficient fixture has been provided in the tables below to demonstrate the saving potential and payback of each option.

2.4.1. Hold-flush toilet saving and payback

Hold flush toilet retrofits in this example household can save 68% of the toilet flushing volumes and costs. The payback period is 1 month and yearly saving is R1 392.

Table 2: Cost and saving for hold-flush installation

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: The figures above are based on an average size four person household; 1 000 litres = 1 kilolitre (kl); City of Cape Town Municipality water tariff 2016/2017, R23.54/kl (for10.5kl to 20kl/month)

2.4.2. Low-flow aerated taps saving and payback

Low-flow aerated taps in this example can save 60% of the taps volumes and costs. The payback period is 6 months and yearly saving is R619. There may be additional water heating cost savings but these have been ignored.

Table 3: Cost and saving for low-flow aerated taps

Device description	Flow rate (l/min	Daily Use (min/day)	Water usage (kl/yr)	Water cost (R/yr)	Payback (yrs)
Standard tap (existing)	15	8	44	R 1 031	**0.16**
Low-flow aerated tap (efficient)	6	8	18	R 412	
Saving			**26 (60%)**	**R 619**	

Note: The figures above are based on an average size four-person household; 1 000 litres = 1 kilolitre (kl); City of Cape Town Municipality water tariff 2016/2017, R23.54/kl (for10.5kl to 20kl/month)

2.4.3. Low-flow aerated showerheads saving and payback

Low-flow aerated showerheads in this example can save 60% of the taps volumes and costs. The Oxygenics shower head has been selected for this example. The payback period is 3 months and combined water and electricity yearly saving is R2413. Additional water heating cost savings are in fact more than the corresponding water cost savings.

Table 4: Cost and saving for low-flow aerated shower heads

Device description	Flow rate (l/min	Shower time (min/use)	Water usage (kl/yr)	Water cost (R/yr)	Energy Cost (R/yr)	Combined cost (R/yr)	Payback (yrs)
Standard showerhead (existing)	15	8	57	R 1 340	R 2 682	R 4 022	**0.25**
Oxygenics e-Shower (efficient)	6	8	23	R 536	R 1 073	R 1 609	
Saving			**34 (60%)**	**R 804**	**R 1 609 (60%)**	**R 2 413**	

Note: The figures above are based on an average size four person household; 1 000 litres = 1 kilolitre (kl); City of Cape Town Municipality water tariff 2016/2017, R7.70/kl (for 9kl to 25kl/month).
0.047kWh is the amount of energy required to heat a litre of water from 20°C to 60°C,
Cape Town Municipality electricity tariff 2016/2017, R1.67/kWh (for single phase electricity)

Appendix: Additional information

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DIY water saving guidelines and information fact sheets

eThekwini Municipality Water Conservation Guideline

Water Consumption Levels in Selected South African Cities

International Water consumption data table (Wastewater Gardens Information Sheet)

Smart Living – City of Cape Town