GreenCape

Industry brief
2020

Reusing wastewater
Promoting on-site treatment and reuse

Main insights

1) The treatment & reuse of wastewater is a key intervention to mitigate the risk of water supply shortages.

2) Grey- and blackwater can be treated to non-potable standards through on-site wastewater treatment processes.

3) Non-potable water can be used in a wide range of applications

4) A strong business case, compliance with regulations and reputable technology providers are important considerations when investing in this solution.

Context

- South Africa is a water scarce country and is projected to have a 30% water supply deficit by 2030.
- The reuse of wastewater, in conjunction with increasing water-use efficiency and developing alternative sources of water (Figure 1), is seen as a key intervention to mitigate this supply deficit.
- Non-potable water has a multitude of uses ranging from simple household reuse of greywater, to on-site treatment and reuse of grey, black, organic and inorganic wastewater in commercial and industrial settings, to municipal-scale reuse of effluent.

This brief focusses on the on-site treatment of grey- and blackwater to non-potable standards for on-site reuse. It highlights applicable regulations and standards, available technology types and drawbacks or barriers to these technologies.

1. Understand water uses and risks
- Water audits
- Meter and monitor (incl. leak detection)
- Water quality requirements (fit-for-purpose)
- Set water targets

2. Reduce consumption
- Efficient processes
- Efficient fittings and technologies
- Behaviour change

3. Reuse wastewater on-site
- **Use of greywater**
- **Treat water for reuse**
- **Divert water for reuse**

4. Find an alternative water supply
- Ground water production
- Rainwater/stormwater harvesting
- Use of treated municipal effluent

Increasing cost and complexity →

Figure 1: Key interventions that build water resilience.

The Opportunity

1. Wastewater in residential and commercial buildings can be reused for a number of different purposes.
2. While wastewater can be treated to potable standards, this is rarely cost-effective and can be overly complex.
3. Certain industries also produce organic wastewater, while others produce inorganic wastewater, both of which can be treated and reused on-site in many instances.
4. Residential and commercial buildings (offices, retailers, hotels, schools and guesthouses) will have a smaller demand for potable water than non-potable water (Figure 2a), and will produce organic wastewater (grey and blackwater). Therefore, these applications are most likely to be suitable for on-site wastewater treatment and non-potable reuse (Figure 2b).

Key:

- Potable uses
  - drinking
  - food / body washing
- Non-potable uses
  - toilet flushing
  - irrigation
  - outside surfaces
  - vehicle washing
- Losses
  - evaporation
  - drinking
  - irrigation
- Grey water
  - from showers,
  - basins,
  - surface washing
- Blackwater
  - from toilets / kitchen sinks

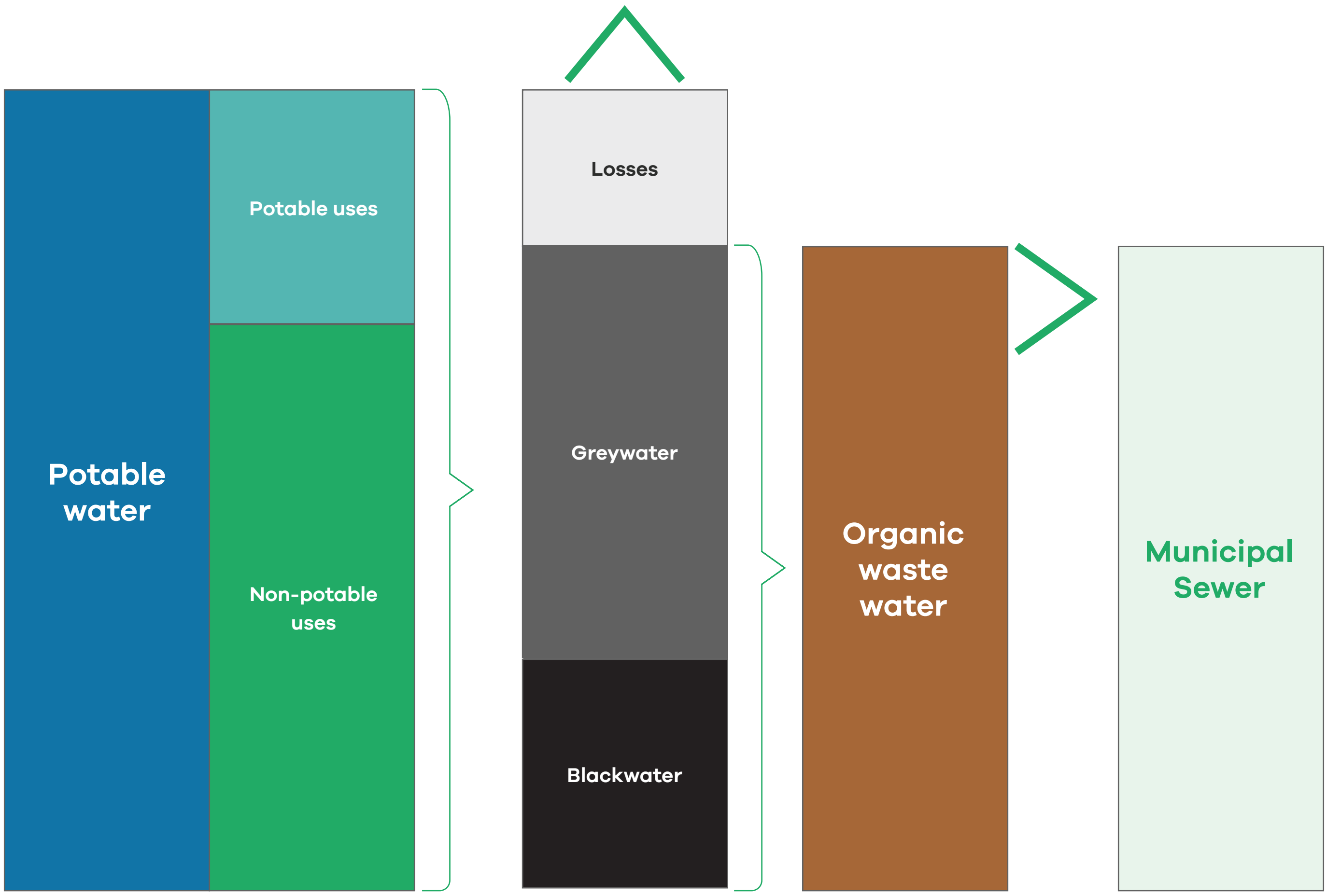

Figure 2a: Water use and wastewater generation flows within a typical residential or commercial property, without on-site wastewater treatment (indicative relative volumes represented by size of blocks).

Glossary:

Organic wastewater:	wastewater that is contaminated with carbon-based contaminants, for example human waste, plant or animal matter.
Greywater:	lightly contaminated wastewater typically from bathroom basins, showers, baths, laundries and light cleaning; classed as organic wastewater.
Blackwater:	contaminated with human excrement (urine and faeces), classed as organic wastewater.
Organic industrial wastewater:	typically wastewater from food and beverage industries with contaminants from food and beverage production
Inorganic industrial wastewater:	contaminated wastewater from industrial processes other than food and beverage production, e.g. mining, petrochemical production
Potable water:	water that is safe to drink, used to wash food or used in production of food and beverage products. Typically supplied by municipality, with quality parameters prescribed by SANS 241.
Non-potable water:	water that does not meet potable standards and, depending on quality, can be used for irrigation, cleaning of vehicles, toilet flushing, industrial processes that do not require high hygiene standards (subject to appropriate guidelines for use). E.g. raw water from a river or dam, or wastewater that has been treated adequately (treated effluent).

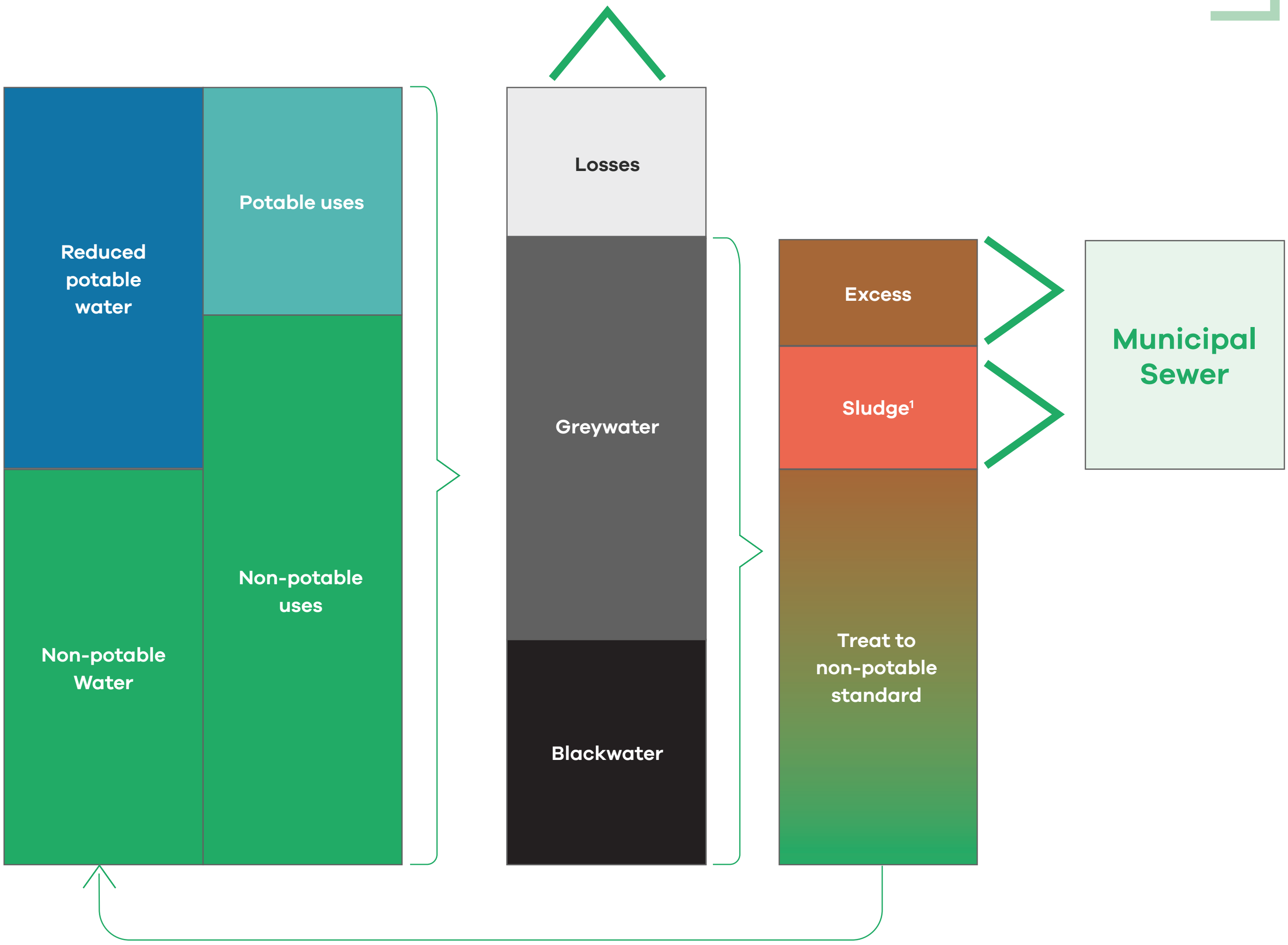

Figure 2b: Water use and wastewater generation flows within a typical residential or commercial property with on-site wastewater treatment and reuse[1] (indicative relative volumes represented by size of blocks).

[1] Sludge can also be removed periodically if it exceeds municipal effluent discharge parameters, or if municipal sewer connection is not available.

The Options

In *urban* settings, a significant proportion of the water demand is for non-potable uses, which is historically met with potable water. Potable water is costlier in most municipalities, and costs are projected to rise at above inflationary rates. In addition, where water restrictions are in place, the cost of water is generally higher, and in many cases, there are restrictions on using potable water for irrigation. Furthermore, in cases where existing wastewater infrastructure doesn't exist (many informal settlements, or in some cases new developments), it may be more cost effective to install on-site wastewater treatment than expanding infrastructure networks to connect to the central wastewater treatment plants.

In *rural* settings, the main driver for on-site wastewater treatment would be the high costs or unfeasibility of connecting to the municipal sewer system, and compliance with the future ban on septic tanks. This would typically apply to:

- Remote / off-grid (farms, schools, guesthouses, hotels; historically serviced by septic tanks, which are unreliable and don't always meet the regulatory standards for treated effluent discharge).
- Mining staff (in addition to being off-grid, staff numbers may fluctuate and can be serviced through temporary on-site wastewater treatment solutions that can be moved to other operations when needed).

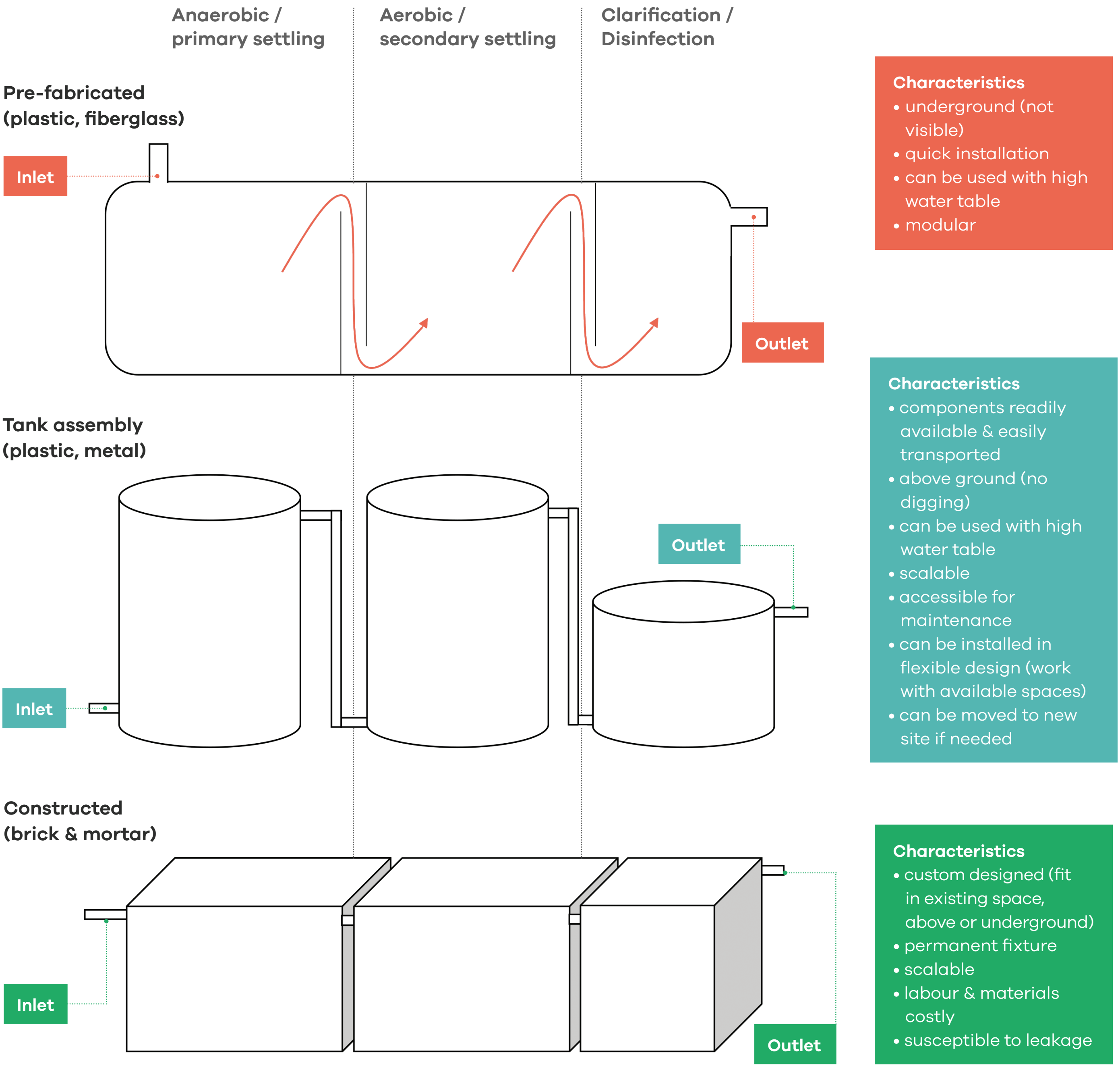

Figure 3: Variants of on-site wastewater treatment technologies, and characteristics specific to each of these.

Technology variants

Organic wastewater is generally treated using biological processes (such as micro-organisms that consume and digest the organic contaminants). In most cases, the following steps are included:

1. Screening to remove large solids;
2. Primary settling where solids settle down, and fats and oils rise to the surface, and initial treatment with anaerobic bacteria occurs (Anaerobic Digestion, AD);
3. Secondary settling where the water from the first treatment step is treated with aerobic bacteria, which requires the addition of oxygen through a variety of mechanisms. Variants here are known as Activated Sludge (AS), or Sequential Batch Reactor (SBR), Trickle Filter, or Rotating Biological Contactor;
4. The final step is clarification and disinfection, typically through chlorination, UV or ozone treatment.

During these treatment steps, sludge is produced, which in some cases has to be extracted and disposed of periodically (every 6 or 12 months depending on the design). While these generalised treatment steps are most common, **technology providers do vary in how they implement these and may exclude one of the steps to reduce costs, or include additional steps to improve performance, depending on the application, the quality of wastewater and desired final water quality.** These variants influence the production and operational costs of a system.

Additionally, materials used to produce or construct on-site wastewater treatment plants vary. These can come in the form of pre-manufactured products, with internal divisions and components, or built using plastic or metal tanks using components commonly available in hardware stores, or constructed with bricks and mortar (see Figure 3 for characteristics of each). The best solution will be determined by site-specific constraints and client needs.

Drawbacks and barriers

On-site wastewater treatment can be effective, but there are some drawbacks even when a system is correctly designed, installed and operated.

- If the design parameters of the system are not adhered to, e.g. with the introduction of **inorganic contaminants, the plant can be rendered ineffective** as the bacteria that treat the organic load are killed. These bacteria can be re-established, but this can take several weeks (during which time the plant will not operate correctly). In some cases, this limitation requires using alternative chemicals or cleaning agents, in conjunction with user education.

- **Variable wastewater volumes or organic loading** (for example seasonal changes in the amount of wastewater that gets discharged into the system) can be problematic as the bacterial populations that digest the organics die off when there is low loading, and cannot multiply quickly enough with sudden increases in loading. Technology suppliers can usually advise on how to address this problem.

- Possible consequences are that effluent that has not been treated to the required quality is discharged / reused (either human or environmental risk). Systems with quality control and ability to over-ride the system until the effluent quality is suitably treated are preferable, and required by the SABS standards.

- Increased **operational complexity**, as some technologies require periodic de-sludging or frequent dosing with bacteria and / or chlorine. These activities are not overly difficult, but do require additional attention, and some technology suppliers offer this as a service contract.

- **Upfront costs** can be prohibitive, although some technology providers do offer internal financing arrangements, or financing via commercial banks.

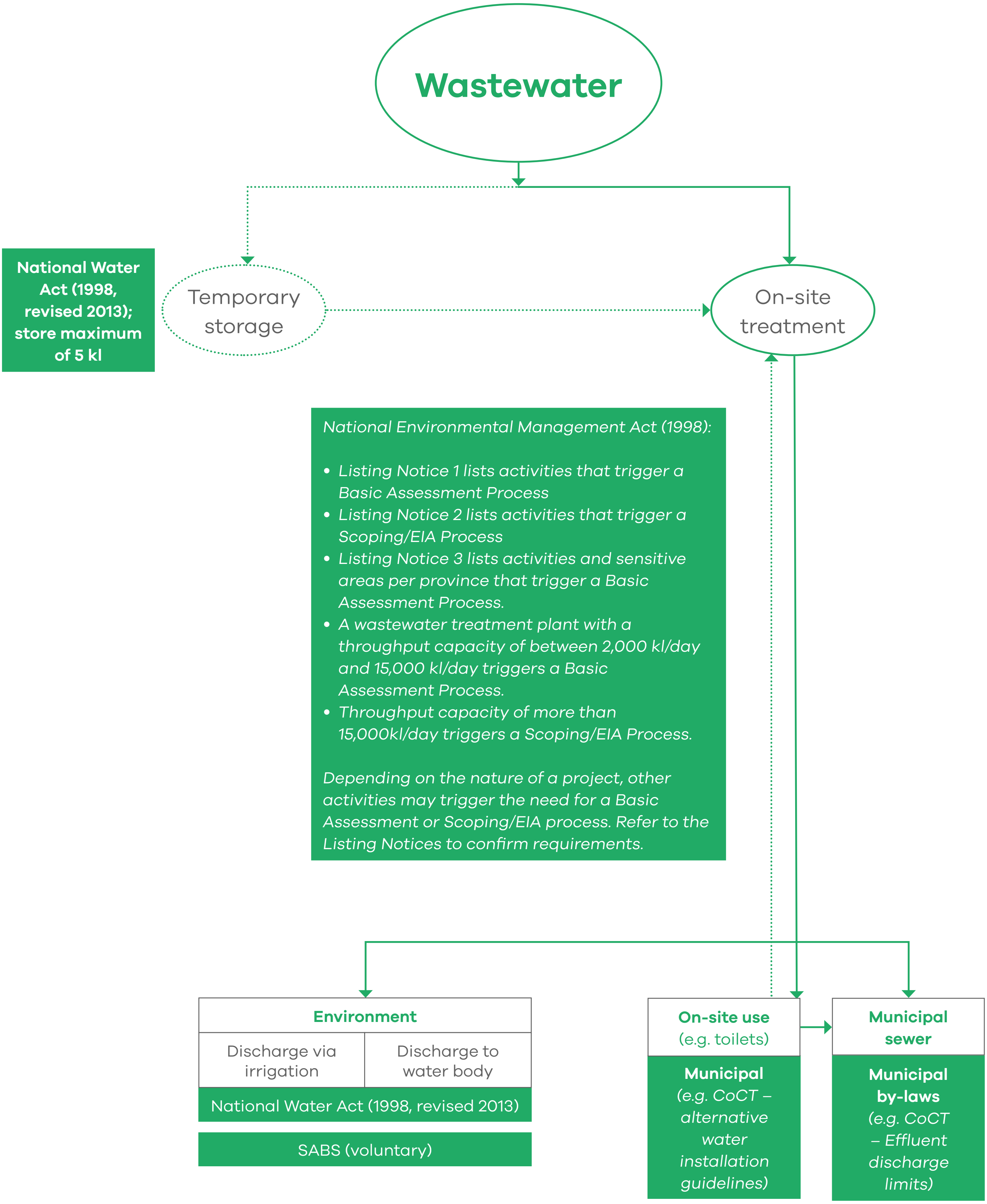

Figure 4: Relevant regulations and standards applicable to on-site wastewater treatment and reuse.

Regulations & standards[2]	
National Water Act (1998) with Revision (2013)	The NWA regulates all wastewater discharged into the environment, and these regulations on General Authorisations for wastewater were revised in 2013. Discharge of wastewater (e.g. for irrigation or into a water body; see Figure 4) should be registered with the national Department of Human Settlements, Water and Sanitation (DHSWS). If the water quality parameters fall within the general limits (see Figure 3) a general authorisation for discharging of wastewater applies. If the conditions of the general authorisation are not met, a Water Use Licence should be applied for. The general authorisation has different maximum limits for the water quality parameters, depending on the total daily discharge volume. Special limits are to be adhered to if treated wastewater is discharged within certain sensitive catchments that are listed in the NWA (revision 2013).
National Environmental Management Act (1998)	The NEMA outlines the conditions that require an environmental impact assessment (EIA) or a basic assessment (see Figure 4).
Municipal	By-laws related to the discharge of effluent or treated effluent into the municipal sewer system (sewer discharge limits, specific to each municipality) Guidelines for the installation of alternative water systems (any alternative water source, such as rainwater harvesting or on-site reuse of wastewater for non-potable uses).
Standards The SABS has recently produced standards for non-sewered sanitation systems or NSSS (SANS 30500:2019) which include back-end products like on-site wastewater treatment systems. These standards were adopted from the International Organisation for Standardization (ISO), specifically ISO 30500:2018. Importantly, this standard is voluntary and can only be applied to pre-fabricated on-site wastewater treatment products (as tank assemblies and constructed systems cannot be tested for quality assurance according to these standards). The categories of wastewater reuse differ between the SABS and NWA, and it's important to note that the NWA should always be complied with.	

<table>
<tr><th></th><th colspan="2">Irrigation[4]</th><th>Discharge to water body</th></tr>
<tr><td rowspan="2">General Authorisation under the National Water Act (1998, and revised 2013)</td><td colspan="2" rowspan="2">General limit: urban & non-urban irrigation <2000m^3/day
• TSS < 25 mg/l
• COD < 75 mg/l
• Faecal coliforms < 100 000 / 100ml

General limit: urban & non-urban irrigation <500m^3/day
• COD < 400 mg/l
• Faecal coliforms < 100 000 / 100ml

General limit: urban & non-urban irrigation <50m^3/day
• COD < 5000 mg/l
• Faecal coliforms < 100 000 /100ml</td><td>General limit: < 2000m^3/day
• TSS < 25 mg/l
• COD < 75 mg/l
• Faecal coliforms < 1000 / 100ml</td></tr>
<tr><td>Special limit (discharge within Listed Water Sources)
• TSS < 10 mg/l
• COD < 30 mg/l
• Faecal coliforms = 0 /100ml</td></tr>
<tr><td>SANS 30500:2019 (SABS)</td><td>Category A (unrestricted urban uses[5])
• TSS ≤ 10 mg/l
• COD ≤ 50 mg/l
• E.coli < 100 /l</td><td>Category B (restricted urban uses[5])
• TSS < 30 mg/l
• COD < 150 mg/l
• E.coli < 100 /l</td><td>Category B (surface water, no indication of discharge to groundwater)
• TSS < 30 mg/l
• COD < 150 mg/l
• E.coli < 100 /l</td></tr>
</table>

Figure 5: Maximum discharge limits of key parameters provided by relevant regulations and standards[3] (TSS: total suspended solids, COD: chemical oxygen demand).

[2] This is a brief overview of regulations and standards, and does not constitute regulatory or legal advice. Responsibility of full regulatory compliance lies with each landowner / installer of wastewater treatment technology.

[3] Note that the key parameters are a subset of all the water quality parameters provided. Check the relevant regulations for the limits for all water quality parameters.

[4] In terms of the NWA, irrigation with wastewater is not allowed within 100m of the edge of a water resource (stream, river, dam, borehole) that is used for human consumption or animal watering, or within the 100-year flood-line, or on land that overlies a majour aquifer.

[5] Unrestricted urban uses refers to uses (such as landscape irrigation and includes toilet flushing e.g. at schools, parks, golf courses) where access by the general public is not restricted. Restricted urban use (similarly irrigation and toilet flushing) refers to areas that are not accessible to the general public (e.g. private or municipal land with perimeter fencing).

Western Cape Provincial Government

Department of Environmental Affairs & Development Planning; Dorp Street, Cape Town

Key points:

- Large commercial building (office space)
- 50% of wastewater (grey- and blackwater) is treated on-site.
- The treated non-potable water is used for toilet flushing (100% of the demand)
- Excess treated water is directed to the municipal sewer (the property has no irrigation needs).

Benefits:

- Potable water savings of ~1 million litres per year
- Water and sanitation tariff savings of ~R50 000 / year (at 2019/20 tariffs, excluding VAT)

Primary motivation:

- Water savings, cost savings and technology demonstration

Iona Wine Farm

Western Cape

Key points:

- Grey and blackwater from 24 homes on the farm and wastewater from the cellar (industrial organic wastewater) was previously discharged, with no treatment, into a small holding dam which then overflowed into a nearby river.
- In response, the owners installed an on-site wastewater treatment facility (MBR) to treat 100% of the household and cellar effluent.
- The MBR treats 10 million litres per year to comply with the General Limits.

Benefits:

- Total cost (capital costs and operating expenditure) over 20 years is ~R25/kl. In comparison, the combined rates for water and sanitation is R51.86/kl in the CoCT.
- Treated water used on-site for irrigation and excess is discharged to dam.

Primary motivation:

- Compliance with wastewater discharge regulations

Informal Settlements

Western Cape

A study conducted by the Western Cape Department of Environmental Affairs and Development Planning, compared the total cost of various sanitation technologies over a 10-year period (which includes capital and operating expenditure).

Primary motivations:

- Least-cost solution
- Improved service delivery

Key points:

- On-site (or decentralised) wastewater treatment is the lowest cost technology option, and can be implemented in a short time-frame.
- Connection to centralised wastewater treatment is marginally costlier, but often not feasible and usually requires much longer development timeframes.
- The highest cost option is chemical toilets (currently a widely prevalent solution used in informal settlements)

Next steps

For further information and support on any of the content provided here, please contact GreenCape's water sector desk: **water@greencape.co.za**.

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Additional resources on improving water resilience are available from:
https://www.greencape.co.za/content/focusarea/drought-business-support

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BETTER TOGETHER.