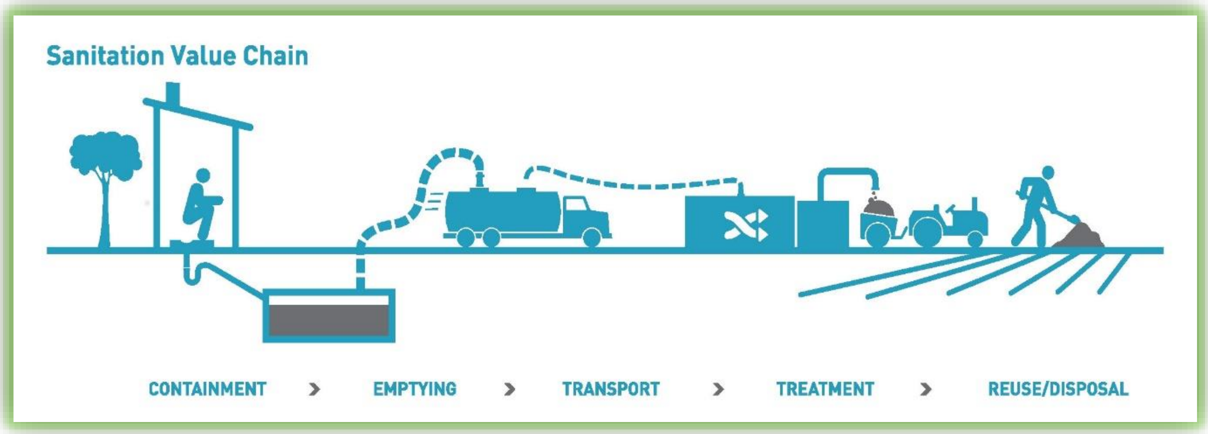
Guidelines for Inclusive Urban Sanitation Service Provision

(Incorporating Non-Sewered Sanitation Services)



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1. Introduction

1.1 Background

Sanitation systems are built and operated mainly to protect public health and the environment. The type of sanitation/wastewater system needs to be chosen and adapted in context with the density of the population, climatic conditions, environmental requirements for treatment and the technical/socio-economical ability of the responsible body to implement it, operate it and maintain it. It needs to be cost effective and sustainable, as well as permitting phased development to overcome the financial constraints while not compromising the stated objectives.

Operationally, the broad objectives of a utility are to provide wastewater collection services on a continuous or at least intermittent basis (depending on the service mechanism chosen), meeting the related capacity requirements. Methods of wastewater treatment and/or disposal need to correspond to the chosen collection system.

Appropriately treated wastewater is eventually returned to the environment and can have significant impact on both quantity and quality of natural water resources.

Effective and safe management of residues resulting from wastewater treatment, including their final disposal or reuse, is becoming increasingly important due to concerns about both environmental protection and resource conservation.

Since it often has a lifetime stretching over several human generations, sanitation/wastewater infrastructure needs to demonstrate intergenerational equity (the concept of fairness or justice in relationships between children, youth, adults and seniors, particularly in terms of treatment and interactions). Consequently, a utility involved with wastewater or sanitation in this case, regardless of ownership, is public in nature and will be subject to public scrutiny, regulation and policy.

The importance of regulation is to ensure efficient, affordable, reliable and quality services while balancing the commercial interest (sustainability) with that of social consideration (affordability). Water Services Regulatory Board (WASREB) has generally been mandated to undertake both economic and technical regulation of WSS service provision to ensure a balance between the quality of the service, the interests of consumers and the financial sustainability of the providers.

The attainment of Sustainable Development Goal (SDG) 6 which calls for clean water and improved sanitation for all and whose official wording is: ''Ensure availability and sustainable management of water and sanitation for all'' is a key target for WASREB. 'Sanitation is defined as access to and use of facilities and services for the safe disposal of human urine and faeces'. (WHO Guidelines on Sanitation and Health, 2018).

SDG target 6.2 calls for adequate and equitable sanitation for all. The target is tracked with the indicator of "safely managed sanitation services" – use of an improved type of sanitation facility that is not shared with other households and from which the excreta produced are either safely treated in-situ, or transported and treated off-site. Achieving the 2030 target of safely managed sanitation requires an inclusive urban sanitation approach that combines regulation of both sewered and non-sewered sanitation service provision.

Consequently, recognizing that the largest proportion of the population in the urban areas of our country depend on non-sewered sanitation, WASREB has adapted a Regulatory Framework and Strategy, developed by ESAWAS, for Inclusive Urban Sanitation Service Provision incorporating Non-sewered Sanitation Services that specifies regulatory touch points along the entire service chain of non-sewered sanitation. This means that all links of the sanitation service chain need to be operated and managed sustainably to ensure continued service provision that protects both public health and the environment.

To achieve safely managed sanitation services, the regulator must ensure that the service provider has 'a safe sanitation system which is a system designed and used to separate human excreta from human contact at all steps of the sanitation service chain from toilet capture and containment through emptying, transport, treatment (in-situ or offsite) and final disposal or end use' (WHO Guidelines on Sanitation and Health,2018).

1.2 Objective of the Guidelines

The objective of the guidelines for inclusive urban sanitation service provision (incorporating non-sewered sanitation) is to provide guidance on service provision requirements from containment, emptying, transportation, storage and treatment facilities as well as disposal/reuse mechanisms, The guidelines promote the use of safe and sustainable technology as well as service delivery which include community participation, cost-effectiveness, disability, social inclusion and gender intentionality (including gender equality, differences, diversity and gender gap).

1.3 Scope of the Guidelines

It is important to note that sanitation includes all four of these technical and non-technical systems namely: Excreta management systems, wastewater management systems (involving wastewater treatment plants), solid waste management systems as well as drainage systems for rainwater, also called stormwater drainage. However, for the purposes of the guidelines, the word 'sanitation' alone is taken to mean the safe management of human excreta and wastewater. It therefore includes both the 'hardware' (e.g. latrines and sewers) and the 'software' (regulation) needed to reduce faecal-oral disease transmission. It encompasses too the re-use and ultimate disposal of human excreta and wastewater. As a result, the scope of the guidelines is limited to the sanitation component that regards excreta management and wastewater management.

The Guidelines:

(a) Define different sanitation systems (a set of technologies) covering the whole sanitation value chain including applicability, design criteria and operation & maintenance requirements;

(b) Define minimum standards for sanitation facilities including containment, emptying equipment, transportation, storage and treatment facilities as well as disposal/reuse mechanisms;

(c) Propose and define key performance indicators for sanitation services along the value chain (the indicators can be used for benchmarking sanitation services or may be included in contracts while outsourcing the sanitation services);

(d) Stipulate the quality of service or an acceptable minimum level of service that providers must achieve within a defined timeframe in terms of standards and performance targets for all services along the sanitation chain in order to assure continued improvement in service delivery for the user;

(e) Outline general guidance for use by licensed service providers when outsourcing parts of the service provision to the private sector, CBOs, NGOs etc.; and

(f) Define monitoring and reporting obligations for the services provided (what is to be reported about to the regulator).

2. Sanitation systems

A sanitation system includes the capture, storage, transport, treatment and disposal or reuse of human excreta and wastewater. Reuse activities within the sanitation system may focus on the nutrients, water, energy or organic matter contained in excreta and wastewater. This is referred to as the "sanitation value chain" or "sanitation economy."

A sanitation system requires to be properly managed, operated and maintained to ensure that the system functions safely and sustainably.

2.1 Objectives of Sanitation Systems

A sanitation system must:

(a) Protect and promote health – it should keep disease-carrying waste and insects away from people, either at the toilet, in nearby homes or in the neighbouring environment.

(b) Protect the environment – avoid air, soil, water pollution, return nutrients/ resources to the soil, and conserve water and energy.

(c) Be simple – the system must be operational with locally available resources (human and material). Where technical skills are limited, simple technologies should be favoured.

(d) Be affordable – total costs (including capital, operational, maintenance costs) must be within the users' ability to pay.

(e) Be culturally acceptable – it should be adapted to local customs, beliefs and desires. Work for everyone – it should address the health needs of children, adults, men, and women.

2.2 Types of Sanitation Systems

The type of sanitation systems recommended for urban context can be grouped into broad categories as listed below:

(a) Onsite sanitation system

(b) Onsite systems with faecal sludge management and offsite treatment;

(c) Onsite system with faecal sludge management, sewerage and offsite treatment;

(d) Offsite systems with sewerage and offsite treatment.

Each of these categories have certain types of infrastructure and processes that passes through functional groups i.e. capture and containment, conveyance/transportation, treatment, end use of by products and disposal as illustrated in figure 1 and figure 2.

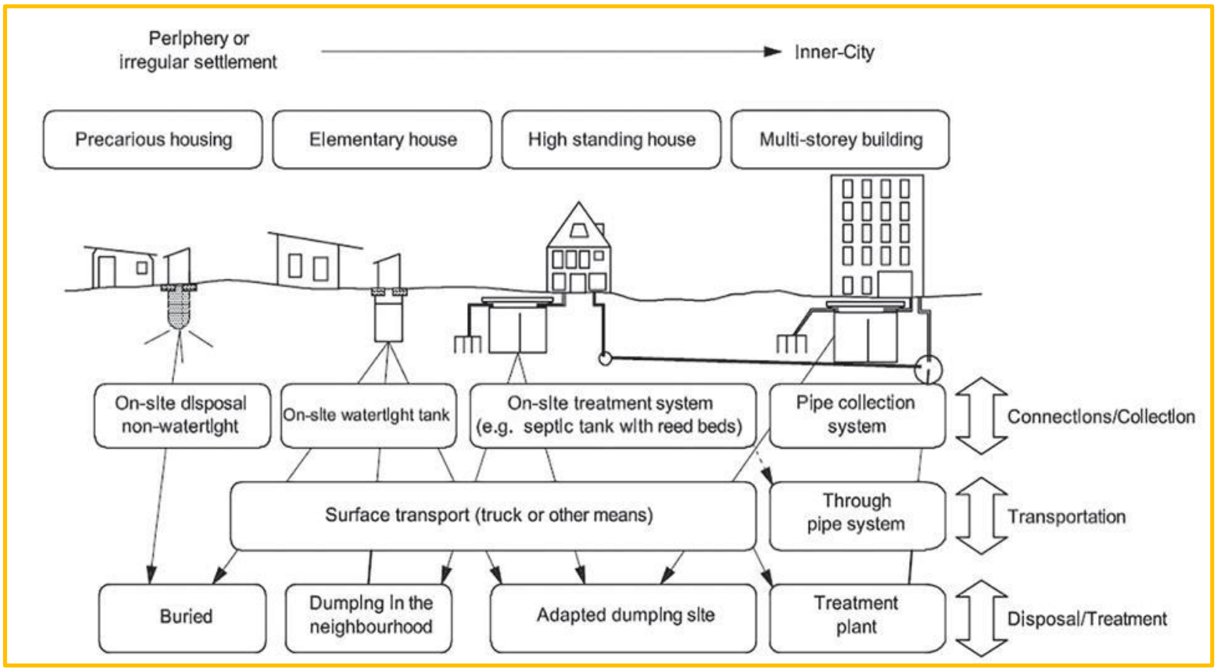


Figure 1 Overview of components of wastewater systems (Source: ISO 24511:2007, Figure B.2)

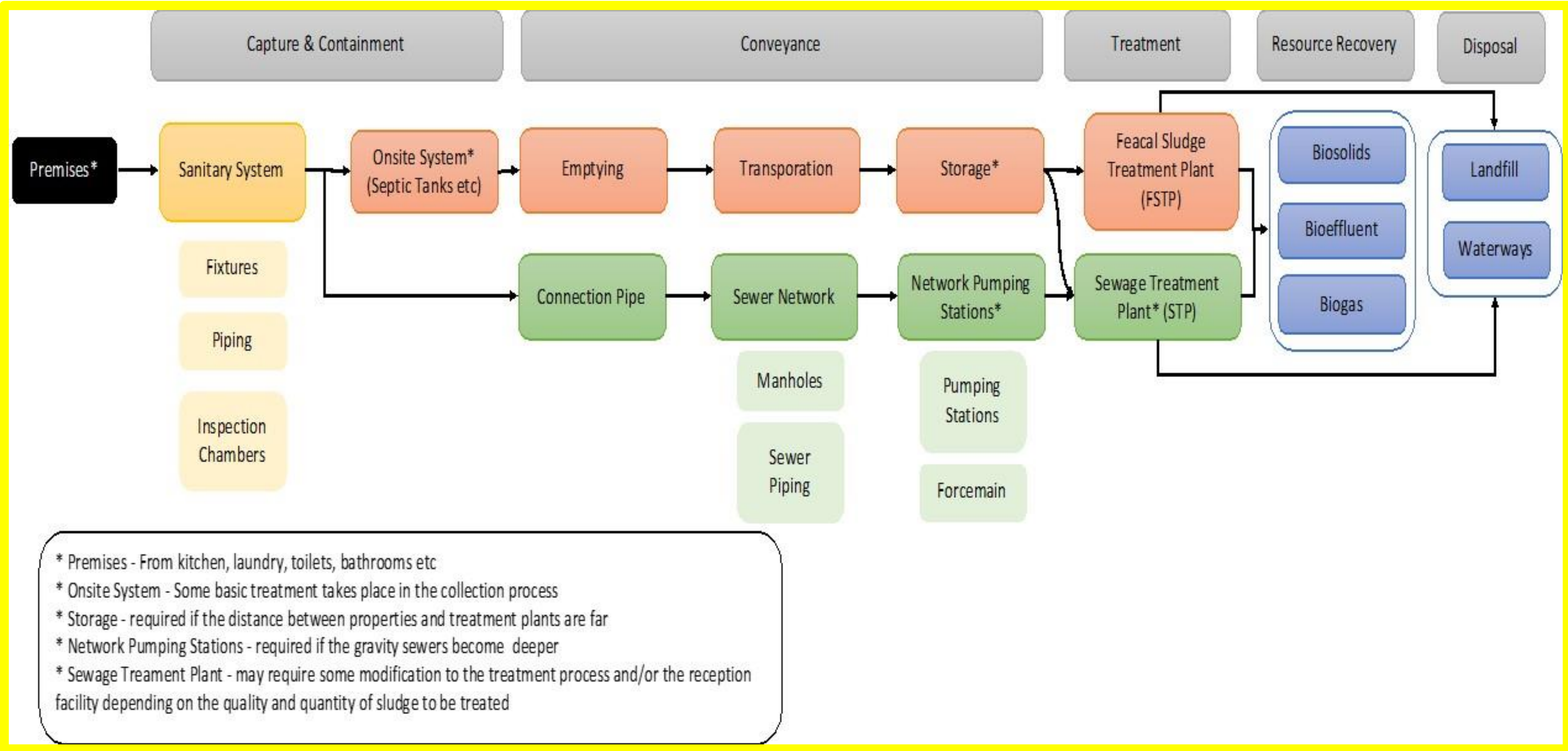


Figure 2: Overview of Sanitation Infrastructure

Table 1: The Category and Types of Sanitation Systems

	Category		Type	Capture	Containment	Conveyance	Treatment	End Use
A	**Onsite sanitation systems**	**1**	Flush toilet with onsite treatment	Pour Flush Toilet	Twin Pit	Manual emptying and transport	Treatment plant for sludge and effluent	Soil conditioner
B	**Onsite systems with faecal sludge management and offsite treatment**	**2**	Flush toilet with biogas reactor and offsite treatment	Pour Flush Toilet or Cistern Flush Toilet	Biogas reactor or anaerobic digester	Pipework for conveyance of biogas		Biogas: used as liquid fuel for cooking, lighting or electricity generation
						Motorized emptying and transport of partially digested liquid sludge (digestate)	Treatment plant for sludge and effluent	Soil conditioner; solid fuel; building materials; irrigation; surface water recharge
		3	Flush toilet with septic tank and effluent infiltration, and offsite faecal sludge treatment	Pour Flush Toilet Or Cistern Flush Toilet	Septic tank or (anaerobic baffled reactor or anaerobic filter) connected to soak pit or leach field	Motorized emptying and transport	Faecal sludge treatment plant for sludge and effluent	Soil conditioner; solid fuel; building materials; irrigation; surface water recharge
C	**Onsite system with faecal sludge**	**4**	Flush toilet with septic tank, sewerage and	Pour Flush Toilet or	Interceptor tank (e.g. septic tank or anaerobic baffled	Motorized emptying and transport	Faecal sludge treatment plant	Sludge: treated and used as soil conditioner, solid

Table 1: The Category and Types of Sanitation Systems

	Category		Type	Capture	Containment	Conveyance	Treatment	End Use
	management, sewerage and offsite treatment		offsite treatment of faecal sludge and effluent	Cistern Flush Toilet	reactor or anaerobic filter) connected to a solids-free sewer			fuel or building materials
						Solids-free sewer for effluent	Effluent treatment plant	Effluent: treated and used for irrigation or surface water recharge
D	**Offsite systems with sewerage and offsite treatment**	**5**	Flush toilet with sewerage and offsite wastewater treatment	Pour Flush Toilet or Cistern Flush Toilet		Simplified or conventional gravity sewer	Wastewater treatment plant – for wastewater and wastewater sludge	Soil conditioner; solid fuel; building materials; irrigation; surface water recharge *

2.3 Onsite Sanitation System

Onsite sanitation is defined as a sanitation system in which excreta and wastewater are collected and stored or treated on the plot where they are generated.

The basic onsite sanitation system is a reliable system in achieving safe sanitation practices as it provides a more sustainable and economically feasible solution. The basic onsite sanitation systems are still very much relevant in order to ensure the transition towards improved sanitation systems which can be done progressively and within affordability range. However dry toilets are not recommended as the management of urine transportation and treatment independently is not feasible and practical.

2.3.1 Flush Toilet with Onsite Treatment

This is a water-based system utilising the pour flush toilet (squat pan or pedestal) and twin pits to produce a partially digested, humus-like product, that can be used as a soil conditioner. Inputs to the system can include faeces, urine, flush-water, cleansing water, dry cleansing materials and greywater. The toilet technology for this system is a pour flush toilet. A urinal could additionally be used. The blackwater output from the pour flush toilet (and possible greywater) is discharged into twin pits for containment.

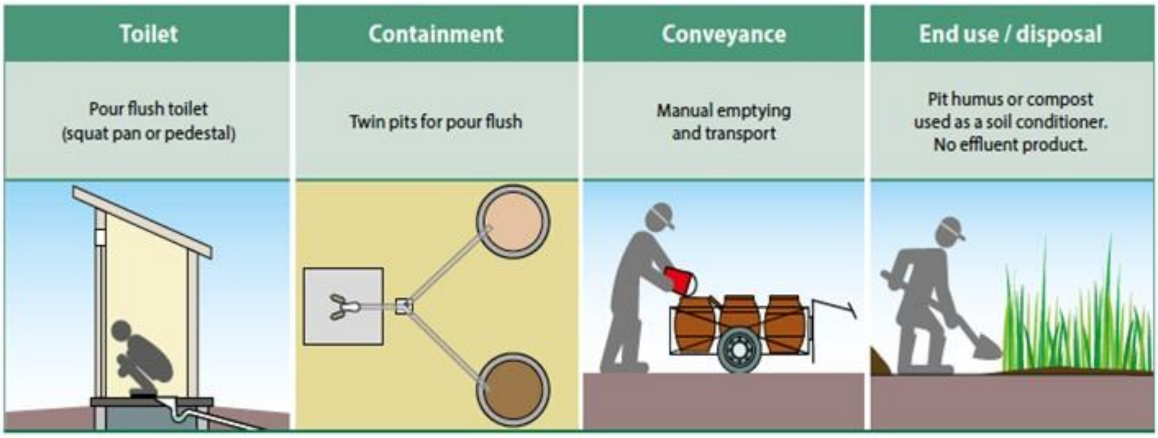


Figure 3: Flush Toilet with Onsite Treatment in Twin Pits
Source: WHO Sanitation System Fact Sheet 3

The twin pits are lined with porous material, allowing the liquid to infiltrate into the ground while solids accumulate and degrade at the bottom of the pit. While one pit is filling with blackwater, the other pit remains unused. When the first pit is full. It is covered and temporarily taken out of service. It should take a minimum of two years to fill a pit. When the second pit is full, the first pit is reopened and emptied.

After a resting time of at least two years as this is a water-based technology, the content potentially could have transformed into pit humus (sometimes also called eco-humus). Pit humus is nutrient-rich, safer, humus material which is safe to excavate for end use as a soil conditioner, or disposal. However, to ensure safety of the handlers, users and environment, the sludge should be treated. The emptied pit is then put back into operation. This cycle can be indefinitely repeated.

It is not recommended for twin pits to be replaced with Double VIP since twin pit allows for water to be discharged into the pits and it is not necessary to add soil or organic material into the pits. However, too many wet pits in a small area is not recommended as the soil matrix may not be of sufficient capacity to absorb all the liquid and the ground could become water-logged (over- saturated).

Applicability and Operation & Maintenance Considerations

Applicability	Operation & Maintenance
1) best suited to rural and peri-urban area 2) appropriate soil that can continually and adequately absorb the leachate 3) not appropriate for areas with clayey or densely packed soil 4) has one of the lowest capital costs	1) dry cleansing material should be collected and disposed to avoid clogging in the piping 2) user is responsible for cleaning of toilet and ensure the pit humus is removed 3) very affordable maintenance cost for the user for upkeep of superstructure and pit emptying 4) the excreta in resting pit naturally drains and degrades over at least 2 years 5) the dried sludge cake needs to be removed manually using shovels 6) the workers must wear appropriate personal protection during removal, transport and end use.

2.4 Onsite Systems with Faecal Sludge Management and Offsite Treatment

The onsite sanitation system refers to the approach whereby sewage is generated and contained onsite to be transported offsite for either treatment or for safe application with or without treatment.

2.4.1 Flush Toilet with Biogas Reactor and Offsite Treatment

This system is based on the use of a biogas reactor to collect, store and treat the excreta. Additionally, the biogas reactor produces biogas, which can be burned for cooking, lighting or electricity generation. Inputs to the system can include urine, faeces, flush water, cleansing water, dry cleansing materials, organics (e.g., market or kitchen waste) and, if available, animal waste. The system requires a pour flush or cistern flush toilet directly connected to a biogas reactor, which is also known as an anaerobic digester. Although the sludge has undergone anaerobic digestion, it is not pathogen free and must be removed with caution and transported for further treatment, where it will produce both effluent and sludge.

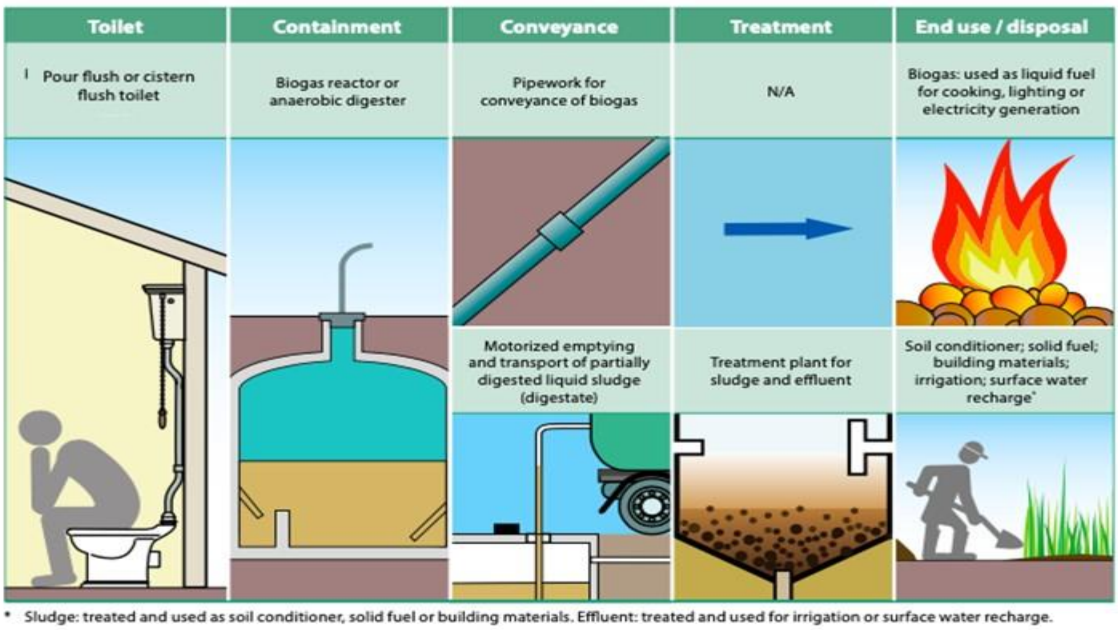


Figure 4: Flush (or urine-diverting flush) toilet with biogas reactor and offsite treatment
Source: WHO Sanitation System Fact Sheet 6: (the diagram was modified to suit the report)

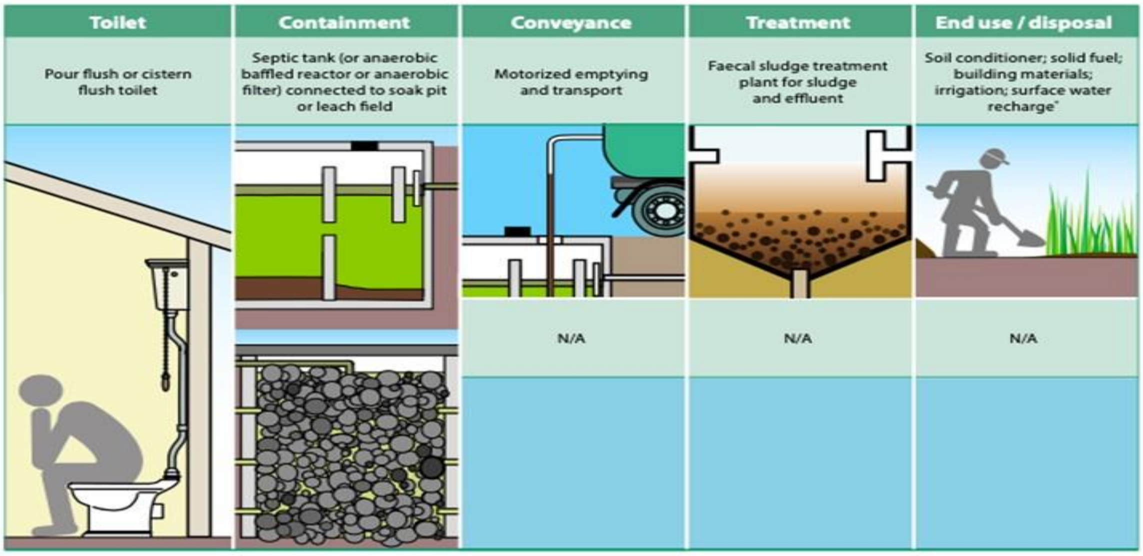
The biogas produced must be constantly used, for example as a clean fuel for cooking or for lighting. If the gas is not burned, it will accumulate in the tank and, with increasing pressure, will push out the partially digested sludge (digestate) until the biogas escapes to the atmosphere through the digestate outlet. The sludges require dewatering and drying followed by co-composting with organics before use as a compost-type soil conditioner, but for use as a solid fuel or building material additive, they only require dewatering and drying. Effluent will require stabilization and pathogen inactivation in a series of ponds or wet- lands before use as crop irrigation water.

Applicability and Operation & Maintenance Considerations

Applicability	Operation & Maintenance
1) best suited to rural and peri urban area as requires larger space 2) in urban areas can be built underground to reduce the land area required 3) feasible in a dense urban area provided, proper sludge management in place as the digestate production is continuous and requires year-round emptying and transported away from the site. 4) biogas can be safely burned for cooking, lighting or electricity generation 5) higher capital and maintenance costs	1) user is responsible for the construction of the toilet and biogas reactor 2) user is be responsible for cleaning of the toilet and employing an emptying service provider to empty digestate from the biogas tank periodically 3) handling of biogas reactor requires specific skills to safely handles gas leaks and explosive hazards 4) emptiers should not enter a biogas tank but use long handled shovels to remove any hard to shift sludge at the bottom 5) digestate emptying and conveyance are typically operated and maintained by either private or public service providers 6) digestate is treated by public service providers 7) plant, tools and equipment used in the conveyance and treatment steps will require regular maintenance by the relevant service providers

2.4.2 Flush Toilet with Septic Tank and Effluent Infiltration, and Offsite Faecal Sludge Treatment

This is a water-based system that requires a flush toilet and a containment technology that is appropriate for receiving large quantities of water as shown on the schematic below. The anaerobic processes reduce the organic and pathogen load, but both the effluent and sludge are still not suitable for direct use. Effluent is disposed through a soak pit or a leach field and the sludge is generated from the containment technology is emptied. The sludges require dewatering and drying followed by co-composting with organics before use as a compost-type soil conditioner. However. to use as a solid fuel or building material additive, they only require dewatering and drying. Effluent will require stabilization and pathogen inactivation in a series of ponds or wetlands before use as crop irrigation waters



* Sludge: treated and used as soil conditioner, solid fuel or building materials. Effluent: treated and used for irrigation or surface water recharge.

Figure 5: Flush toilet with septic tank and effluent infiltration, and offsite faecal sludge treatment
Source: WHO Sanitation System Fact Sheet 7

<u>Applicability and Operation & Maintenance Considerations</u>

Applicability	Operation & Maintenance
1) only appropriate in areas where desludging services are available and affordable 2) sufficient available space for soak pit or leach field 3) the soil must have a suitable capacity to absorb the effluent 4) requires a constant source of water for toilet flushing 5) high capital cost for both septic tank and treatment plant 6) high maintenance cost of septic tank depending on the frequency and method of tank emptying 7) treatment plant maintenance cost depends on the technology	1) user is responsible for the construction of toilet and septic tank 2) user will be responsible for cleaning the toilet and employing an emptying service provider to empty the septic tank periodically 3) emptying and transportation of sludge may be done by private and/or public service providers 4) treatment plants are operated by public service providers 5) plant, tools and equipment used in the conveyance and treatment steps will require regular maintenance by the relevant service providers 6) motorized emptying using vacuum trucks (or similar) fitted with long-reach hoses is the preferred method of emptying 7) emptiers should not enter a septic tank but use long handled shovels to remove any hard to shift sludge at the bottom

2.5 Onsite System with Faecal Sludge Management, Sewerage and Offsite Treatment

This system combines onsite system to contain solids to be conveyed through transportation. While the liquid component is conveyed via simplified sewers to offsite sewers.

2.5.1 Flush toilet with septic tank, sewerage and offsite treatment of faecal sludge and effluent

This system is characterized by the use of a household-level containment technology to remove and digest settleable solids from the blackwater, and a sewer system to transport the effluent to a treatment facility as shown on the schematic pictorial diagram below. Inputs to the system can include faeces, urine, flush water, cleansing water, dry cleansing materials and greywater. An affordable and systematic method for emptying sludge from the interceptor tanks is essential since one user's improperly maintained tank could adversely impact the entire sewer network

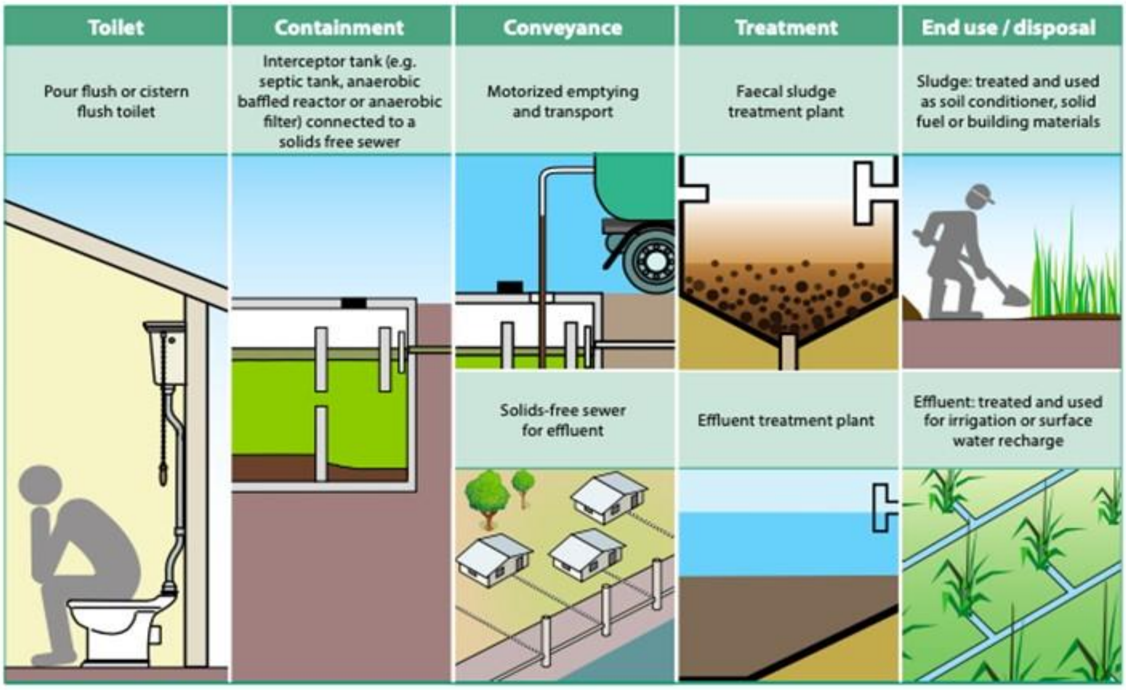


Figure 6: Flush toilet with septic tank, sewerage and offsite treatment faecal sludge and effluent
Source: WHO Sanitation System Fact Sheet 9

In this system, the effluent from septic tanks, anaerobic baffled reactors or anaerobic filters is transported to a treatment facility via a solids-free sewer. The containment technologies serve as "interceptor tanks" and allow for the use of small-diameter sewers, as the effluent is free from settleable solids. The sludges require dewatering and drying followed by co-composting with organics before use as a compost-type soil conditioner, but for use as a solid fuel or building material additive, they only require dewatering and drying. Effluent will require stabilization and pathogen inactivation in a series of ponds or wetlands before use as crop irrigation water.

Applicability and Operation & Maintenance Considerations

Applicability	Operation & Maintenance
1) urban settlements where the soil is not suitable for the infiltration of effluent 2) applicable for areas with high groundwater table 3) can be used as a way of upgrading existing, under-performing containment technologies such as septic tanks by providing improved treatment 4) a constant supply of water to ensure that the sewers do not become blocked 5) most appropriate when there is a high willingness and ability to pay for the capital investment and maintenance costs and where there is an appropriate treatment facility	1) user is responsible for the construction of toilet and septic tank 2) user will be responsible for cleaning the toilet and employing an emptying service provider to empty the septic tank periodically 3) emptying and transport may be done by private and/or public service providers who maintain the sewer network 4) the operations of faecal sludge to treatment plants operated by public service providers 5) the emptier should not enter an interceptor tank but use long handled shovels to remove any hard to shift sludge at the bottom 6) motorized emptying using vacuum trucks (or similar) fitted with long-reach hoses is the preferred method of removing the sludge 7) all machinery, tools and equipment used in the conveyance, treatment and end use/disposal steps will require regular maintenance by the service providers

2.6 Offsite Systems with Sewerage and Offsite Treatment

Sewage generated is not contained onsite. It's captured and conveyed offsite for treatment. This is a water-based sewer system in which wastewater is transported to a treatment facility.

2.6.1 Flush toilet with sewerage and offsite wastewater treatment

Inputs to the system include faeces, urine, flush water, cleansing water, dry cleansing materials, greywater and possibly storm water. There are two toilet technologies that can be used for this system: a pour flush toilet or a cistern flush toilet. The blackwater that is generated at the toilet together with greywater is directly conveyed to a treatment facility through a conventional or a simplified gravity sewer network. As there is no containment, all of the blackwater is transported to a treatment facility where a combination of technologies is used to produce treated effluent for end use and/or disposal, and wastewater sludge. This sludge must be further treated prior to end use and/or disposal.

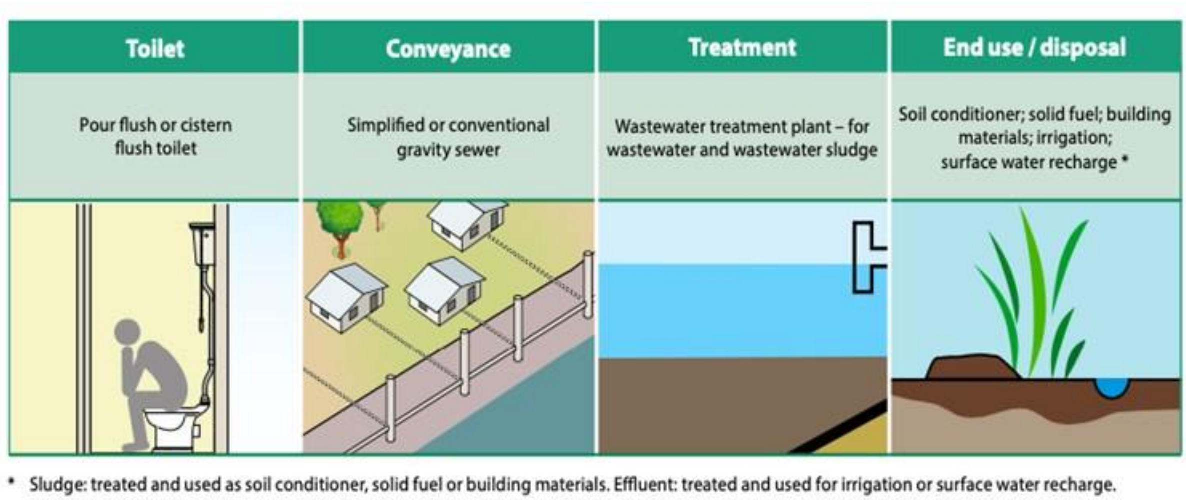


Figure 7: Flush toilet with sewerage and offsite wastewater treatment
Source: WHO Sanitation System Fact Sheet 10

<u>**Applicability and Operation & Maintenance Considerations**</u>

Applicability	**Operation & Maintenance**
1) appropriate in dense, urban and peri-urban area 2) suitable for areas with high groundwater tables 3) requires a constant supply of water for flushing, to ensure that the sewers do not become blocked 4) most appropriate when there is a high willingness and ability to pay for the capital investment and maintenance costs and where there is an appropriate treatment facility	1) user is responsible for the construction of toilet and for cleaning the toilet 2) inclusion of greywater in the conveyance technology helps to prevent solids from accumulating in the sewers and storm water could also be put into the gravity sewer network 3) all machinery, tools and equipment used in the treatment step will require regular maintenance by the relevant service providers

3. Minimum Standards for Design and Operation of Sanitation Systems

3.1 Conservancy Tanks, Septic Tanks, French Drains and Soak Pits

3.1.1 General

As per the building code (2006) in Kenya, any conservancy tank shall, subject to the clearing services provided by an authorised private contractor or County Government in question:

(a) Have a capacity as prescribed by The Authority;
(b) be constructed with means of access for cleaning;
(c) be provided with a means for clearing as prescribed by The Authority.

Any conservancy tank or septic tank to be used on a site for the reception of sewage shall:

(a) be so designed and constructed that it will be impervious to liquid;
(b) be so sited: -
  (i) that there will be a ready means of access for the clearing of such tank;
  (ii) as not to endanger the structure of any building or any services on the site; and
(c) be so designed and sited that it is not likely to become a source of nuisance or a danger to health.

3.1.2 Discharge to a French drain.

Any septic tank shall:

(a) where it is to serve a dwelling house or dwelling unit be of a designed capacity and be capable of receiving one day's sewage flow as given in Table O1 of the building code (2006) of not less than 1.7 m^3
(b) where it is to serve any building not being a dwelling house or dwelling unit, be of a designed capacity not less than 3 times the daily flow from such building, using the per capita sewage flow given in Table O1 or such other flow as may be determined by the authority where not so given;
(c) be so constructed that:
  (i) it is provided with a means of access for the purpose of emptying and cleaning; and liquid contained therein and the underside of the top cover of such tank.

3.2 Capture

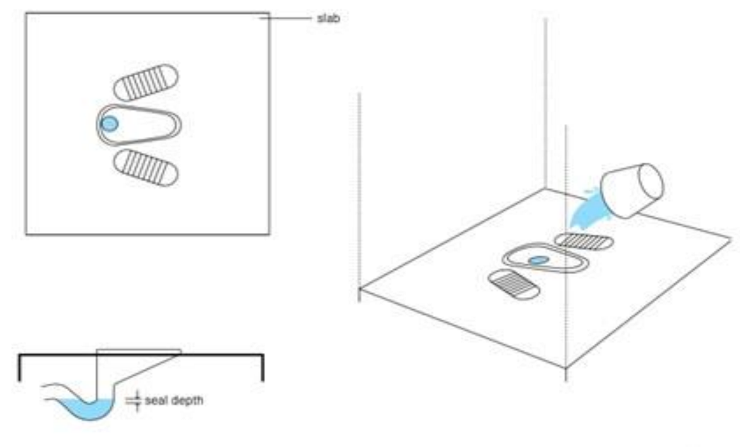
All toilets in schools, health care facilities, workplaces and public places should meet the standards for a safe toilet and safe containment. Paying special attention to the need for availability, accessibility, privacy and security and menstrual hygiene management. In order to ensure sufficiency a minimum required number of water closets or toilets or bathrooms in a given premise should be determined based on the population it serves.

A British Standard (BS) 6465-1 for sanitary installations for the number of water closets or toilets or bathrooms required. has been adopted and is as attached in **Appendix A.** This standard is especially important to ensure sufficient sanitation facility are provided for women and girls in public and workplace. The general provisions of toilets for public and workplace such as availability, accessibility, security, privacy issues and facilities for menstrual hygiene management.

3.2.1 Pour Flush Toilet

A pour flush toilet is like a regular cistern flush toilet except the water is poured in by the user, instead of coming from the cistern above. The pour flush toilet has a water seal that prevents odours and flies from coming back up the pipe. Water is poured into the bowl to flush the toilet of excreta. The quantity of water and the force of the water (pouring from a height often helps) must be sufficient to move the excreta up and over the curved water seal. Both pedestals and squatting pans can be used in the pour flush mode. Due to demand, local manufacturers have become increasingly efficient at mass-producing affordable pour flush toilets and pans.

The pour flush toilet is appropriate for those who sit or squat (pedestal or slab), as well as for those who cleanse with water. Yet, it is only appropriate when there is a constant supply of water available. The pour flush toilet requires (much) less water than a traditional Cistern Flush Toilet. However, because a smaller amount of water is used, the pour flush toilet may clog more easily and, thus, require more maintenance. If water is available, this type of toilet is appropriate for both public and private applications. Because there are no mechanical parts, pour flush toilets are quite robust and rarely require repair. Despite the fact that it is a water- based toilet, it should be cleaned regularly to maintain hygiene and prevent the build-up of stains. To reduce water requirements for flushing and to prevent clogging, it is recommended that dry cleansing materials and products used for menstrual hygiene be collected separately and not flushed down the toilet.



Source: Compendium of Sanitation Systems and Technologies, 2nd revised edition; EAWAG: pg 50

Figure 8: Pour Flush Toilet

Design Requirements

(a) Amount of water required to flush is about 2 L to 3 L.

(b) Concrete, fibre glass, porcelain or stainless steel for ease of cleaning.

(c) Water seal at bottom of the pour flush toilet or pan should have a slope of at least 25°.

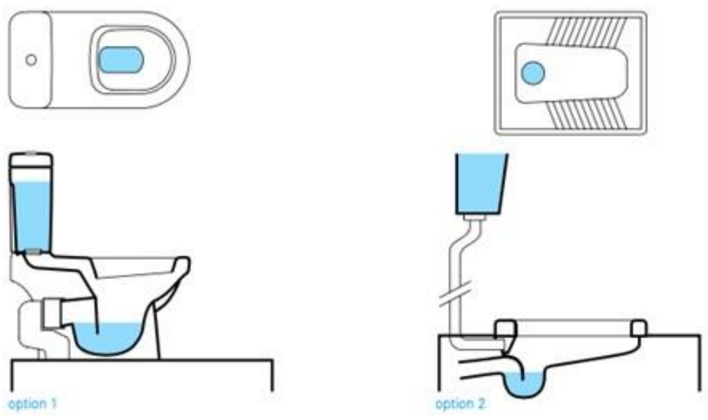
(d) Water seal should be made out of plastic or ceramic to prevent clogs and to make cleaning easier.

(e) Optimal depth of the water seal head is approximately 2 cm to minimize the water required to flush the excreta.

(f) The trap should be approximately 7 cm in diameter.

3.2.2 Cistern Flush Toilet

The cistern flush toilet is usually made of porcelain and is a mass-produced, factory-made user interface. The flush toilet consists of a water tank that supplies the water for flushing the excreta and a bowl into which the excreta are deposited. The attractive feature of the cistern flush toilet is that it incorporates a sophisticated water seal to prevent odours from coming back up through the plumbing. Water that is stored in the cistern above the toilet bowl is released by pushing or pulling a lever. This allows the water to run into the bowl, mix with the excreta, and carry them away. When the water supply is not continuous, any cistern flush Toilet can become a pour flush toilet.



Source: Compendium of Sanitation Systems and Technologies, 2nd revised edition; EAWAG: pg 52

Figure 9: Cistern Flush Toilet

<u>Design Requirements</u>

(a) Amount of water required to flush is about 6 L to 9 L.

(b) Low flush toilets using only 3 L of water are available.

3.3 Containment

Containment refers to the function of retaining generated sewage either liquid or solid or both for the purposes of treatment or disposal. Containment serves to separate and isolate as much as possible human contact with faecal matter. The type of containments referred to in this document are described below.

3.3.1 Twin Pits

As leachate from twin pits directly infiltrates the surrounding soil, this system should only be installed where there is a low groundwater table. If there is frequent flooding or the groundwater table is too high and enters the twin pits, the dewatering process, particularly in the resting pit, will be hindered. Greywater can be co-managed along with blackwater in the twin pits, especially if the greywater quantities are relatively small and no other management system in place to control it.

The twin pits for pour flush technology can be designed in various ways; the toilet can be located directly over the pits or at a distance from them. The superstructure can be permanently constructed over both pits or it can move from side to side depending on which one is in use. No matter how the system is designed, only one pit is used at a time. While one pit is filling, the other full pit is resting.

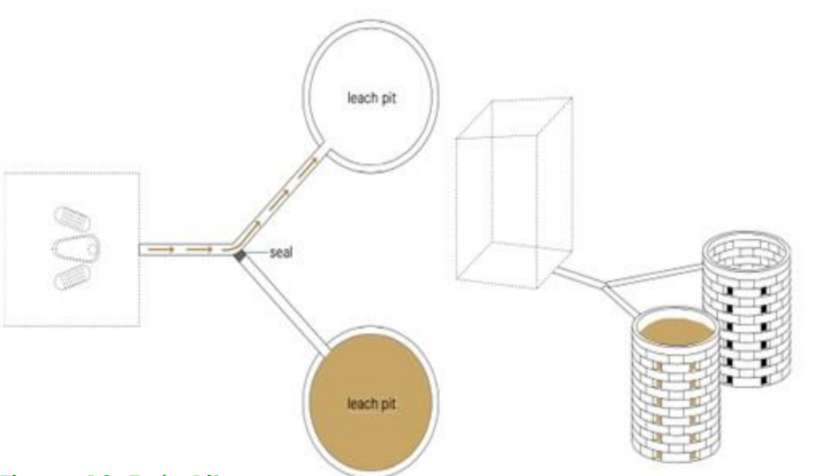


Figure 10: Twin Pits
Source: Compendium of Sanitation Systems and Technologies, 2nd revised edition; EAWAG: pg 68

As liquid leaches from the pit and migrates through the unsaturated soil matrix, pathogenic germs are absorbed onto the soil surface. In this way, pathogens can be removed prior to contact with groundwater. The degree of removal varies with soil type, distance travelled, moisture and other environmental factors.

The difference between twin pit and Double VIP is that it allows for water and it is not necessary to add soil or organic material to the pits. As this is a water-based (wet) technology, the full pits require a longer retention time (two years is recommended) to degrade the material before it can be excavated safely.

Design Requirements

(a) The pits must be sized to accommodate sewage volume over two years.

(b) Twin pits should be constructed 1 m apart from each other to minimize cross contamination between maturing pit and the one in use.

(c) Twin pits should be constructed 1 m apart from any structural foundation as leachate can impact structural support.

(d) The full depth of the pit must be lined to prevent collapse and the top 30 cm should be fully mortared to provide support for superstructure and prevent direct infiltration into ground water.

(e) A minimum horizontal distance of 30 m between pit and water source is recommended to limit potential microbial contamination.

(f) The idle pipe of the junction connecting to the out-of-use pit should be capped with material such as cement or bricks.

3.3.2 Septic Tank

A septic tank is a watertight chamber through which blackwater and greywater flows for primary treatment. Settling and anaerobic processes reduce solids and organics, but the treatment is only moderate. Liquid flows through the tank and

heavy particles sink to the bottom, while scum (mostly oil and grease) floats to the top. Over time, the solids that settle to the bottom are degraded anaerobically. However, the rate of accumulation is faster than the rate of decomposition, and the accumulated sludge and scum must be periodically removed. The effluent of the septic tank must be dispersed by using a soak pit or leach field, or transported to another treatment technology via a solids-free sewer.

Most of the solids settle out in the first chamber. The baffle, is to prevent scum and solids from escaping with the effluent. A T-shaped outlet pipe further reduces the scum and solids that are discharged. Accessibility to all chambers (through access ports) is necessary for maintenance. Septic tanks should be vented for controlled release of odorous and potentially harmful gases. The design of a septic tank depends on the number of users, the amount of water used per capita, the average annual temperature, the desludging frequency and the characteristics of the wastewater. Septic tanks are not efficient at removing nutrients and pathogens.

This technology is most commonly applied at the household level. Larger, multi-chamber septic tanks can be designed for groups of houses and/ or public buildings (e.g., schools). A septic tank is appropriate where there is a way of dispersing or transporting the effluent. If septic tanks are used in densely populated areas, onsite infiltration should not be used, otherwise, the ground will become oversaturated and contaminated, and wastewater may rise up to the surface, posing a serious health risk. Instead, the septic tanks should be connected to some type of conveyance technology, through which the effluent is transported to a subsequent treatment or disposal site. Even though septic tanks are watertight, it is not recommended to construct them in areas with high groundwater tables or where there is frequent flooding.

Design Requirements

(a) The septic tank should be a watertight design with at least 2 chambers using either concrete, fibre glass, PVC or plastic.

(b) Design and locate the facility such that odours do not bother community members.

(c) The 1st chamber should be at least 50% of the total length.

(d) Should be designed to remove 50% of solids and 30 to 40% of BOD.

(e) The retention time should be 48 hours to achieve moderate treatment.

(f) The provision to access the location for desludging activity must be made available.

(g) The solids accumulation in septic tank should be designed to match the frequency of desludging.

3.3.3 Biogas Reactor or Anaerobic Digester

A biogas reactor or anaerobic digester is an anaerobic treatment technology that produces a digested slurry (digestate) that can be used as a fertilizer and biogas that can be used for energy.

Biogas is a mix of methane, carbon dioxide and other trace gases which can be converted to heat, electricity or light. A biogas reactor is an airtight chamber that facilitates the anaerobic degradation of blackwater, sludge, and/or biodegradable waste. It also facilitates the collection of the biogas produced in the fermentation processes in the reactor. The gas forms in the slurry and collects at the top of the chamber, mixing the slurry as it rises. The digestate is rich in organics and nutrients, almost odourless and pathogens are partly inactivated.

Biogas reactors can be brick constructed domes or prefabricated tanks, installed above or below ground, depending on space, soil characteristics, available resources and the volume of waste generated. They can be built as fixed dome or floating dome digesters. In the fixed dome, the volume of the reactor is constant. As gas is generated it exerts a pressure and displaces the slurry upward into an expansion chamber. When the gas is removed, the slurry flows back into the reactor. The pressure can be used to transport the biogas through pipes. In a floating dome reactor, the dome rises and falls with the production and withdrawal of gas. Alternatively, it can expand (like a balloon). To minimize distribution losses, the reactors should be installed close to where the gas can be used. Often, biogas reactors are directly connected to private or public toilets with an additional access point for organic materials. Because the digestate production is continuous, there must be provisions made for its storage, use and/or transport away from the site.

Design Requirements

(a) Design and locate the facility such that odours do not bother community members.

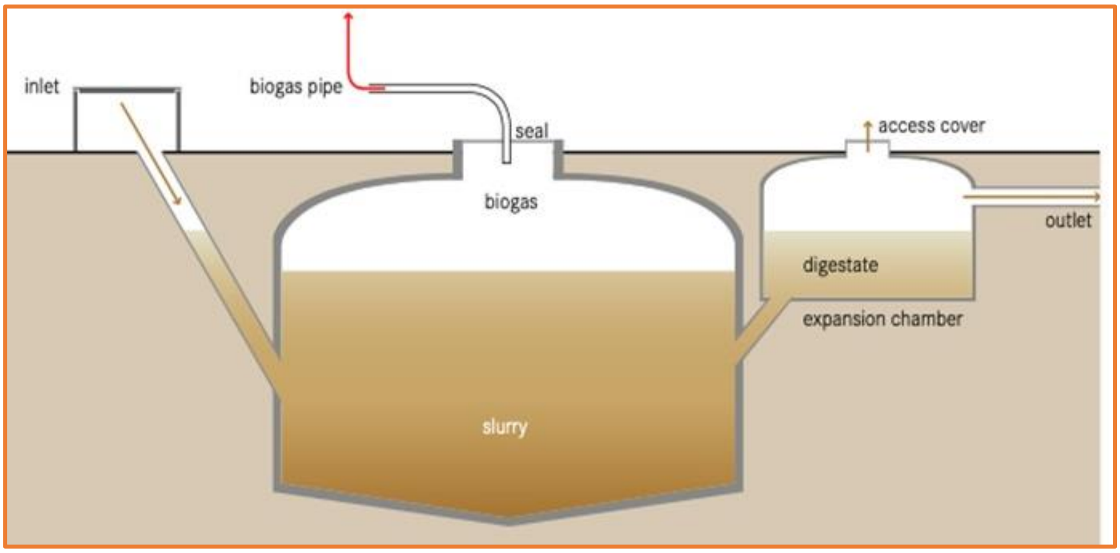
(b) Reactors can be made out of plastic containers or bricks.

(c) Sizes can vary from 1,000 L for a single family up to 100,000 L for institutional or public toilet applications.

(d) HRT is at least 15 days in hot climates and 25 days in temperate climates.

(e) The provision to access the location for desludging activity must be made available.

(f) The solids accumulation in the reactor should be designed to match the frequency of desludging.



Source: Compendium of Sanitation Systems and Technologies, 2nd revised edition; EAWAG: pg 80

Figure 12: Biogas Reactor or Anaerobic Digester

This technology can be applied at the household level, in small neighbourhoods or for the stabilization of sludge at large wastewater treatment plants. It is best used where regular feeding is possible. Often, a biogas reactor is used as an alternative to a Septic Tank, since it offers a similar level of treatment, but with the added benefit of biogas. However, significant gas production cannot be achieved if black- water is the only input. The highest levels of biogas production are obtained with concentrated substrates, which are rich in organic material, such as animal manure and organic market or household waste. It can be efficient to co-digest blackwater from a single house- hold with manure if the latter is the main source of feed- stock. Greywater should not be added as it substantially reduces the HRT. Wood material and straw are difficult to degrade and should be avoided in the substrate. Biogas reactors are less appropriate for colder climates as the rate of organic matter conversion into biogas is very low below 15 °C. Consequently, the HRT needs to be longer and the design volume substantially increased.

The digestate is partially sanitized but still carries a risk of infection. Depending on its end-use, further treatment might be required. There are also dangers associated with the flammable gases that, if mismanaged, could be harmful to human health. To start the reactor, it should be inoculated with anaerobic bacteria, e.g., by adding cow dung or Septic Tank sludge. Organic waste used as substrate should be shredded and mixed with water or digestate prior to feeding. Gas equipment should be carefully and regularly cleaned so that corrosion and leaks are prevented. Grit and sand that have settled to the bottom should be removed.

3.4 conveyance

This section describes the removal and/or transportation of generated sewage either the liquid or solid or both sludge from the capture infrastructure to offsite facility. As the untreated sludge is full of pathogens, human contact and direct agricultural application, it should be avoided. Conveyance via transportation is used, if a treatment facility is far or is not easily accessible. The sludge can be discharged to a transfer station. From the transfer station it can then be transported to the treatment facility by a motorized transport technology.

3.4.1 Manual Emptying and Transport

Manual emptying and transport of products generated in onsite sanitation facilities i.e. pits, vaults and tanks can be done in one of two ways:

a) using buckets and shovels,

b) using a portable, manually operated pump specially designed for sludge (e.g., the Gulper, the Rammer, the MDHP or the MAPET).

The sludge can be collected in barrels, bags or carts, and removed from the site and preferably to the transfer station for further transport to the treatment facility. Manually operated sludge pumps are appropriate for areas that are not served or not accessible by vacuum trucks, or where vacuum truck emptying is too costly.

All workers should be trained on the risks of handling faecal sludge and standard operating procedures (SOPs). All workers should wear personal protective equipment (e.g. gloves, masks, hats, full overalls and enclosed waterproof footwear) particularly where manual sewer cleaning or manual emptying is required. Service providers or emptiers should establish SOPs that builds in zero contact with sewage. The emptiers should undergo specially designed HSE training which incorporates confined space training before allowed to perform the job. The companies must be held responsible to provide (Personal Protective Equipment) PPEs to their workers.

3.4.2 Motorized Emptying and Transport

Motorized emptying and transport refer to a vehicle equipped with a motorized pump and a storage tank for emptying and transporting faecal sludge and urine. These are mostly trucks fitted with a pump which is connected to a hose that is lowered down into a tank (e.g., Septic Tank) or pit, and the sludge is pumped up into the holding tank on the vehicle. Alternative motorized vehicles or machines have been developed for densely populated areas with limited access. Designs such as the Vacutug, Dung Beetle, Molsta or Kedoteng carry a small sludge tank and a pump and can negotiate narrow pathways.

Generally, the storage capacity of a vacuum truck is between 3 and 12 m^3. Local trucks are commonly adapted for sludge transport by equipping them with holding tanks and pumps. Modified pick-ups and tractor trailers can transport around 1.5 m^3, but capacities vary. Smaller vehicles for densely populated areas have capacities of 500 to 800 L. These vehicles use, for example, two-wheel tractor or motorcycle-based drives and can reach speeds of up to 12 km/h. Pumps can usually only suck down to a depth of 2 to 3 m (depending on the strength of the pump) and must be located within 30 m of the pit. In general, the closer the vacuum pump can be to the pit, the easier it is to empty.

Depending on the containment technology, the sludge can be so dense that it cannot be easily pumped. In these situations, it is necessary to thin the solids with water so that they flow more easily, but this may be inefficient and costly.

3.4.3 Conventional Gravity Sewer

Conventional gravity sewers are large networks of underground pipes that convey blackwater, greywater and, in many cases, storm water from individual households to a centralized treatment facility, using gravity (and pumps when necessary). The conventional gravity sewer system is designed with many branches. Typically, the network is subdivided into primary (main sewer lines along main roads), secondary and tertiary networks (networks at the neighbourhood and household level). If well-constructed and maintained, sewers are a safe and hygienic means of transporting wastewater. This technology provides a high level of hygiene and comfort for the user. However, because the waste is conveyed to an offsite location for treatment, the ultimate health and environmental impacts are determined by the treatment provided by the downstream facility.

Conventional gravity sewers normally do not require onsite pre-treatment, primary treatment or storage of the household wastewater before it is discharged. However, the sewer must be designed so that it maintains self-cleansing velocity (i.e., a flow that will not allow particles to accumulate).

Design Requirements

(a) A minimum velocity of 0.6 to 0.7 m/s during peak dry weather conditions.

(b) The primary sewers must be laid beneath roads, at depths of 1.5 to 3 m to avoid damages caused by traffic loads.

(c) A constant downhill gradient must be guaranteed along the length of the sewer to maintain self-cleansing flows

(d) When the deep excavations are no more feasible, pumping stations must be installed.

(e) Access manholes must be placed at set intervals above the sewer, at pipe intersections and at changes in pipeline direction (vertically and horizontally).

(f) Manholes should be designed to ensure the inflow of storm water and groundwater infiltration can be avoided.

The sewer depth also depends on the groundwater table, the lowest point to be served (e.g., a basement) and the topography.

The selection of the pipe diameter depends on the projected average and peak flows. Commonly used materials are concrete, PVC, and ductile or cast-iron pipes.

If the connected users discharge highly polluted wastewater (e.g., industry or restaurants), onsite pre- and primary treatment may be required before discharge into the sewer system to reduce the risk of clogging and the loading of the wastewater treatment plant.

When the sewer also carries storm water (known as a combined sewer), sewer overflows are required to avoid hydraulic surcharge of treatment plants during rain events. However, combined sewers should no longer be considered state of the art. Rather, local retention and infiltration of storm water or a separate drainage system for rainwater are recommended. The wastewater treatment system then requires smaller dimensions and is, therefore, cheaper to build, and there is a higher treatment efficiency for less diluted wastewater.

Because they can be designed to carry large volumes, conventional gravity sewers are very appropriate to transport wastewater to a centralized treatment facility. Planning, construction, operation and maintenance require expert knowledge. Construction of conventional sewer systems in dense, urban areas is complicated because it disrupts urban activities and traffic. Conventional gravity sewers are expensive to build and, because the installation of a sewer line is disruptive and requires extensive coordination between authorities, construction companies and property owners, a professional management system must be in place.

3.5 Treatment

Treatment of sewage and faecal sludge comprise of various type of processes. Each type of treatment process had different objectives and capabilities which will impact the treatment process design. In addition, the selected treatment process requires the following considerations:

(a) predict inflow and characteristics of the influent or faecal sludge;
(b) available land;
(c) available energy sources;
(d) available human resource capacity;
(e) location of population centres;
(f) topography;
(g) soil characteristics;
(h) water table;
(i) local climate and prevailing winds;
(j) seasonal and climatic variations;
(k) overall capital cost; and
(l) estimated operation and maintenance cost.

The effluent and sludge from treatment technologies, may require further treatment prior to end use and/or disposal. For example, effluent from a faecal sludge treatment facility could be co-treated with wastewater in waste stabilization ponds or in constructed wetlands.

3.5.1 Wastewater Treatment Plant

The type of treatment processes available, it's objective and capabilities are summarized in the Table 2 below.

Table 2: Type of Wastewater Treatment Processes, the Objective and Capabilities

No	Treatment Process	Treatment Objective	Pathogen Reduction Measures	PRL[1]	Treatment products & pathogen level[2]
Low Flow Rate					
1	Waste stabilization ponds	BOD reduction Nutrient management Pathogen reduction	Aerobic ponds (maturation) UV radiation	H	Liquid sludge with low pathogens Effluent with low pathogens
2	Constructed Wetlands	BOD reduction Suspended solids removal Nutrient management Pathogen reduction	Natural decay Predation from higher organism Sedimentation UV radiation	M	Plants – no pathogens Effluent with medium pathogens
High Flow Rate					
3	Primary Sedimentation	Suspended solids reduction	Storage	L	Liquid sludge with high pathogens Effluent with high pathogens
4	Advanced or chemically enhanced sedimentation	Suspended solids reduction	Coagulation/ Flocculation Storage	M	Liquid sludge with medium pathogens Effluent with medium pathogens
5	Anaerobic up flow sludge	BOD reduction	Storage	L	Liquid sludge with high pathogens

[1] Pathogen Reduction Level (log_{10} reduction): L-Low = < 1 log_{10} ; M- Medium = 1 to 2 log_{10} ; H-High =>2 log_{10}
[2] Pathogen Level (pathogens per litre): L-Low = < 2 log_{10} ; M- Medium = 2 to 4 log_{10} ; H-High =>4 log_{10}

No	Treatment Process	Treatment Objective	Pathogen Reduction Measures	PRL[1]	Treatment products & pathogen level[2]
	blankets reactors				Effluent with high pathogens Biogas
6	Anaerobic baffled reactor	BOD reduction Stabilization/ Nutrient Management	Storage	L	Liquid sludge with high pathogens Effluent with high pathogens Biogas
7	Activated sludge	BOD reduction Nutrient management	Storage	M	Liquid sludge with medium pathogens Effluent with medium pathogens
8	Trickling filters	Nutrient management	Storage	M	Liquid sludge with medium pathogens Effluent with pathogens
9	Aerated lagoon and settling pond	BOD reduction Pathogen reduction	Aeration	M	Liquid sludge with medium pathogens Effluent with pathogens
10	High rate granular or slow rate sand filtration	Pathogen reduction	Filtration	H	Effluent with low pathogens
11	Dual media filtration	Pathogen reduction	Filtration	H	Effluent with low pathogens
12	Membranes	Pathogen reduction	Ultrafiltration	H	Effluent with low pathogens

No	Treatment Process	Treatment Objective	Pathogen Reduction Measures	PRL[1]	Treatment products & pathogen level[2]
13	Disinfection	Pathogen reduction	Chlorination (oxidation)/ Ozonation/ Ultraviolet radiation	H	Effluent with low pathogens

Commonly used system in Kenya is the Waste Stabilization Pond (WSP). If designed and operated appropriately, the WSP can produce effluent with low pathogen content even better than the constructed wetlands. Moreover, fish can also be introduced to WSP which might be of economic value i.e. food for animals[3]. If the effluent does not attain the required qualities, a constructed wetland can be introduced to further polish the resulting effluent.

Important to note that fishes are commonly added in the effluent chamber prior to discharge as a show case on the effluent quality and has no influence in the treatment. The improvement of each and every treatment facility are case specific. For instance, a WSP can be compartmentalized to introduce various type of processes. Such as surface aerator can be introduced in one block, suspended bio-media based on moving bed bioreactor can be introduced in cages for another. Sludge can be scraped from the bottom continuously in one compartment and even introducing wet land in the final compartment. There are various ways to improve and optimize WSP. For that purpose, specific WSP need to be identified to purpose specific solution.

There are multiple considerations that can influence in treatment optimization such as the land area, sewage characteristics, appropriate technology for hybrid solution, stability of power supply, suitable man power etc.

3.5.2 Faecal Sludge Treatment Plant

The design a faecal sludge or a wastewater treatment process, the choice of technologies, and their sequence, must be determined with a full understanding of the output products and their eventual end use or disposal. For instance, if the end use product of faecal sludge is a cement additive, then the sludge requires dewatering and drying but, since the cement manufacturing process destroys all pathogens, pathogen inactivation at the faecal sludge treatment plant is not required. In contrast, if a soil conditioner (such as compost) is the required end product, faecal sludge should undergo pathogen inactivation process. Table 3

[3] D9 and T.5 Compendium of Sanitation Systems and Technologies

shows the suitable treatment processes of faecal sludge, the objectives and capabilities.

Ponds can handle faecal sludge to a certain degree. As long as the ponds are desilted regularly, some features are put in place to improve the treatment process and increase the capacity. However, in the event the designated ponds do not have the capacity to treat faecal sludge, a sludge treatment facility may be constructed before the WSP i.e. the digester or constructed wetlands. Even simple technology such as sludge drying bed are suitable solutions for faecal sludge treatment.

Table 3: Type of Sludge Treatment Processes, the Objective and Capabilities

No	Treatment Process	Treatment Objective	Pathogen Reduction Measures	PRL[4]	Treatment products & pathogen level[5]
1	Settling-thickening ponds and tanks	Dewatering	Storage	L	Liquid sludge with high pathogens Effluent with high pathogens
2	Unplanted drying beds	Dewatering	Dehydration UV radiation Storage	L	Dewatered or dry sludge with high pathogens Effluent with high pathogens
3	Planted drying beds	Dewatering Stabilization/ nutrient management	Dehydration UV radiation Storage	Sludge – L Effluent - H	Plants – no pathogens Dry stabilized sludge with low pathogens Effluent with high pathogens
4	Co-composting	Pathogen reduction Stabilization/ nutrient management	Storage Temperature	Sludge - H	Dewatered stabilized sludge (compost) with low pathogens
5	Burial	Pathogen reduction Stabilization/ nutrient management	Storage Adsorption	High	Trees or plants – no pathogens (and buried, stabilized sludge with low pathogens)

3.6 End Use

[4] Pathogen Reduction Level (log_{10} reduction): L-Low = < 1 log_{10} ; M- Medium = 1 to 2 log_{10} ; H-High =>2 log_{10}
[5] Pathogen Level (pathogens per litre): L-Low = < 2 log_{10} ; M- Medium = 2 to 4 log_{10} ; H-High =>4 log_{10}

The final or by product in the sanitation system chain will either be disposed of or used for certain applications. Some of the potential and suitable applications of the final or by product are described below.

3.6.1 Application of Sludge

Depending on the treatment type and quality, digested or stabilized sludge can be applied to public or private lands for landscaping or agriculture. Sludge that has been treated (e.g., co-composted or removed from a planted drying bed, etc.) can be used in agriculture, home gardening, forestry, sod and turf growing, landscaping, parks, golf courses, mine reclamation, as a dump cover, or for erosion control. Although sludge has lower nutrient levels than commercial fertilizers (for nitrogen, phosphorus and potassium, respectively), it can replace an important part of the fertilizer need. Additionally, treated sludge has been found to have properties superior to those of fertilizers, such as bulking and water retention properties, and the slow, steady release of nutrients.

Solids are spread on the ground surface using conventional manure spreaders, tank trucks or specially designed vehicles. Liquid sludge (e.g., from anaerobic reactors) can be sprayed onto or injected into the ground. Application rates and usage of sludge should take into account the presence of pathogens and contaminants, and the quantity of nutrients available so that it is used at a sustainable and agronomic rate.

Although sludge is sometimes criticized for containing potentially high levels of metals or contaminants, commercial fertilizers are also contaminated to varying degrees, most likely with cadmium or other heavy metals. Faecal sludge from pit latrines should not have any chemical inputs and is, therefore, not a high- risk source of heavy metal contamination. Sludge that originates at large-scale wastewater treatment plants is more likely to be contaminated since it receives industrial and domestic chemicals, as well as surface water run-off which may contain hydrocarbons and metals. Depending on the source, sludge can serve as a valuable and often much-needed source of nutrients. Application of sludge on land may be less expensive than disposal.

The greatest barrier to the use of sludge is, generally, acceptance. However, even when sludge is not accepted by agriculture or local industries, it can still be useful for municipal projects and can actually provide significant savings (e.g., mine reclamation). Depending on the source of the sludge and on the treatment method, it can be treated to a level where it is generally safe and no longer generates significant odour or vector problems. Following appropriate safety and application regulations is important. WHO guidelines on excreta use in agriculture should be consulted for detailed information. Spreading equipment must be maintained to ensure continued use. The amount and rate of sludge application should be monitored to prevent overloading and, thus, the potential for nutrient pollution. Workers should wear appropriate protective clothing.

3.6.2 Soak Pit

A soak pit, also known as a soak away or leach pit, is a covered, porous-walled chamber that allows water to slowly soak into the ground. Pre-settled effluent from containment and treatment technology is discharged to the underground chamber from which it infiltrates into the surrounding soil. As wastewater (greywater or blackwater after primary treatment) percolates through the soil from the soak pit, small particles are filtered out by the soil matrix and organics are digested by microorganisms. Thus, soak pits are best suited for soil with good absorptive properties; clay, hard packed or rocky soil is not appropriate.

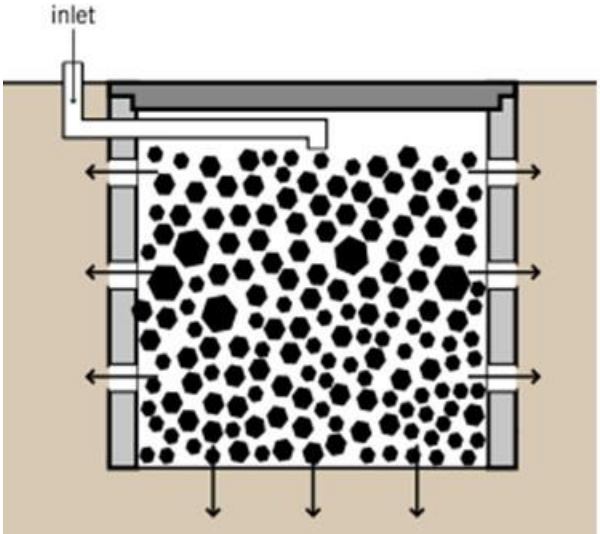


Figure 13: Soak Pit

Source: Compendium of Sanitation Systems and Technologies, 2nd revised edition; EAWAG: pg 152

Design Requirements

(a) Depth should be between 1.5 and 4 m deep.

(b) Must be 2m above the groundwater table.

(c) Located in a safe distance of minimum 30 m from a drinking water source.

(d) Located away from high-traffic areas so that the soil above and around it is not compacted.

(e) If the soak way is lined, it must be filled with a porous material to provide support and prevent collapse.

(f) If the soak way is unlined, it must be filled with coarse rocks and gravel. The rocks and gravel will prevent the walls from collapsing.

(g) The filling material must be spread across the bottom to help disperse the flow.

(h) A removable (preferably concrete) lid should be used to seal the pit until it needs to be maintained.

A soak pit does not provide adequate treatment for raw wastewater and the pit will quickly clog. It should be used for discharging pre-settled blackwater or greywater. Soak pits are appropriate for rural and peri-urban settlements. They depend on soil with a sufficient absorptive capacity. They are not appropriate for areas prone to flooding or that have high groundwater tables. Since the soak pit is odourless and not visible, it should be accepted by even the most sensitive communities.

3.6.3 Biogas Combustion

In principal, biogas can be used like other fuel gas. When produced in household-level biogas reactors, it is most suitable for cooking. Additionally, electricity generation is a valuable option when the biogas is produced in large anaerobic digesters. Household energy demand varies greatly and is influenced by cooking and eating habits (i.e., hard grains and maize may require substantial cooking times, and, therefore, more energy compared to cooking fresh vegetables and meat). Biogas has an average methane content of 55-75%, which implies an energy content of 6-6.5 kWh/m^3.

Gas demand can be defined on the basis of energy previously consumed. The following consumption rates in litres per hour (L/h) can be assumed for the use of biogas:

(a) household burners: 200-450 L/h;

(b) industrial burners: 1,000-3,000 L/h;

(c) refrigerator (100 L) depending on outside temperature: 30-75 L/h;

(d) gas lamp, equivalent to a 60 W bulb: 120-150 L/h;

(e) biogas/diesel engine per bhp: 420 L/h; and

(f) generation of 1 kWh of electricity with biogas/diesel mixture: 700 L/h.

Compared to other gases, biogas needs less air for combustion. Therefore, conventional gas appliances need to be modified when they are used for biogas combustion (e.g., larger gas jets and burner holes). The distance through which the gas must travel should be minimized since losses and leakages may occur. Drip valves should be installed for the drainage of condensed water, which accumulates at the lowest points of the gas pipe.

Biogas is usually fully saturated with water vapour, which leads to condensation. To prevent blocking and corrosion, the accumulated water has to be periodically emptied from the installed water traps. The gas pipelines, fittings and appliances must be regularly monitored by trained personnel. When using biogas for an engine, it is necessary to first reduce the hydrogen sulphide because it forms corrosive acids when combined with condensing water. The reduction of the carbon-dioxide content requires additional operational and financial efforts. As CO_2 “scrubbing” is not necessary when biogas is used for cooking, it is rarely advisable in developing countries.

4. Key Performance Indicators for Sanitation Services

Performance indicators are used to measure the efficiency and effectiveness of a utility in achieving the following objectives:

(a) Protection of public health
(b) Meeting users' needs and expectations
(c) Provision of services under normal and emergency situations
(d) Sustainability of the wastewater utility
(e) Promotion of sustainable development of the community
(f) Protection of the environment

4.1 Performance Indicators for Sanitation Services

A safe sanitation system is a system designed and used to separate human excreta from human contact at all steps of the sanitation value chain from toilet, capture and containment through emptying, transport, treatment (in-situ or off-site) and eventually final disposal or end use. Hence the performance indicators in the following sections are designed to ensure safe sanitation services can be achieved gradually.

The performance indicators for sanitation services are categorized as follows:

(a) Specific Indicators (exclusively for sanitation):
  (i) Onsite sanitation indicators
  (ii) Sewered sanitation indicators
  (iii) Non-sewered sanitation indicators
(b) General Indicators: Indicators which are also applicable to water services (applicable for all utility services).

4.2 Specific Performance Indicators for Sanitation

4.2.1 Onsite Sanitation Indicators

Safely managed sanitation indicators considerations

(a) Percentage of open defecation eradication
(b) Percentage of population using a pour-flush toilet connected to a septic tank, which is emptied and the faecal sludge disposed of safely
(c) Percentage of population using a pour-flush toilet connected to a pit, which is emptied and the faecal sludge disposed of safely
(d) Percentage of population using a compost latrine which can be emptied and compost disposed of safely

(e) Percentage of population using a VIP latrine which can be emptied and faecal sludge disposed of safely

(f) Percentage of population using a urine-diversion latrine which can be emptied and sanitation products disposed of safely or reused

4.2.2 Sewered Sanitation Indicators

Sewered sanitation indicators are further categorized in accordance with the sewerage sanitation chain components which are: Collection and transport of wastewater; Wastewater treatment; and Sludge and effluent disposal or re-use.

(a) Collection and Transport of waste water

(i) Sewer system coverage: Percentage of population that are connected to the sewer system;

(ii) Utilization of sewerage system: Percentage of capacity utilization of a sewerage system;

(iii) Sewer Flooding: Percentage of connected properties that are affected by flooding from sewers during the assessment period (Only flooding from sewers that are the responsibility of the wastewater undertaking should be included. Flooding may affect properties that are not connected to the sewers. These properties should be included.)

(iv) Interruption of wastewater collection and transport services: Percentage of the number of properties affected by service interruption during assessment period

(v) Sewer blockages: the average number of blockages occurring per 100 km of sewers during the assessment period

(b) Waste water treatment

(i) Capacity of the treatment plant: Inflow waste water (volume) as a percentage to the capacity of the treatment plant

(ii) Compliance to sewage quality standards: Percent of sewage effluent quality tests which meet the effluent quality standards.

(iii) Proportion (percentage) of wastewater (sewage and faecal sludge) generated by households and by economic activities which is safely treated compared to total wastewater generated by households and economic activities

(c) Sludge and effluent disposal/re-use

(i) Re-use and recycling of treated sewage- treated sewage re-use/recycled as a percentage of total treated sewage (%)

4.2.3 Non-Sewered Sanitation Indicators

Non-sewered sanitation indicators are further categorized in accordance with the non-sewered sanitation chain components which are: Sludge collection; Sludge Transportation; Sludge Treatment; and Reuse of Treated Sludge:

(a) Sludge Collection Indicators

(i) Septic tank coverage: Percentage of households connected to septic tanks (%)

(ii) Collection efficiency of septage (%) – Percentage of septage which is collected to the total expected sewage to be collected during the assessment period

(iii) Percentage of septic tanks connected to soak pit for effluent disposal (%

(iv) Percentage collected from emptiable toilets

(b) Sludge Transportation Indicators

(i) Number of septage sucking machines/1000 septic tanks (Ratio)

(c) Sludge Treatment

(i) Percentage of received septage at the treatment plant to total expected septage during the assessment period (%)

(ii) Compliance to sludge quality standards: Percent of sludge effluent quality tests which meet the effluent quality standards.

(d) Reuse of Treated Sludge

(i) Percentage of reuse treated sludge (from septic tank and grey water) to total treated effluent.

4.3 General Indicators

Indicators below are applicable to both to sewered and non-sewered system and also to a water supply system which is mostly an integral part of the sewerage system.

(a) Total cost coverage ratio – total operation and maintenance costs that are covered by revenues (ratio), i.e. the total sanitation revenues over the total O&M costs for sanitation during the assessment period.

(b) Billing Complaints: number of billing complaints and queries during the assessment period over the number of registered customers).

(c) Timely resolution of billing complaints: percentage of the total number of billing complaints that are resolved within the maximum time specified in a local service commitment.

(d) Billing Efficiency: - ratio in percentage of the number of bills prepared to the total number of sewerage customers.

(e) **Revenue collection efficiency**: percentage of revenue collection to billed revenue during the assessment period.

(f) **Personnel Indicator**: Personnel per 1,000 sewerage connections

(g) **Gender**: % of women in leadership positions within sanitation related decision-making bodies

(h) **Subsidy:** Subsidy amount paid to NSS/SS (non-sewered sanitation / sewered sanitation)

5. Minimum Service Level Standards and Performance Targets

5.1 Setting of Minimum Service Level Standards and Performance Targets

The required minimum service level is a standard which defines the acceptable minimum level of service in terms of standards and performance indicators targets which providers must achieve over time and is measured by service indicators. It complements the standards approved by the Bureau of Standards Institutions in member countries. The service level and performance targets are regularly adjusted according to the development of the sector.

The standards and performance targets which are also currently being used by other developing countries were adopted by regulators in ESAWAS region and are being used to set targets in ESAWAS performance benchmarking reports. Timeframe for achievement of the minimum service levels (MSLs)are set independently by each respective member country depending on the levels in which the MSLs have been achieved.

However, Kenya, being one of the signatory countries that committed themselves to attain the Sustainable Development Goals, have had their targets for indicators which are related to SDG .6.2 being set to be achieved by 2030. These are indicators which add up together to contribute to a global SDG target 6.2 on sanitation which is *proportion of the population using safely managed sanitation services reach 100 percent by 2030*. This target is further defined as the population using an improved sanitation facility that is not shared with other households, and where excreta are either: treated and disposed of in-situ; stored temporarily and then emptied and transported to treatment off-site; or transported through a sewer with wastewater and then treated off-site.

There are performance indicators and service levels which are not assigned any target, because it was not possible to benchmark them with any utility or regulator. It is therefore recommended for ESAWAS to start monitoring these service levels and indicators and ultimately establish the respective targets. Table 4 below indicates minimum service level standards and performance targets for sanitation services.

5.2 Instruments for Regulating the Attainment of Service Levels and Targets

In order to regulate the attainment of minimum service level standards and performance targets within a set time frame and to guarantee the provision of agreed service levels to customers the regulator may prepare and agree with the utility on a Service Level Guarantee (SLG) and Service Level Agreement (SLA).

(a) Service Level Guarantee (SLG)

The providers shall at all times guarantee a specific service level to the customer with progression towards the minimum service level. The regulator and provider agree on a Service Level Guarantee, which shall ensure the required standard of service at any time for an agreed period say 3 years and thereafter revised upwards. The service level guarantee shall be made public.

(b) Service Level Agreement (SLA)

A Service Level Agreement is an agreement in terms of a schedule which indicates the progressive attainment (annually) of Minimum Service Level standards and Performance Targets over a planning period of say three years. The detailed plan for attaining the Minimum Service Level Standards and Performance Targets should be an integral part of the utility business plan.

Upon formation, a provider proposes a first Service Level Agreement for a period of three years corresponding to the Business Plan. Subsequent upward adjustments to the service level are signed upon in the form of a Service Level Adjustment Agreement each for a further period of three years. This procedure remains in place as long as the provider has not been able to fulfil all indicators of the required minimum service level.

Table 4: Recommended Minimum service levels/ standards and performance targets for sanitation services

No	Performance Indicator/ Quality of Service	Performance Target	Minimum Standards
1	**Indicators along the SDG Sanitation ladder**		
	Percent of population practising safely managed sanitation (Use of improved facilities that are not shared with other households and where excreta are safely disposed of in situ or transported and treated off-site)	100% by 2030	N/A
	Percentage of population practising basic sanitation (Use of improved facilities that are not shared with other households)	Annual targets to be established aiming at attaining safely managed sanitation by 2030.	N/A
	Percentage of population practising limited sanitation (Use of improved facilities shared between two or more households)		
	Percentage of population practising unimproved sanitation (Use of pit latrines without a slab or platform, hanging latrines or bucket latrines)		
	Percentage of population practising open defecation	0% by 2030	N/A

Table 4: Recommended Minimum service levels/ standards and performance targets for sanitation services

No	Performance Indicator/ Quality of Service	Performance Target	Minimum Standards
	(Disposal of human faeces in fields, forests, bushes, open bodies of water, beaches or other spaces, or with solid waste)		
2	**a) Sewered sanitation indicators – collection and transport indicators**		
(i)	Sewer system coverage: Percentage of population that are connected to the sewer system	To be established	N/A
(ii)	Utilisation of a sewerage system	100 %	N/A
(iii)	Provision of sewerage connection	N/A	a) Within 15 working days where existing infrastructure can be used and the distance to connect a household to a sewer is within 90m. b) If new sewers are required or if connection is required for industrial or commercial consumers, then the period for sewerage connection has to be as follows: within 30 working days for distances greater than 90m but less than 500m
(iv)	Sewer Flooding: Percentage of connected properties that are affected by flooding from sewers during the assessment period	Maximum of 0.5% of total connections per year	The sewage flooding, within the network of the Licensee, should be repaired within 24 hours after the Licensee has been informed.

Table 4: Recommended Minimum service levels/ standards and performance targets for sanitation services

No	Performance Indicator/ Quality of Service	Performance Target	Minimum Standards
(v)	Interruption of wastewater collection and transport services: Percentage of the number of properties affected by service interruption during assessment period	% of connected properties subject to an unannounced interruption of 20-36 hours from the time the interruption is reported <15%, 36-48 hours <8% and >48hours<3%	N/A
(vi)	Sewer blockages: the average number of blockages occurring per 100 km of sewers during the assessment period	To be determined	N/A
2	**b) Sewered sanitation indicators – wastewater treatment indicators**		
(i)	Capacity of the treatment plant: Inflow waste water (volume) as a percentage to the capacity of the treatment plant	At least 75 %	N/A

Table 4: Recommended Minimum service levels/ standards and performance targets for sanitation services

No	**Performance Indicator/ Quality of Service**	**Performance Target**	**Minimum Standards**
(ii)	Compliance to sewage quality standards: Percent of sewage effluent quality tests which meet the effluent quality standards.	100 % by 2030	The Licensee must ensure that the quality of treated wastewater at its treatment plants complies with the wastewater quality standard published by the responsible regulators
(iii)	Proportion (percentage) of wastewater (sewage and faecal sludge) generated by households and by economic activities which is safely treated compared to total wastewater generated by households and economic activities	100% by 2030	N/A
2	**c) Sewered sanitation indicators – Re-use**		
	Re-use and recycling of treated sewage - treated sewage re-use/ recycled as a percentage of total treated sewage (%)	At least 20%	N/A
3	**a) Non-sewered sanitation indicators – sludge collection indicators**		
(i)	Septic tank coverage: Percentage of households connected to septic tanks (%)	Contributes to SDG	N/A
(ii)	Collection efficiency of septage (%) – Percentage of septage which is collected to the total expected sewage to be collected during the assessment period	100% by 2030	N/A

Table 4: Recommended Minimum service levels/ standards and performance targets for sanitation services

No	Performance Indicator/ Quality of Service	Performance Target	Minimum Standards
3	**b) Non-sewered sanitation indicators – sludge transportation indicators**		
(i)	Number of septage sucking machines / 1000 septic tanks (Ratio)	To be established	N/A
(ii)	Percentage of households connected to sewer network (%)	30%	N/A
(iii)	Percentage of septic tanks connected to soak pit for effluent disposal (%)	100% by 2030	N/A
3	**c) Non-sewered sanitation indicators – sludge treatment indicators**		
(i)	Percentage of received septage at the treatment plant to total expected septage during the assessment period (%)	100% by 2030	N/A
(ii)	Compliance to sludge quality standards: Percent of sludge effluent quality tests which meet the effluent quality standards.	100% by 2030	N/A
3	**d) Non-sewered sanitation indicators – Reuse of treated sludge indicators**		

Table 4: Recommended Minimum service levels/ standards and performance targets for sanitation services

No	Performance Indicator/ Quality of Service	Performance Target	Minimum Standards
	Re-use of treated sludge: Percentage of reuse and recycling of treated effluent (from septic tank and grey water) to total treated effluent.	At least 20%	N/A
4	**General Indicators – applicable to both sewered and non-sewered**		
(i)	Total cost coverage ratio – a ratio of total operation and maintenance costs over the revenue during the assessment period.	Less than 1.0	N/A
(ii)	Subsidy amount paid to NSS/SS (non-sewered sanitation / sewered sanitation)	To be established	N/A
(iii)	Billing Complaints: number of billing complaints and queries during the assessment period over the number of registered customers)	N/A	To be established
(iv)	Timely resolution of billing complaints: percentage of the total number of billing complaints that are resolved within the maximum time specified in a local service commitment	N/A	General complaints (water quality, pressure, behaviour of staff, etc.) received telephonically, or in person should be responded to on a one-stop basis without referral within 1 day. Written customer complaints should be responded to in writing within five working days and the problem should be solved

Table 4: Recommended Minimum service levels/ standards and performance targets for sanitation services

No	Performance Indicator/ Quality of Service	Performance Target	Minimum Standards
(v)	Customer Complaints	N/A	Maximum time of 5 working days to complete investigation and respond from the date of receipt of complaints not bill related Maximum time of 5 working days to complete investigation and respond, from the date of receipt of complaint. Waiting time should not exceed to be heard one hour.
(vi)	Billing and payment	N/A	Minimum of one bill per month for all customers, with minimum of meter read once in 2 months. Maximum period for payment after bill delivery is 2 weeks.
(vii)	Billing Efficiency: - ratio in percentage of the number of bills prepared to the total number of sewerage customers	N/A	One bill per month for all customers, Period for payment after bill delivery is 2 weeks.
(viii)	Disconnection/ Reconnection after non-payment, tampering	N/A	A sewerage connection shall be blocked following 5 days written notice if the customer continues to use it following disconnection from water supply.

Table 4: Recommended Minimum service levels/ standards and performance targets for sanitation services

No	Performance Indicator/ Quality of Service	Performance Target	Minimum Standards
			Disconnection shall be affected immediately without prior notice; Reconnections of the sewerage connection shall be affected as promptly as possible; and no later than 24HRS after applicable fees have been settled and necessary rectification of installation have been done to standards.
(ix)	Revenue collection efficiency; percentage of revenue collection to billed revenue during the assessment period.	At least 85%	N/A
(x)	Staff/Personnel per 1000 sewerage customers	Less than 5	
(xi)	Essential communication services	N/A	a) 24 hours communication services (eg telephone service, internet, mobile communication etc.) shall be provided for the reporting of faults and emergencies. b) Communication service for complaints, requests and queries shall be available during normal working hours
(xii)	Call handling (response to a call)	N/A	All incoming calls to be answered within 60 seconds

Table 4: Recommended Minimum service levels/ standards and performance targets for sanitation services

No	Performance Indicator/ Quality of Service	Performance Target	Minimum Standards
(xiii)	Unjustified Disconnection	N/A	a) The number of unjustified disconnections shall not exceed 0.2% of all connections per year. b) Reconnections of unjustified disconnection shall be affected as promptly as possible; and not later than 8 hours after the unjustified disconnections have been confirmed.
(xiv)	Account queries	N/A	An account query shall be acted upon and be responded to within 5 working days.

6. Guidance on Outsourcing Sanitation Services

6.1 Outsourcing Sanitation Services

(a) Definition Outsourcing

Outsourcing is the business practice of hiring a party outside a utility to perform sanitation services that in accordance with the existing legal framework were performed in-house by the utility or were supposed to be performed by the utility. Outsourcing is a practice usually undertaken by companies as a cost-cutting measure or as a measure to dial down and focus on the critical aspects of the business, spinning off the less critical operations to outside organizations.

(b) Institutional Arrangement for Outsourcing Sanitation Services

Figure 14 illustrates the institutional arrangements recommended for outsourcing sanitation services.

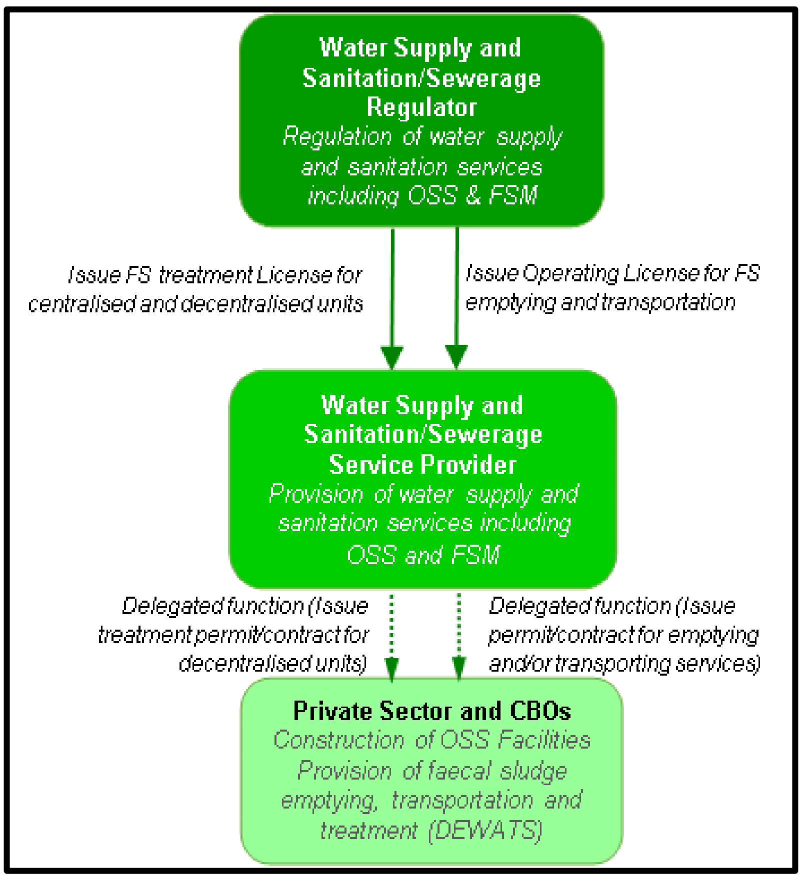


Figure 14: Institutional arrangement recommended for outsourcing sanitation services

According to the above institutional arrangement, the Licensee may outsource emptying and transportation of faecal sludge and provision of decentralised faecal sludge treatment services also known as Decentralized Wastewater Treatment Systems (DEWATS).

(c) Criteria for Outsourcing Sanitation Services

For Sanitation utilities, no other provider should be allowed to provide sanitation services in areas where the utility has exclusive rights to provide sanitation services, unless the utility does not have an appropriate and any credible plan or is not capable to provide such services. Sanitation services in areas which are not provided by the utility may be outsourced to the private sector, CBOs, NGOs etc. Such services may include but not limited to;

(i) emptying and transport of faecal sludge and;
(ii) treatment of faecal sludge using DEWATS.

Before being outsourced by the Licensee, the service provider should first acquire a permit from the County Government to operate the intended sanitation business in the area under question.

6.2 Outsourcing Faecal Sludge Emptying and Transportation

The Licensee shall ensure that no person provides services within its area of the license related to provision of faecal sludge emptying and transport without its authority.

The Licensee may outsource the provision of faecal sludge emptying and transport services however, a licensee shall at all times be fully responsible for the acts and omissions of the operator (including their agents, servants and employees) for provision of the services.

The outsourced service is the provision of faecal sludge emptying services using exhauster trucks. For outsourcing the service, a Licensee shall issue a permit or register the operator whereby the Licensee has to ensure that the following conditions are complied with:

(a) Prior to registering an operator to carry the business of transporting faecal sludge, the Licensee shall ensure that the exhauster truck;

(i) has a containment mechanism to conceal the contents except during loading and unloading;
(ii) is water and air tight manufactured to prevent leakage and facilitate thorough cleaning;
(iii) has self-sucking and offloading mechanisms;
(iv) has safety devices including devices to detect leaks of liquid waste from the tank;
(v) has been visibly marked as strictly carrying and transporting wastewater and sewage only;
(vi) has a vehicle inspection certificate;

(vii) has a vehicle insurance;

(viii) Possess hazard warning signs including multilingual signs together with appropriate information regarding remedial action;

(ix) Has adequate safety equipment for workers involved in liquid waste collection and transportation.

(b) During the registration process of the operator, the Licensee must capture the following:

(i) identification details of the owner of the exhauster truck;

(ii) vehicle registration number;

(iii) the area of operation of the exhauster truck; and

(iv) the volume of the exhauster truck.

(c) The registration certificate shall include the following provisions in the terms and conditions;

(i) taking of samples and checking the compliance of faecal sludge/waste water before discharge to wastewater disposal works;

(ii) prescription of the nature and quality of the sewage and wastewater;

(iii) on the details of wastewater disposal works;

(iv) prescription of the fees, tariff, and charges and show up the source;

(v) technical support to the private operator by the Licensee where necessary;

(vi) maintenance of equipment to the standards required by the Authority;

(vii) provide instructions and appropriate trainings to employees to minimize risks;

(viii) provide insurance of employees against illness or injury;

(ix) avail protective clothing masks, safety shoes, eye protection gadgets, gumboots, and other safety equipment for risk prevention and management;

(x) not to dispose of liquid waste in an unapproved place; and

(xi) ensuring that vehicles, tanks or tankers employed for liquid waste are not used to transport hazardous waste or potable water.

(d) The licensee shall:

(i) ensure that, all operators of faecal sludge exhausting trucks operating in areas not covered by the licensee sewer network are registered with the Licensee

(ii) ensure that the designated points of disposal of the waste water and sludge are known to the exhauster operators and meets the standards for such facilities and is maintained to protect the environment and safe disposal of waste;

(iii) ensure that all such waste shall be treated to the required standard;

(iv) ensure that operators are registered with the local administration;

(v) maintain a daily register of all disposals in volume undertaken at the discharge point and shall as per sampling schedule under the Water Quality and Effluent Monitoring Guideline test sludge samples;

(vi) the operator complies to the tariff as approved by the regulator; and

(vii) ensure that the service provider meet the service provisions standards on safety, price and environmental protection

6.3 Outsourcing Decentralised Faecal Sludge Treatment

The Licensee shall ensure that no person shall provide services within its area of the license related to provision of faecal sludge treatment services without its authority.

The Licensee may outsource the provision of faecal sludge treatment services with decentralised units (DEWATS) to the operator. However, a licensee shall at all times be fully responsible for the acts and omissions of the operator (including their agents, servants and employees) for provision of faecal sludge treatment services.

The services to be offered by the operator may either be;

1. construction, own and operation of the faecal sludge treatment facility or;
2. to operate and maintain the faecal sludge treatment facility which is owned by the utility. For outsourcing faecal sludge treatment services, a contract should be entered into between the Licensee and the Operator whereby a Licensee has to ensure that the following conditions are complied with:

(a) The operator is able/has capacity to construct and operate or only operate the faecal sludge treatment facility by reviewing and evaluating the following:

(i) business permit issued by the respective County Government;

(ii) design of the Faecal Sludge Treatment Facility;

(iii) construction permit of the treatment facility;

(iv) approval by the Environmental Regulatory Authority;

(v) business plan for conducting the business;

(vi) financial status of the operator;

(vii) technical description and flow chart of the system operation;

(viii) training manual for system operators; and

(ix) health and safety policy.

(b) The contract shall include the following provisions in its terms and conditions:

(i) General Conditions:

- provide necessary staff, material and equipment for effective service delivery;
- comply with the tariff as approved by the regulator;
- comply to the service quality standards as issued by the regulator from time to time;
- operate in accordance with existing, standards, laws and regulations related to the services to be provided;
- comply with general directives issued by the Regulatory Board
- keep a record of its services in a form specified by the Regulatory Board and submit the report to the Regulatory Board every year from the commencement of the year in which the license has been issued;
- indemnify consumers against any claims in any proceedings arising from any breach or failing on the part of the licensee;

(ii) Operational Conditions:

- to optimize the performance of faecal sludge treatment system and to provide adequate training to employees in both routine operations and maintenance procedures;
- to regularly monitor the effluent quality as per regulators guidance;
- to follow engineering construction, maintenance and operational best practices to ensure consistent, effective and safe performance of the system;
- to extremely care about the operation of machinery during or after installation to prevent damage to the system;
- to have a manual of operation and maintenance.
- periodical removal of sludge from inside the treatment system is required to ensure that the system continues to operate satisfactorily and to produce quality effluent and ensure safe disposal of effluent and sludge;

(iii) The regulator may impose such terms and conditions on the sub-contracting arrangement as it thinks fit, including the terms of the subcontract and the utility shall ensure that the terms and conditions are complied with.

7. Monitoring and Reporting

7.1 Issues for Monitoring and Reporting

Monitoring here refers to the regular observation and recording of activities taking place in sanitation service provision and to check the progress. Monitoring also involves giving feedback about the progress of the project /service (In terms of a report) to the regulator, government, funders, implementers, development partners and beneficiaries of the project.

Monitoring is a key sanitation function to track progress and inform management decisions. This is especially important given that safe sanitation systems depend on continuous provision of services meeting the principles of safe sanitation management at each step. Monitoring tracks the attainment of minimum service standards and performance targets discussed in chapter 5.

Monitoring and reporting of sanitation services is represented on Table 5 below indicating key issues for monitoring and reporting, responsible individuals/ institution and what is to be monitored and reported.

Table 5: Monitoring and Reporting of Sanitation Service

No.		Key Issue for Monitoring and Reporting	Responsibility for Monitoring, Reporting and Inspection	What Is to be Monitored and Reported? To be synchronised with indicators (log frame for M&E)
1		Sanitation and related facilities (superstructure, handwashing facilities) and the way they are used. For on-site facilities, the extent, effectiveness and safety of *in-situ* treatment	Data and information to be collected through the inspection of dwellings and buildings (this may be done routinely, in periodic/ Special surveys by Health Officers or in the national census). The sanitation service provider to monitor the	Attainment of minimum standards for sanitation facilities including containment. Attainment of performance targets for

No.		Key Issue for Monitoring and Reporting	Responsibility for Monitoring, Reporting and Inspection	What Is to be Monitored and Reported? To be synchronised with indicators (log frame for M&E)
			improvement of onsite facilities	onsite sanitation
2		For on-site facilities, the extent, effectiveness and safety of emptying and transport of faecal sludge	Data and information to be continuously obtained from customers, formal (Utility)and informal operators. Data and information to be collected by the sanitation authority with assistance from health officers and to be reported to the regulator	Attainment of minimum standards for sanitation facilities including containment, emptying equipment and transportation of sludge. Attainment of performance targets
3		For sewerage, the extent of leakage and overflow of untreated sewage	Data and information to be collected by the sanitation Utility and to	Attainment of minimum standards for sanitation

No.		Key Issue for Monitoring and Reporting	Responsibility for Monitoring, Reporting and Inspection	What Is to be Monitored and Reported? To be synchronised with indicators (log frame for M&E)
4		The effectiveness of faecal sludge and sewage treatment against national standards or permits	be reported to the regulator. These data should be backed up by periodic inspection by the regulator to make sure that the information and data reported is correct.	facilities including conveyance, treatment and disposal/end use of sludge and respective performance targets.
5		The extent and effectiveness of community engagement on sanitation	Community engagement requires discussions with local officials and community members.	
6		Services provided by the sanitation utility	Data and information to be continuously monitored by the sanitation service provider and to be reported to the regulator	Attainment of minimum levels of service and performance targets

7.2 Compliance Monitoring and Evaluation by Regulator

The regulator shall monitor compliance of the Licensee with license conditions with regard to sanitation regulation which include, among others, the following:

(a) Track data and information reported to establish whether there is an improving or declining trend and establish the reason thereof.

(b) Monitor the achievements made in relation to set targets in the respective Service Level Agreements, Service Level Guarantee Agreements and Business Plans.

(c) In the framework of monitoring the provision of sanitation services, inspection will be conducted by the Regulator with the objectives of:

  (i) checking the performance of a sanitation utility.

  (ii) to make sure that the information and data reported is correct.

  (iii) recommending the service provider on the way to improve the performance and quality of services offered, complying with existing regulations.

(d) All monitoring results should be kept for a minimum period of three (3) years.

(e) The regulator should evaluate and monitor the impact and attainment of global indicators. In this case the regulator should monitor the attainment of SDG indicators on sanitation.

7.3 Submission of Reports

Subject to the results of monitoring and evaluation (7.1 and 7.2) and other information requirements by the regulator, the utility responsible for sanitation services shall submit the following reports to the Regulator;

(a) Monthly operational reports in accordance with the format and timing as established by the regulator.

(b) Annual report prepared in accordance with the format established by the regulator detailing activities and operations of the utility during the year.

7.4 Quality of The Information

A scheme providing information on data quality is needed so that users of the performance indicators and context information are aware of the reliability of the information available. The value of the performance indicators can be questionable without this scheme. The confidence grade of a performance indicator can be assessed in terms of its accuracy and reliability.

7.4.1 Data Reliability

The reliability of the source of data accounts for uncertainties in how reliable the source of data may be, such as the extent to which data source yields consistent, stable, and uniform results over repeated observations or measurements under the same conditions each time. Reliability of the data will be analysed as per definition in Table 5.

Table 6: The Definitions of Data Reliability Band

Reliability Bands	Definition
A	Reliable data based on sound records, procedures, investigations or analyses that are properly documented and recognized as the best available assessment methods
B	Fairly data based on records, procedures, investigations or reliable analyses that are properly documented and recognized as the best available assessment methods. However, up to 30% of the data is based on extrapolation
C	Unreliable data based on extrapolation from records that cover more than 30 percent of the service provider's system.

7.4.2 Data Accuracy

The accuracy accounts for measurement errors in the acquisition of input data, i.e. the closeness of observations, computations or estimates to the true value. Accuracy of the data will be analysed as shown in Table 6.

Table 7: The Range of Accuracy Bank

Accuracy Band	Associated uncertainty
1	(0 -5%): Better than or equal to+/- 5%
2	(5 - 20%): Worse than± 5%, but better than or equal to+ *I* -20%
3	>20%

7.4.3 Confidence Grading

Confidence grades can only be estimated directly for the variables. Based on these, performance indicators confidence grades can either be assessed quantitatively or qualitatively. Data source reliability and data accuracy should be assessed for every input variable. The overall confidence grade of the indicator will be the minimum of the confidence of any of the constituting variables. For example, Non-Revenue Water (NRW) is computed from variables namely water production (input into the distribution network) and billed volume (water consumption). If water production is measured with an estimated uncertainty of ±15% and from a reliable source will have a **confidence grade of A2** and if billed volume is measured from a fairly reliable source with estimated uncertainty of +15 will have a confidence grade of B2. Therefore, the overall confidence grade for NRW will be B2. Service providers should aim for a grade of at least **B2.**

7.5 Sanctions and Incentives Related to Performance Requirements

Failure by the utility to attain the minimum service level standards and performance targets contained in Service Level Guarantee and Service Level Agreement (item 5.2) of these Guidelines, may lead to regulatory sanctions. Specifically, where it is proved that there is no justification for failure to attain the service levels and performance targets, the following sanctions may apply:

(a) the regulator may decide to impose special performance monitoring which includes enhanced performance reporting; and/or

(b) sanctions/penalties for non-performance.

References

1. ISO 24510: Activities relating to drinking water and wastewater services - Guidelines for the assessment and for the improvement of the services to users
2. ISO 24511: Activities relating to drinking water and wastewater services - Guidelines for the management of wastewater utilities and for the assessment of wastewater services
3. ISO 24521: Activities relating to drinking water and wastewater services - Guidelines for the management of basic on-site domestic wastewater services.
4. WHO 2018 Guidelines for Sanitation and Health
5. ESAWAS Regulation Strategy and Framework for Inclusive Urban Sanitation Service Provision Incorporating Non-sewered Sanitation
6. ESAWAS Guidelines for Inclusive Urban Sanitation Service Provision (Incorporating Non-Sewered Sanitation Services)
7. BS 6465-1, Sanitary installations – Part 1: Code of practice for the design of sanitary facilities and scales of provision of sanitary and associated appliances.
8. Compendium of Sanitation Systems and Technologies, 2nd revised edition; EAWAG.
9. Sustainable Sanitation and Water Management (SSWM) Toolbox; www.sswm.info.

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