INTEGRATED WASTEWATER AND FAECAL SLUDGE MANAGEMENT FOR GHANA

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Abbreviations

CSIR-IIR	Council for Scientific and Industrial support from Research-Institute of Industrial Research
CT	Community toilet
CWSA	Community Water and Sanitation Agency
DEHOs	District Environmental Health Officers
DESSAP	District Environmental Sanitation Strategy and Action Plan
EHSD	Environmental Health and Sanitation Directorate
EPA	Environmental Protection Agency
FGDs	Focussed group discussions
GAMA	Greater Accra Metropolitan Authority
GSGDA	Ghana Shared Growth and Development Agenda
IWMI	International Water Management Institute
JMP	Joint Monitoring Progress Report
JVL	Jekora Ventures Ltd
KIIs	Key Informant Interviews
KVIP	Kumasi Ventilated Improved Pit
LGA	Local Governance Act
M&E	Monitoring and evaluation
MESSAP	Metropolitan Environmental Sanitation Strategic Action Plan
MESTI	Ministry of Environment, Science, Technology and Innovation
MLGRD	Ministry of Local and Rural Development
MMDA	Metropolitan, Municipal District Authority
MoE	Ministry of Education
MoFEP	Ministry of Finance and Economic Planning
MoH	Ministry of Health
MSWR	Ministry of Sanitation and Water Resources
MTDP	Mid-Term Development Plans
NDPC	National Development Planning Commission
NESSAP	National Environmental Sanitation Strategy and Action Plan
NGOs	Non-governmental organizations
OSS	On-site sanitation systems
PPP	Public–private partnership
PT	Public toilet
RCC	Regional Coordinating Councils
SESIP	Strategic Environmental Sanitation Investment Plan
SPS	Sewage pumping station
STP	Sewage treatment plant
TMA	Tema Metropolitan Area
US $	US dollars (conversion rate: US $1 = 4.80 Cedi)
VALCO	Volta Aluminium Company
WC	Water closet

Glossary

Black water: A mixture of urine, faeces and flush water along with anal cleansing water (if water is used for cleansing) and/or dry cleansing materials. Black water contains pathogens of faeces and the nutrients of urine that are diluted in flush water.

Effluent: The supernatant liquid discharged from a septic tank. The liquid separated from the faecal is also referred to as effluent.

Faecal sludge: The settled contents of pit latrines and septic tanks. It differs from sludge produced in municipal wastewater treatment plants. The characteristics of faecal sludge differ from household to household, city to city, and country to country. The physical, chemical and biological qualities of faecal sludge are influenced by the duration of storage, temperature, soil conditions and intrusion of groundwater or surface water into septic tanks or pits, performance of septic tanks, and tank-emptying technology and pattern.

Faecal sludge management: The collection, transport and treatment of faecal sludge from pit latrines, septic tanks or other on-site sanitation systems.

Grey water: The total volume of water generated from washing food, clothes and dishware, as well as from bathing, but not from toilets. It may contain traces of excreta and, therefore, also pathogens. Grey water accounts for approximately 65 per cent of the wastewater produced in households with flush toilets.

Integrated wastewater and faecal sludge management (IWFM): IWFM is a holistic approach that address the whole sanitation service chain, including both wastewater and faecal sludge. It recognizes that sanitation for all cannot be achieved by managing either faecal sludge or wastewater alone.

Pit latrine: Latrine with one or two pits for collection and decomposition of excreta. The liquid generally infiltrates into the surrounding soil.

Pour-flush latrine: Latrine with a rural pan, where small quantities of water are poured from a container by hand to flush away faeces.

Scum: Grease, oil and other substances floating on the surface of a septic tank.

Sewage: Untreated wastewater which contains faeces and urine. This wastewater gets conveyed through the sewerage system. Grey water from kitchen and bathroom also generally becomes part of sewage.

Septage: The semi-solid matter from onsite sanitation systems like septic tanks. It has an offensive odour, appearance and high concentration of BOD, COD and TSS etc.
In this document, all kind of sludge from onsite sanitation systems are referred as "Faecal Sludge". Since it is an overarching term.

Septic tank: A water-tight single-storied tank in which sewage is retained long enough to permit sedimentation and digestion.

Self-cleansing velocity: Velocity of liquid high enough to initiate self-scrubbing action.

Sludge: Settled matter in a semi-solid condition.

Soak pit: A porous, covered chamber that allows wastewater to permeate into the ground. It is also known as a soakaway or leach pit.

Suspended solids: Small solid particles which remain in suspension in sewage, faecal sludge or effluent.

Vacuum tanker or truck: A vehicle that has a pump and a tank designed to pneumatically suck liquids and slurries (like faecal sludge). The vehicles are also used to transport extracted liquids.

1. Introduction

Ghana, on the west coast of Africa, is one of the most urbanized countries in Africa. As per the Ghana Statistical Service (GSS), 2010, its population was 24,658,823, and estimated to be 29.6 million in 2018. An estimated 53 per cent of the population lived in towns and cities in 2014.[1]

Ghana has made significant progress in providing access to improved water sources to 80 per cent of the population and eliminating guinea worm disease from the country. However, despite these successes, about 4,000 Ghanaian children die each year from diarrhoea, even more die from pneumonia, and about 23 per cent of children suffer from stunting (chronic malnutrition linked to poor water and sanitation).[2]

According to the Community Water and Sanitation Agency, urban water-supply coverage in Ghana is estimated at 59 per cent, while in rural and small towns it is about 54 per cent. According to UNICEF's and WHO's Joint Monitoring Programme Report for Water Supply and Sanitation, the supply of piped water has drastically reduced from 41 per cent in urban areas in 1990 to 32 per cent in 2015. However, at the same time, there is a substantial increase in other improved source of piped water in urban areas from 43 per cent in 1990 to 61 per cent in 2015, possibly due to the government focusing more on communal water supply than individual household connections (see *Table 1: Access to water in Ghana*).[3]

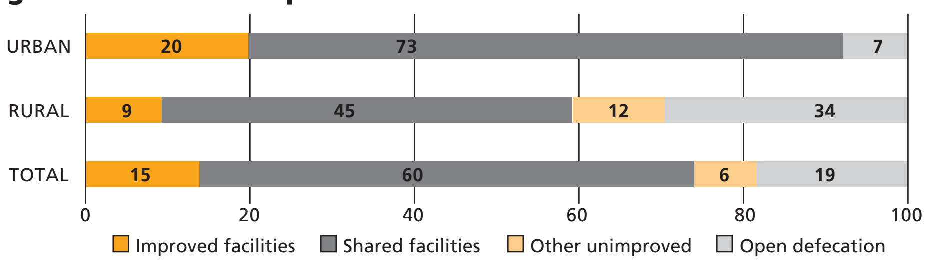
Almost half of the country now lives in towns and cities; less than one fifth of this number has access to improved sanitation services. Nearly half of the population in Kumasi rely on public toilets, with only one toilet for every 1,000 people and nearly non-existent water supply services in low-income urban areas. This has massive consequences on the people’s health, dignity and economic growth.[4]

Table 1: Access to water in Ghana

Drinking water	Drinking water coverage estimates					
	Urban (%)		Rural (%)		Total (%)	
	1990	2015	1990	2015	1990	2015
Piped onto premises	41	32	2	3	16	19
Other improved source	43	61	37	81	40	70
Other unimproved	8	7	11	8	9	7
Surface water	8	0	50	8	35	4

Source: Joint Monitoring Programme, 2015.

Figure 1: Access to improved sanitation facilities



Source: Joint Monitoring Programme, 2015.

Almost 73 per cent of urban residents rely on shared sanitation facilities, which can either be compound toilets (shared by a few households) or public toilets (usually fee-paying and accessible to all).[5] JMP estimates that only 20 per cent of urban residents have individual improved facilities (see *Figure 1: Access to improved sanitation facilities*).[6] Open defecation is practised by 7 per cent of urban dwellers. WaterAid's 2017 report *Out of Order: The State of the World's Toilets* named Ghana among the world's top 10 countries with the highest percentage of population without decent toilet facilities. The national average for sewerage coverage is as low as 4.5 per cent.[7]

Sewered facilities serve a small fraction of urban residents. Only three main cities have sewerage network—Accra, Tema and Kumasi. Accra has only 1,100 sewerage connections. Tema reports about 23,000 official connections to the sewer system. In recent years, Kumasi developed decentralized sewerage networks serving about 300 households. Akosombo, a small town with a population of about 15,000, whose water supply is managed by the Volta River Authority (which is responsible for production of electricity from the Akosombo Dam), is 100 per cent sewered. Open defecation was practised in 2015 by about 5.1 million (19 per cent) Ghanaians, of which 4.2 million (or 82 per cent) were rural dwellers. The remaining population was largely dependent on the On-site Sanitation Systems (OSSs) (see *Table 2: Sanitation technologies for corresponding percentage of population*).[8]

Containment systems: Septic tanks are the most prevalent lined tanks in Ghana. They have vents and have a varying number of chambers (normally >2). The number of chambers directly correlate with the number of opening lids on the tank. This technology is used for both individual household toilets, public toilets and institutional toilets (e.g. schools). The design of private septic tanks

Table 2: Sanitation technologies for corresponding percentage of population

Housing facilities	**Per cent (all regions)**
No facility	19.3
WC	15.4
Pit latrine	19.0
KVIP	10.5
Bucket/pan	0.7
Public toilets	34.6
Other	0.4
Liquid waste disposal	
Through the sewerage system	3.4
Through plumbing system into a gutter	10.9
Through drainage into a pit (soakaway)	3.1
Thrown onto the street/outside	28.1
Thrown into gutter	18.7
Thrown onto compound	35.2
Other	0.7

Source: Census of Ghana, 2010.

depends on the knowledge/skills of masons who construct them. Generally, private and public septic tanks are connected to a soakaway. Households in urban areas also have fully lined tanks without outlet/overflow.

Households are dependent on—apart from septic tanks and fully lined tanks—lined pits with semi-permeable walls, locally called as Kumasi Ventilated Improved Pits (KVIPs). A small population still uses bucket/pan latrines. Buckets latrines/toilets are basically vessels that are emptied daily. These were introduced in Kumasi in the colonial period when collection was organized via local government.[9] This practice has been illegal in Ghana since 2010.

KVIP, a semi-lined twin-pit system, are alternatively used. It takes more than two years for the pit to fill. When one pit is ready to be emptied, the material in the pit is like dry compost; this is then dug out manually and disposed of in the local environment or used in gardens. In low-income settlements, the government provides toilets under the scheme 'Get a Complete Toilet at 1,100 GH¢'. The containments provided under this scheme are fully lined tanks with no outlet/overflow.[10]

Emptying and transportation of faecal sludge from OSS is largely provided by privately owned vacuum tankers. The emptying service providers work either as company or individual emptiers. They usually distribute business cards to advertise their services. Use of personal protective equipment while emptying is subject to the behaviour of emptiers. It was found, prima facie, during a visit to Accra FSTP and Tema city that emptiers do wear personal protective equipment (PPE). Manual emptying of containment systems may also be in practice in areas that are not accessible to vacuum tankers. The vacuum tankers are pre-owned trucks purchased from European countries, as Ghana doesn't have its own manufacturing plants for vacuum tankers. A vacuum tanker operator charges an emptying fee from a customer depending on the capacity of tanker requested by the customer. The emptying frequency varies from one containment system to the other; for a septic tank in a public toilet the frequency of emptying is three months to one year, for septic tanks in households is six months to one year, for fully lined tanks it is three to six months and for various pits it is one year to three years.[11]

A survey conducted by the Environmental Protection Agency in 2015 in the Greater Accra region showed that out of 24 STPs in the Accra and Tema metropolises, only 16 STPs (67 per cent) are functioning; the rest are either malfunctioning (17 per cent), abandoned (8 per cent), or under rehabilitation (4 per cent) (see *Annexure 2: Inventorization of STPs in Greater Accra region*).[12] Faecal sludge and sewage treatment plants are slowly developing in urban areas. A draft Shit Flow Diagram (SFD) of the Accra Metropolitan Region estimated that excreta of only 61 per cent population is being safely managed; a draft SFD of the Tema Metropolitan Assembly indicated that excreta of only 18 per cent of population is being safely managed, and SFD of Kumasi estimates that excreta of 55 per cent of the population is being safely managed (see *Annexure 1: Shit Flow Diagrams of three metropolitan assemblies*).

As only 4 per cent of the population of Ghana is connected to sewerage system; the rest either rely on on-site systems or defecate in open.[13] Hence, there is a clear need for access to toilets and management of faecal sludge generated from most establishments. But focusing on faecal sludge management only will not meet the sanitation goals of the country until the grey water and effluent from septic tanks is managed. Therefore, a holistic and integrated approach for management of wastewater and faecal sludge is needed, where the population, whether living in rural or urban settlements, should be provided with solutions that sustainably manage their waste.

This guideline elaborates the IWFM approach that can help Metropolitan Municipal District Authorities (MMDAs) achieve sanitation for all (see *Figure 2: Key considerations for planning sanitation service chain*).

Faecal sludge management versus integrated wastewater and faecal sludge management
Faecal sludge management (FSM) is the collection, transportation and treatment of faecal sludge from pit latrines, septic tanks or other on-site sanitation systems.

Integrated wastewater and faecal sludge management (IWFM) is the recognition that sanitation for all cannot be achieved by just managing either faecal sludge or wastewater alone. IWFM is a holistic approach that addresses the whole sanitation chain, including both wastewater and faecal sludge.

1.1 Need for guidelines

Ghana has many sanitation policies and plans in place, but few guiding documents for planning and implementing effective wastewater and faecal sludge management projects to achieve sustainable sanitation for all.

Faecal sludge: How is it different from sewage?

Sewage is untreated wastewater that contains faeces and urine and gets conveyed through the sewerage system. Generally, grey water from kitchens and bathrooms also becomes part of sewage. The BOD of sewage is 150–350 mg/l and all sewage treatment plants are designed for this load.

Faecal sludge on the other hand is slurry that is emptied out of the on-site sanitation system. It is the solid or settled contents of pit latrines and septic tanks and is much more concentrated than sewage, with BOD ranging from 1,000 to 20,000 mg/l. It is raw or partially digested, slurry or in a semisolid form, and results from the storage and/or partial treatment of black water, with or without grey water. It differs from sludge produced in municipal wastewater treatment plants. The characteristics of faecal sludge can differ widely from household to household, from city to city, and from country to country. The physical, chemical and biological qualities of faecal sludge are influenced by the duration of storage, temperature, soil condition and intrusion of groundwater or surface water in septic tanks or pits, performance of septic tanks, and tank-emptying technology and pattern.

Source: Strande, L., Ronteltap, M., Brdjanovic, D. (eds) (2014). *Faecal Sludge Management: Systems Approach for Implementation and Operation*, Chapter 9. IWA Publishing, UK.

Figure 2: Key considerations for planning sanitation service chain

User interface	Containment	Emptying and transportation	Treatment	End-use
Individual toilets, community and public toilets, bathrooms, kitchen and sinks	Off-site sanitation (sewer and drains) and on-site sanitation (septic tanks, pits and conservancy tanks	Emptying (vacuum tankers, Vacutugs), sewerage network	Wastewater (WW) treatment and faecal sludge (FS) treatment	WW and FS used for agriculture (treated or untreated); WW and FS disposal into surface water and neighbourhood; groundwater recharge; industrial uses

Source: Compiled by CSE, 2019..

Table 3: Characteristics of faecal sludge

Parameter	Faecal sludge source		WWTP sludge	Reference
	Public toilet	Septic tank		
pH	1.5–12.6			USEPA (1994)
	6.55–9.34			Kengne et al. (2011)
Total solids, TS (mg/l)	52,500	12,000–35,000		Koné and Strauss (2004)
	30,000	22,000		NWSC (2008)
		34,106		USEPA (1994)
	≥ 3.5%	< 3%	< 1%	Heinss et al. (1998)
Total volatile solids, TVS (as percentage of TS)	68	50–73		Koné and Strauss (2004)
	65	45		NWSC (2008)
COD (mg/l)	49,000	1,200–7,800		Koné and Strauss (2004)
	30,000	10,000	7–608	NWSC (2008)
	20,000–50,000	<10,000	500–2,500	Heinss et al. (1998)
BOD (mg/l)	7,600	840–2,600		Koné and Strauss (2004)
			20–229	NWSC (2008)
Total nitrogen, TN (mg/l)		190–300		Koné and Strauss (2004)
			32–250	NWSC (2008)
Total Kjeldahl nitrogen, TKN (mg/l)	3,400	1,000		Katukiza et al. (2012)
NH4-N (mg/l)	3,300	150–1,200		Koné and Strauss (2004)
	2,000	400	2–168	NWSC (2008)
	2,000–5,000	< 1,000	30–70	Heinss et al. (1998)
Nitrates, NO_3 (mg n/l)		0.2–21		Koottatep et al. (2005)
Total phosphorus, TP (mg p/l)	450	150	9–63	NWSC (2008)
Faecal coliform (cfu/100 ml)	1×10^5	1×10^5	6.3×10^4–6×10^5	NWSC (2008)
Helminth eggs (numbers/l)	2,500	4,000–5,700		Heinss et al. (1994)
	20,000–60,000	4,000	300–2,000	Heinss et al. (1998)
		600–6,000		Ingallinella et al. (2002)
		16,000		Yen-phi et al. (2010)

Source: Faecal sludge management, IWA, 2014.

Although the National Environmental Sanitation Strategy and Action Plan (NESSAP) is in place and there is a strategy that set ambitious targets for the country, the support structure to MMDAs for the planning of sanitation services is non-existent outside donor projects. NESSAP emphasizes incremental development on both temporal and spatial parameters but there are no guidelines endorsed by the concerned ministries. It identifies potential roles and the need for the private sector as key to delivering services but lacks a technical guideline to regulate them.

This guideline aims to provide a snapshot of sanitation in Ghana by giving a brief overview of the current situation along with steps to plan and design sustainable solutions to achieve nationwide sanitation. Various national literatures—such as NESSAP, District Environmental Sanitation Strategy and Action Plan (DESSAP), Rural Sanitation Strategy, Guidelines for Targeting the Poor and Vulnerable for Sanitation Services in Ghana—and international literature, including draft SFD reports of Tema, Accra and Kumasi, were reviewed and several relevant stakeholders were interviewed before finalizing this IWFM guideline.

Under the current Environmental Sanitation Policy, enforcement of sanitation bylaws and regulation is the responsibility of the environmental health units (EHOs) within MMDAs. This had not been effective, as institutional fragmentations meant that EHOs would be trained by the Ministry of Health (MoH) but employed by the Ministry of Local and Rural Development (MLGRD). Further, there is a lack of technical knowledge and resources at the municipal level to draft and enforce these bylaws. MMDAs are under-resourced to carry out the full scope of the mandate for sanitation, especially against other competing priorities. It might be more effective to consider how to incorporate approaches that incentivize good behaviour—and thus make enforcement more effective—and to identify opportunities for public and private sector actors to better coordinate on enforcement.

In a move to tackle the capacity and enforcement more directly, the new MSWR has in the pipeline a Bill to Parliament to establish a National Sanitation Authority. The proposed Bill includes the director general at the national, regional and district levels, who will work with the MMDAs to coordinate and better manage the sanitation functions across the country.

Gaps and issues in the service chain

NESSAP notes that sanitation technologies will not be prescriptive as the policy emphasizes the concept of the ‘sanitation ladder’ and thus endorses all categories of improved technologies. It is, however, conceded that even where facilities have been available (on-site, communal or network), effective treatment and disposal of the faecal sludge is still a major challenge in urban areas. Thus, whilst immediate delivery arrangements may improve access, long-term environmental sustainability is still a critical issue.

Achieving progress in urban sanitation and hygiene delivery is highly dependent on the capacity of the MMDAs to plan, own and drive the agenda; there is no national, dedicated utility. A major challenge in this regard is the ability of local level structures to attract and retain the requisite personnel to provide support. The new proposed National Sanitation Authority will deal comprehensively with sanitation challenges.

Although the Environmental Sanitation Policy of Ghana specifies the provision of access to toilets and thereafter the management of generated faecal sludge and domestic wastewater, the policy kept it open and left it to MMDAs to identify and decide on the infrastructure. Hence, based on the demand and political power of a particular community or ward, the MMDAs provide ad hoc services instead of following an incremental planned approach.

NESSAP 2010, prepared in line with the National Environmental Sanitation Policy 2010 envisages that Ghana will become ‘totally clean, sanitized, healthy and livable, ensuring and sustaining good public health and environmental outcomes for all citizens’. The objective of 100 per cent safe management of human excreta and liquid waste along the service chain through decentralized planning and implementation of interventions based on DESSAP, prepared by MMDAs, will further feed into MTDP.[14]

Table 4: Gaps in the service chain

Sanitation service chain	Existing practices	Gaps and issues
Containment	The Ghana Building Code, released on 1 November 2018, specifies the minimum requirements of septic tanks needed for seeking approval for construction of a building. Also, for liquid waste generated from such establishments, the document recommends construction of soil-dispersion trenches and soakaways as the minimum requirement.	There is no government manual prescribing design of containment systems.
Emptying and transportation	Under the Local Government Act 462, MMDAs stipulate the bylaws. Currently, the MMDAs refer to the numerous literature produced by NGOs and universities to prepare bylaws on emptying and transportation.	A government-recognized document to guide MMDAs in drafting the bylaws is missing.
Treatment and disposal	Sewerage systems (conventional or non-conventional) are designed and constructed based on the knowledge of the technology providers (i.e. quality- and cost-based selection criteria). The Ghana Building Code prescribes that sewage treatment plants should be provided for all buildings with area of 1500 m^2 or above and to societies with a minimum of 15 households. The treated water must be used for irrigation, cooling towers or flushing.	It appears that numerous country-wide pilot projects are being carried out without any planning and these projects may or may not follow regulations. There is no government manual prescribing design of sewerage systems.
	EPA Ghana is a regulatory body dedicated to prescribe standards for effluent discharge. It also oversees the implementation of the National Environment Policy.	The standards prescribed by EPA miss out on the permissible discharge limit for treated domestic wastewater and faecal sludge. Also, there is no categorization of permissible limits for discharge of effluent during irrigation, or into the sea or waterbodies.

Source: Compiled by CSE, 2019..

1.2 Framework

These guidelines will serve as an operational framework for all stakeholders involved in the sanitation chain (wastewater and faecal sludge management) in Ghana and are aligned with the following documents:

- Environmental Sanitation Policy (Revised 2010)
- National Environmental Sanitation Strategy and Action Plan (2010)
- Guidelines for targeting the poor and vulnerable for basic sanitation services in Ghana, 2018
- Sustainable Development Goals Indicator Baseline Report, 2018
- District Environmental Sanitation Strategy and Action Plan
- Medium-Term Development Plans of MMDAs

Relevant stakeholders were also engaged through key informant interviews and focus group discussions to prepare this guideline document (see *Annexure 5: List of stakeholders*).

1.3 Objective and scope

The objective of this guideline is to facilitate and provide enabling frameworks for decision-making aimed to contribute to the achievement of SDG 2030, the N'gor Declaration on Sanitation and Hygiene and the Africa Union Agenda 2063. The guideline will also help MMDAs in Ghana to prepare an IWFM action plan and implement wastewater and faecal sludge management services in their administrative boundaries. It would cover aspects across the service chain of sanitation, including safe collection, conveyance, treatment and disposal/reuse of the treated wastewater and faecal sludge for all type of residential and non-residential properties (except industrial properties). The guidelines seek to provide service providers with knowledge and procedures to implement a precise wastewater and faecal sludge management plan. These guidelines also discuss other aspects related to regulation, monitoring and awareness generation that are needed in sustainable implementation of IWFM in the administrative areas.

The scope of the document will be limited to managing sanitation systems across the service chain, including wastewater management at a decentralized scale. The scope includes the entire range of sanitation systems and elements therein across the sanitation value chain and the cross-cutting dimensions (technology, finance, institution and governance, legal and regulation, inclusion and public participation). The cross-cutting dimensions influence the sustainability of the design and implementation of safe and hygienic sanitation systems..

1.4 How to use this guide

These guideline demonstrate how citywide sanitation can be achieved by managing wastewater and faecal sludge, with information presented in an accessible form for users and implementers. The stages of the sanitation chain are explained, the existing scenario in Ghana at each stage is described and action points for each stage are proposed. The guideline enumerates various tools that a reader can refer to at different stages of wastewater and faecal sludge management. It signposts a wide range of guidance sources and presents numerous examples of good practices to show what is possible across the spectrum of faecal sludge management. An example of **City X** is taken to understand how to implement a faecal sludge management plan at each stage of the sanitation chain. It becomes clear, with the example, how to calculate faecal sludge load, number of trucks required, capacity of the treatment plant etc. The example of city given in this document is hypothetical, made with an intention to help reader relate with the context of the document. Any resemblance to an existing settlement is purely coincidental.

1.5 Target groups and guiding principles of IWFM

The target groups of this document are proposed as follows:

Primary target groups: Decision-makers at a strategic level responsible for ensuring an enabling and facilitating environment

Secondary target groups: Public and private professionals, utility managers, service providers and workers, the regional organizations and the private sector that facilitate and participate financially in individual projects.

Key points of this chapter

- Almost 60 per cent of Ghana's population relies on sanitation facilities on a shared basis; only 4 per cent of the urban population is connected to the sewerage system.
- Faecal sludge cannot be handled like sewage; both are discrete in their characteristics. However, IWFM is a holistic approach to handling both wastes along the sanitation-service chain.
- Planning of sanitation services is non-existent outside donor projects.
- The scope of this document is limited to managing sanitation systems across the service chain, including wastewater, on a decentralized scale.

2. Planning for IWFM

This section presents an approach to IWFM planning, its scope and a multi-pronged step-by-step planning process to achieve safe and sustainable sanitation. A set of six guiding principles is suggested to support decision-makers in formulating appropriate sanitation plans that form the backbone of every suitable, affordable, sustainable and economically viable sanitation strategy (see *Figure 3: Set of guiding principles for sanitation plan*).

IWFM is appropriate where several of the above-mentioned elements present developmental challenges that can best be resolved in an integrated way (as in many developing cities) and where there is adequate leadership, governance and institutional capacity to drive the process forward. It typically requires a holistic and diagnostic approach involving all stakeholders, leading to a strategic action plan/framework that prioritizes interventions to be implemented through an integrated programme.

2.1 Identification and engagement of stakeholders for planning process

The IWFM plan preparation process is initiated by the identification of stakeholders by the MMDAs in order to constitute Sanitation Task Force (STF). The STF, which is a multi-stakeholder body comprising representatives from various agencies (government agencies, NGOs, private firms, end-users, civil society representatives etc.) sets the platform for stakeholder interactions which ensures the principal support for the plan. The STF's key task is to mobilize stakeholders and to increase awareness about sanitation amongst the municipal agencies, government departments and, importantly, the people of the city. Once constituted, the STF will initiate the IWFM process preparation through its first meeting (see *Annexure 9: Guidelines to constitute a sanitation task force*).

Stakeholder engagement is a key prerequisite for successful implementation of IWFM. If the district/municipality has a regional collaboration, as recommended by DESSAP, it should deliberate about IWFM.

2.2 Key determinants for planning

Every MMDAs should adopt various approaches (conventional and non-conventional) for the choice of sanitation system. Often the choices are not mutually exclusive and a number of hybrid options also emerge as the viable options that are responsive to local contexts.

Settlement typology and physiography of a region are two key determinants that influence the choice, design, and operation and maintenance (O&M) of a sanitation system while the cross-cutting dimensions influence its viability and

Figure 3: Guiding principles for sanitation plan

Source: Compiled by CSE, 2019..

sustainability. The choice exercised by the city aims to optimize efficiencies and associated costs.

Household size and population density along with the types of settlement determines the wastewater and faecal sludge quantities and qualities, land availability for sewer network and treatment facilities, road widths and access for desludging vehicles. Various parameters such as soil type, topography, terrain and groundwater table influence the containment technology options, construction techniques and associated costs, etc.

Participatory planning, regulation and enforcement, O&M responsibilities can be effective with due consideration on aspects of the asset ownership and land tenure (see *Annexure 4: Key determinants for IWFM*).

2.3 Strategic approaches

The MMDAs need to strategize and plan (both temporal and spatial phasing) for effective IWFM in an incremental way to overcome the institutional, financial capacities and physical characteristic-related challenges. To ensure optimal public health and environmental integrity at all times, the following strategic approaches are recommended:

I. Incremental development: Temporal phasing (Action Plans)

Ghana has framed a long-term development plan. It is a strategic framework for its socioeconomic transformation over the next 40 years, built on and seeking to accelerate the implementation of global and African goals of SDG and Agenda 2063's initiatives for growth and sustainable development. It incorporates a four-yearly MTDP in a single term. The MMDAs will include the IWFM plan in their MTDP in a temporal manner (see *Annexure 7:* Sample questionnaire for baseline data collection for recommended activities to be done in an incremental manner to attain the goal (see *Annexure 8: Milestones and timeline to implement IWFM*).

a) Short-term measures (2021)

In short-term measures, MMDAs should consider the design of a serviceable interim arrangement until the initiation of the medium-term targets as per the IWFM plan.

b) Medium-term measures (2025)

In medium-term measures, MMDAs shall consider the provision of a combination of immediate measures and initiation of the long-term measures to avoid sporadic adverse impacts on environment and public health arising out of the lack of service delivery. The measures shall also perpend to achieve the First Step of African Union's Agenda of 2063 for 2013–23.

c) Long-term measures (2030)

In long-term measures, the MMDAs shall establish robust wastewater and faecal sludge collection, conveyance, treatment and environmentally sound disposal, recycle and reuse measures for safe, effective and sustainable sanitation service delivery. During this time, Ghana shall achieve the Sustainable Development Goals for Clean Water and Sanitation 6.2.

II. Incremental development: Spatial phasing

Spatial integration
The MMDAs shall undertake cluster-based planning that helps to visualize existing levels of sanitation service delivery across the assemblies and focus on the most vulnerable areas in the sanitation chain. They should achieve spatial integration by leveraging the existing levels of improved services in an area to normalize service levels across adjoining service-deficient areas.

Process integration
In the context of project planning, MMDAs will take into consideration the maturity of existing sanitation systems with respect to processes, technology and infrastructure and will explore the possibility of integrating existing systems with the proposed system to the extent possible. The MMDAs shall plan integration of advanced processes with existing services that offer simple interface during transitioning.

The findings should make evident whether the existing infrastructure needs replacement, refurbishment or retrofitting, or can be used in its current condition as part of the proposed system.

2.4 Operationalization of IWFM process

A step-by-step holistic and integrated planning process, not necessarily linear, is needed for all MMDAs to ensure safe, hygienic and sustainable sanitation systems as highlighted (see *Figure 4: Holistic and integrated planning process for sustainability of project*).

i. Initial findings—Pre-planning (steps 1–4)

Four key steps are involved in this stage. They focus on establishing evidence around the existing status of the sanitation sector to identify and define problem statements, underlying reasons and the strategic interventions that will be required to address the problems. The output at this stage is an **identification report** that clarifies the objectives of the project.

The **critical decision** requirements is that concerned authorities will clarify the need for the project.

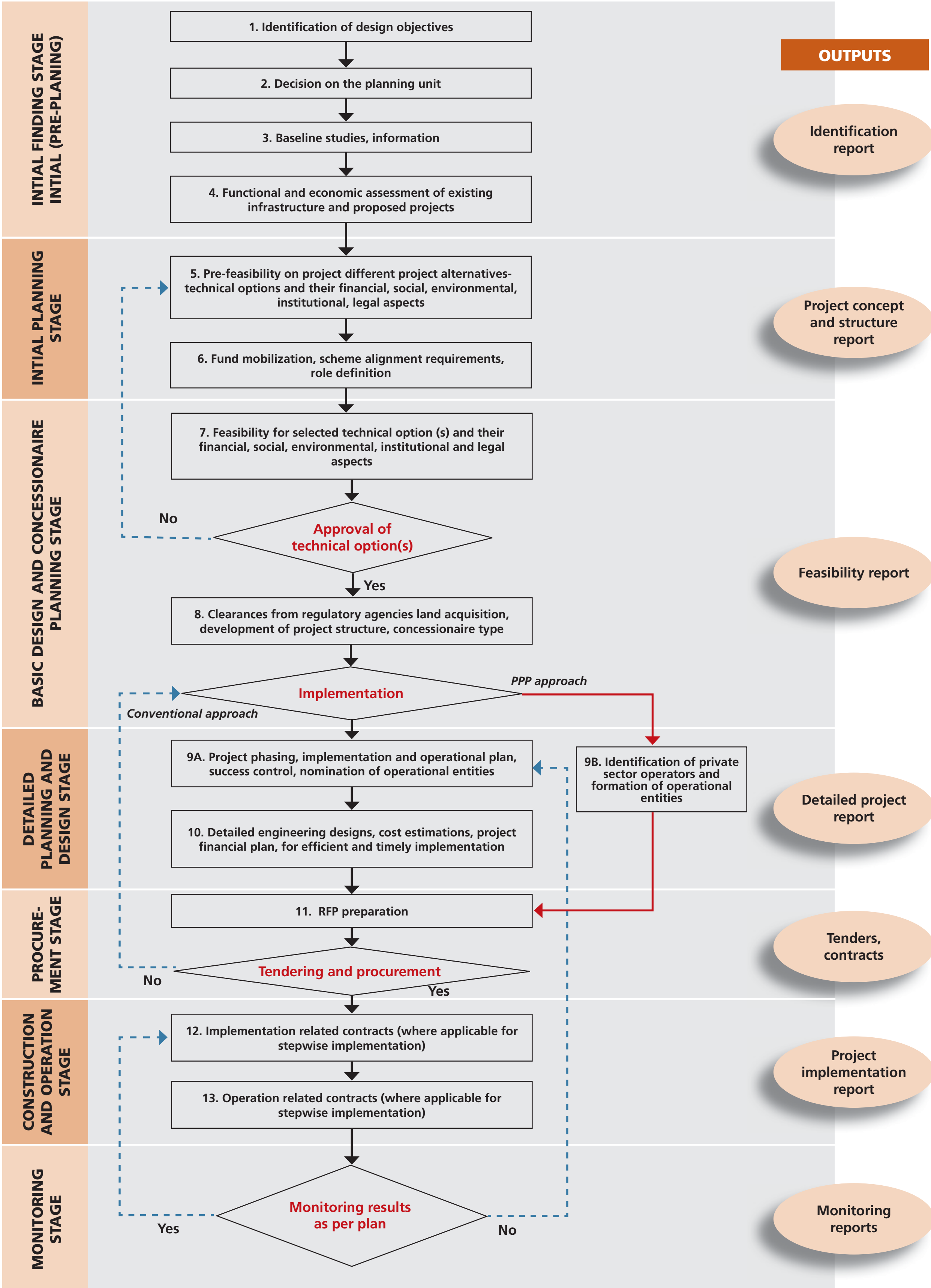
Identification of design objectives
Typical objectives for the project could be the following either individually or in any combination as identified during the visioning exercise:

- Achieve 100 per cent public health and hygiene
- Sustainable and affordable water and sanitation for urban poor
- Best-designated use and management of the water and wastewater resources—resource efficiency, reuse, recovery and sustainability
- Ecological protection, environmental flows and discharge control, natural balance and pollution abatement, adaptation to climate change

Decision on planning unit

- Shall do cluster-based development
- Avoid conflicts with existing projects and ensure convergence of schemes and missions for planning and implementation of the project
- There shall be a window for expansion in future for services and infrastructure

Figure 4: Holistic and integrated planning process for sustainability of IWFM project



Source: Adapted from Integrated Faecal Sludge Management Guidelines, GIZ 2018.

An excreta flow diagram (or shit flow diagram, SFD) is a tool to readily communicate how excreta physically flows through a city or town. For more information visit: www.sfd.susana.org

Baseline studies, information

To develop an IWFM system, the MMDAs shall adopt a holistic approach that puts human settlement's priorities and means at the centre of planning. Collection of baseline information is essential for a situational analysis of the region and for advocacy to prioritize the need and requirements (see *Annexure 8: Guidelines to constitute a sanitation task force [STF]*).

SFD, a diagnostic tool to identify aspects of sanitation service delivery chain that need improvements, can play a vital role in this process. It can establish a window for dialogue on priorities and means to achieve the objective with all stakeholders.[15]

Firstly, MMDAs shall constitute a multi-stakeholder sanitation task force which shall identify the need of the project by analysing the existing problems and further provide suggestions to tackle the issue (see *Annexure 9: Guidelines for constituting a sanitation task force*).

ii. Initial planning (steps 5–6)

There are two key steps in this stage that involve the design of a concept (approaches with regard to decentralized sanitation, centralized sanitation or hybrid) along with the assessment of the different project alternatives based on technical options. Subsequently, the role of key stakeholders is defined. Political buy-in and posing the project under government's schemes and mission is the need at the stage. The concept evolved at this stage can be related to ruling party's manifesto. Also, community representatives can address the requirements based on the issues raised by the dwellers. The output is a **pre-feasibility report**.

The **critical** decision requirement at this stage shall be political buy-in.

MOUNT is an aggregator platform for various sustainable technologies, encouraging and disseminating knowledge and good practices for wastewater management. For more information visit: https://www.cseindia.org/mount/home

Pre-feasibility assessment

- The MMDAs shall identify the demand for the services and the design requirements based on the baseline information and data collected
- Identify the technology options for a given geography; MOUNT can be useful in this process[16]
- Assess the functional efficiency of existing infrastructure and the proposed projects

Fund mobilization assessment

It is imperative that the respective MMDA first understand its financial condition, ability to mobilize internal source of fund and district common funds. Thereafter, if any gap exists in funding, a clear statement shall be produced which shall enable to look for external sources (grants, loans, flagship missions in sanitation sector, markets) or leverage existing assets. Subsequently, lender shall secure the debt paying abilities in response to external finance and capital markets. In that case, if the respective MMDA, happens to be at risk for paying debt, beyond, ministry shall guarantee to pay the debt.

iii. Design and concessionaire planning (steps 7 and 8)

There are two key steps at this stage that involves preliminary planning for the elements of the sanitation value chain and estimation of ball park figure of the project. Accordingly, sources of funding are identified and evaluated for the feasibility of investment. This stage also identifies all clearance required to facilitate an effective implementation. The output is a feasibility report.

The critical decision requirements at this stage shall be selection of technology and related clearance for implementation.

Feasibility assessment

- The MMDAs shall conduct the feasibility assessment of selected technical options identified in the previous stage with respect to financial viability, institutional and governance capability, operational ease, environmental compliances and social aspect
- MMDAs will define the structure of the project including the operational model, financial model, mode of implementation and the related project partners or concessionaires

iv. Detailed planning and design (steps 9 and 10)

There are two key steps at this stage that will result in efficient project phasing and implementation plan including the corresponding detailed design and engineering aspects. The output is a 'detailed project report'.

Project phasing and implementation plan

- The work packages for tender documents will align with planning units. There will be synergies between current services and requirement of the concerned region with respect to public health and environmental concerns.

- MMDAs may also explore the option for private-sector participation to identify private-sector operators, form operational entities for effective operation of standardized containment systems, and schedule emptying service and treatment facilities.

- MMDAs should also explore private-sector participation for procurement, operations and maintenance of the emptying vehicles, construction and operations of wastewater and faecal sludge treatment facility and possible reuse of treated wastewater and faecal sludge within a region as well as in nearby regions. They should develop performance-based contracts such that payment is linked to private-sector performance for providing the services.

Detailed engineering designs

- Detailed engineering designs should be developed for the new assets and/ or retrofitting/rehabilitation of the existing assets and infrastructure, with emphasis on the process design. The designs will provide details of unit capacities/dimensions, context-specific choice of material for construction and phase-wise design. Financial estimates will be based on the Ghana's civil Schedule of Rates (SoR)

Operability conditions, institutional and governance requisites, the legal and regulatory necessities, and the financial sustainability models concerning the detailed engineering designs shall be considered. The financial risks should be clearly set down and delimited to an interval of ± 10per cent

The work packages shall be structured as financial packages with staggered implementation schedule based on the financial implications and feasibility

v. Procurement, construction and operation (steps 11 and 12)

Robust Expression of Interest (EOI) and Request for Proposal (RfP) documents shall be developed. Diligent and efficient bid with appraisal mechanisms shall be carried out based on principles of fairness, transparency, integrity, accountability, and competence in compliance with the statutory rules.

The procurement process shall result in the establishment of governance structures and implementation frameworks that will guarantee safe and sustainable service delivery in the long term.

vi. Monitoring and evaluation (step 13)

The concerned authorities shall monitor the efficiency of services based on the national or international standards. There shall be a mechanism of monitoring the aftereffects of the implementation along with service delivery with an objective to meet step 1.

The authorities can also assign responsibilities, besides the government agencies, to national and international research think-tanks and the private sector as per the contract. Responsibilities may not be limited to monitoring the implementation and service delivery only.

2.5 Integrating a gender-inclusive perspective in sustainable sanitation

Planning, design and implementation of sanitation programmes should not be regarded only as a male domain but can and should equally be undertaken by women. Integrating a gender perspective into the sanitation sector does not only require addressing gender relations but also uncovering and challenging uneven hierarchical structures based on gender. Consequently, a gender-sensitive approach seeks to equalize uneven distribution of sanitation roles and responsibilities and access to safe and appropriate facilities by considering the basic needs of all men, women, children, transgender and physically disabled.[17]

Key points of this chapter

- Stakeholder identification and engagement is the first step for IWFM planning.
- Typology of settlement, physiography and existing facilities are the key determinants in selecting appropriate technology.
- Effective IWFM can be achieved through incremental development (both temporal and spatial).
- Tools like SFD graphic generator and web portals like MOUNT and SANI-KIT are available online for planning and designing IWFM.

3. Decision-making approach

3.1 Decision-making approaches for IWFM systems

The choice between the different sanitation management options depends on the interaction between input-influencing factors and related sanitation outcomes (see *Annexure 6: Decision-making approach for sanitation systems)*.

Conventional (centralized) approach

Conventional wastewater management comprises: (1) a centralized collection system (sewers) that collects wastewater from households, commercial areas, domestic wastewater from enterprises and institutions, and transports it to (2) a centralized wastewater treatment plant in an off-site location outside the settlement, and (3) disposal/reuse of the treated effluent, usually far from the point of origin.[18] Thus, it is also referred to as off-site management.

It is recognized that implementing complete sewerage system throughout the country may never be possible or desirable for both geographical and economic reasons.[19]

Non-conventional (decentralized) approach

Decentralized wastewater management is a concept in which wastewater is collected, treated and disposed/reused at or near the point of generation.[20] Thus, it is also referred to as on-site management.

Under this approach grey water and black water is collected and treated separately or is treated together based on the type of technology selected. The transport options are alternative systems such as simplified sewers, small bore sewers, vacuum trucks, other mobile transport options, etc. Treatment is at the decentralized level, ranging from on-site sanitation (e.g. septic tanks) to community sanitation (e.g. community septic tanks etc.) and decentralized STPs. Recycle and reuse of treated wastewater can be taken up after consideration of local demand.

3.2 Decision-making for appropriate technologies

Objectives and general criteria for selection of technologies

The respective MMDAs shall consider the design objectives (mentioned in 2.4.1) for the strategic planning and design of the sanitation systems, either conventional or non-conventional (see *Figure 5: Characteristics of the most appropriate technology).*

Technical criteria for selection of technologies—Containment

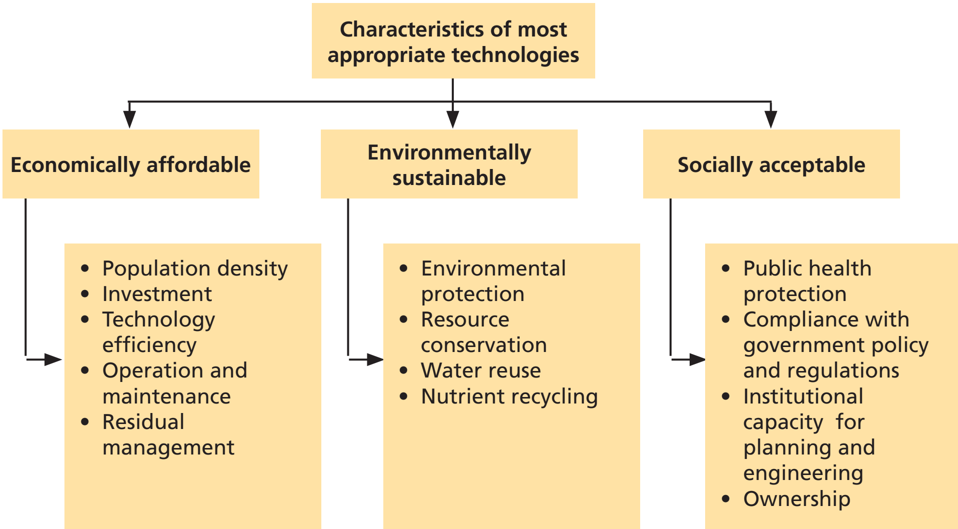
Public health and environmental protection considerations

The respective MMDAs shall recommend an appropriate containment technology for the settlements, in a manner that it should not risk groundwater contamination and water sources. Under any circumstances, the black water and the grey water should not mix with storm water.

Conventional approach

In the case of selection of conventional sanitation approach, wastewater is directly discharged into sewers.[21]

Figure 5: Characteristics of the most appropriate technology



Source: Compiled by CSE, 2019.

Non-conventional approach

At the containment stage: In the non-conventional sanitation approach, the containment is either an on-site sanitation system or a decentralized off-site system in the close vicinity of the households at the community or ward levels. This section covers the containment options for the on-site sanitation systems that include the Kumasi ventilated improved pit, conventional septic tanks and improved septic tanks.

The choice of technology option for the settlement is first driven by the requirement of the local conditions (soil structure, groundwater table, settlement densities, etc.) besides the compliance to the legal and regulatory provisions. The consideration of efficiency and sustainability for selection of technology is reflected in energy efficiency, land footprint and cost optimization that may be achieved both with respect to capital and operational expenditures (see *Annexure 4: Key determinants for IWFM*).[22]

Technical criteria for selection of technologies—Conveyance

Public health and environmental protection considerations

In both conventional or non-conventional approaches of sanitation systems, wherever sewer networks are applicable, the choice of technology for conveyance system should be such that it prevents direct and indirect contact with humans (e.g. avoiding open drains for conveyance systems) and avoids any environment contamination by overflows, leakages, etc. Therefore, the choice should be based on sewer material; simplicity of assembly; physical strength; resistance to acids, alkalis, gases, solvents, etc.; resistance to scouring and durability such that there are no system leakages resulting in adverse health impacts or pollution in the environment.

In the non-conventional approach, where septic tanks or similar containment structures are part of the systems, mobile transportation vehicles should be designed or selected on the basis of similar factors that guarantee public health and environmental protection.

Elements to be considered
The factors influencing selection of materials for sewers include characteristics of flow, level and quality of groundwater, characteristics of wastewater, characteristics of terrain, adequate bearing capacity, availability of fittings in sizes required and ease of handling and installation.[23]

Factors influencing selection of emptying process and methods should be based on adequate size vis-à-vis quantity of faecal sludge, optimal number of trips and characteristics of the road.

Technical criteria for selection of technologies—Treatment

Public health and environmental protection considerations
The MMDAs shall select the technologies in a manner that the reduction of contaminants in wastewater and faecal sludge is achieved to the discharge standards as prescribed in Environment Protection Agency Effluent Guidelines, 2012.

Reuse and recycle considerations
Before selecting the appropriate technology, MMDAs shall prioritize the recycle and reuse of wastewater and faecal sludge as a resource. Costs of water supply can be checked by promoting use of treated wastewater for non-potable purposes.[24]

The MMDAs shall select the most appropriate technology in conjunction with the EPA guidelines such that required level of water quality or quality of byproducts can be achieved depending upon the use of the reclaimed water for land application, groundwater recharge, agricultural and irrigation, landscaping, industrial use and use of treated faecal sludge/sludge for agricultural purposes. As this is a guide on IWFM, our focus will be narrowed down to non-sewered sanitation systems.

Key points in this chapter

- A flowchart details the conventional approach versus non-conventional approach for wastewater and faecal sludge management.
- The selection of a technology should be selected based on three important factors—it should be economically affordable, environmentally sustainable and socially acceptable.
- Based on the size of administrative boundary, an administrative body can prepare, plan, design and implement IWFM.

4. Designing and implementation: Faecal sludge management

IWFM is a process and requires attention at every stage of the sanitation chain. It needs to be comprehensive and requires a step-wise approach, beginning from systematic planning to ensuring availability of infrastructure and human resources to manage grey water and faecal sludge along the service chain.

This chapter details technologies pertaining to correcting the design of on-site sanitation systems that are constructed in a rudimentary way in Ghana.

4.1 Containment systems

Generally, a wide range of pit-type containment systems are used by rural households in Ghana. Lined tanks like septic tanks or fully lined tanks are used by urban households.

There are many technology options whose designs are available in research documents and books, but these guidelines recommend select technologies based on local conditions and the sanitation systems prevalent in Ghana. In practice, the design of containment system constructed is dependent on knowledge of local masons and private entities providing these tanks.

4.1.1 Septic tank

Septic tanks are classified according to the number of chambers, efficiency of treatment, and complexity of the system.

1. Conventional system

a. Single-chambered septic tank
b. Two- or three-chambered septic tank

2. Improved system

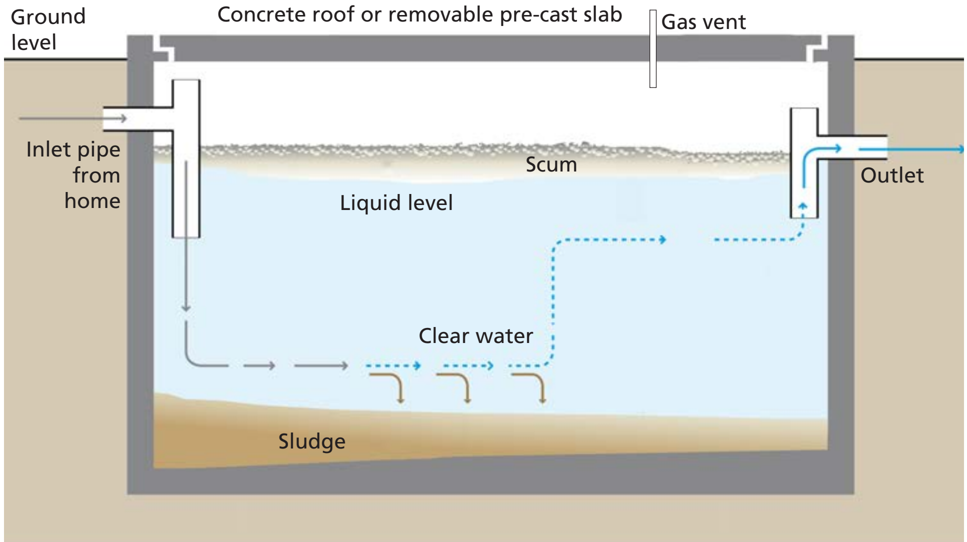
a. Two-chambered septic tank with filter
b. Anaerobic baffled reactor with filter

Conventional system

a) Single-chambered septic tanks
Single-chambered septic tanks are tanks in which anaerobic digestion takes place. This type of on-site sanitation system (OSS) requires frequent emptying as the rate of digestion of solids is comparatively low. This conventional type of septic tank is not suggested as the sole OSS of a household because of its low efficiency and high maintenance-requirements. It can be part of small bore sewer systems.

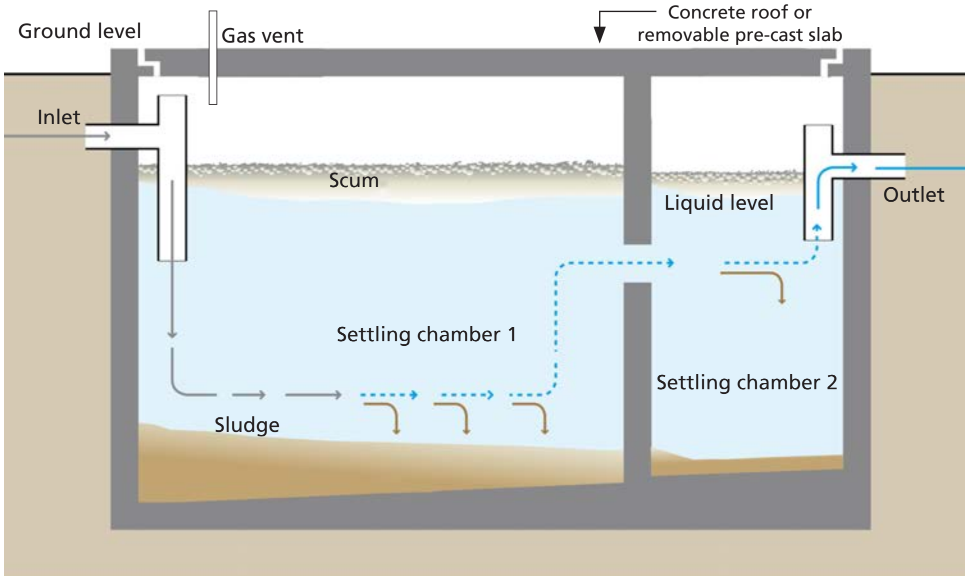
b) Two-chambered septic tanks
Two-chambered septic tanks have two chambers. The first chamber is at least twice the size of the second chamber. Maximum solids settle down in the first chamber and the partition between the chambers prevents scum and solids from escaping with the effluent. A T-shaped outlet pipe further reduces the amount of scum and solids that are discharged. Generally, these septic tanks have to be emptied every two to three years.

Figure 6: Single-chambered septic tank



Source: Tilley et al., *Compendium of Sanitation Technologies*, 2016.

Figure 7: Two-chambered septic tank



Source: Tilley et al., *Compendium of Sanitation Technologies*, 2016.

Improved system

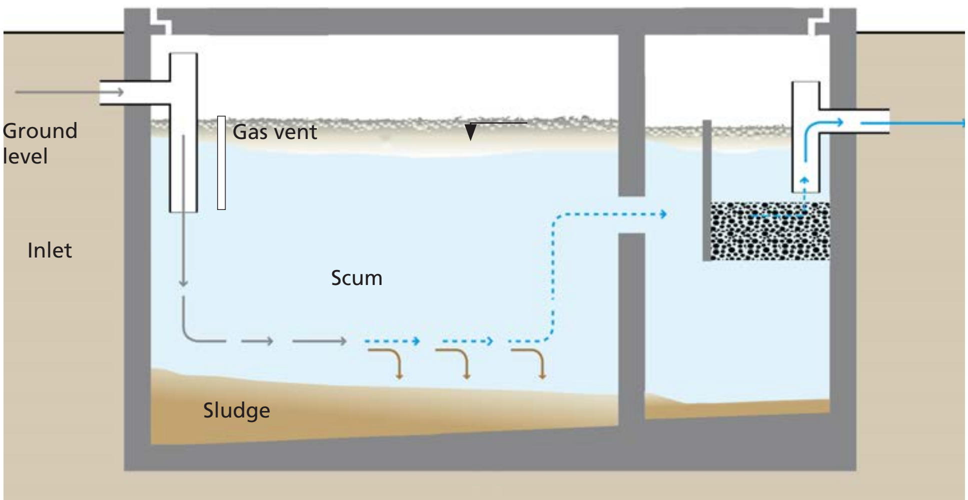
a) Two-chambered septic tanks with filter

This type of system incorporates two chambers with a single filtration chamber resulting in improved treatment. As wastewater flows through the filter, particles are trapped and organic matter is degraded by the active biomass that is attached to the surface of the filter material. Commonly used filter material includes gravel, crushed rocks, cinder and specially manufactured plastic pieces. Typical filter material size is in the range of 12–55 mm in diameter. Ideally, the material will provide 90–300 m^2 of surface area per cubic metre (m^3) of reactor volume. By providing a large surface area for the bacterial mass to work, there is increased contact between the organic matter and active biomass, effectively degrading the organic matter. Suspended solids and BOD removal can be as high as 85–90 per cent, but is typically 50–80 per cent. Nitrogen removal is limited, and normally

does not exceed 15 per cent total nitrogen.
b) Anaerobic baffled reactors with filter
An anaerobic baffled reactor with filter is an improved septic tank with a series of baffles under which wastewater is forced to flow. It incorporates one or more filtration chambers where particles are trapped and organic matter is degraded by the biomass that is attached to the filter media. BOD may be reduced by up to 90 per cent, which is far higher a percentage than a conventional septic tank. In practice, septic tanks are not made according to the standards and, hence, the efficiency of the system is not very good. This further affects the desludging time and quality of effluent and faecal sludge emptied from these tanks.

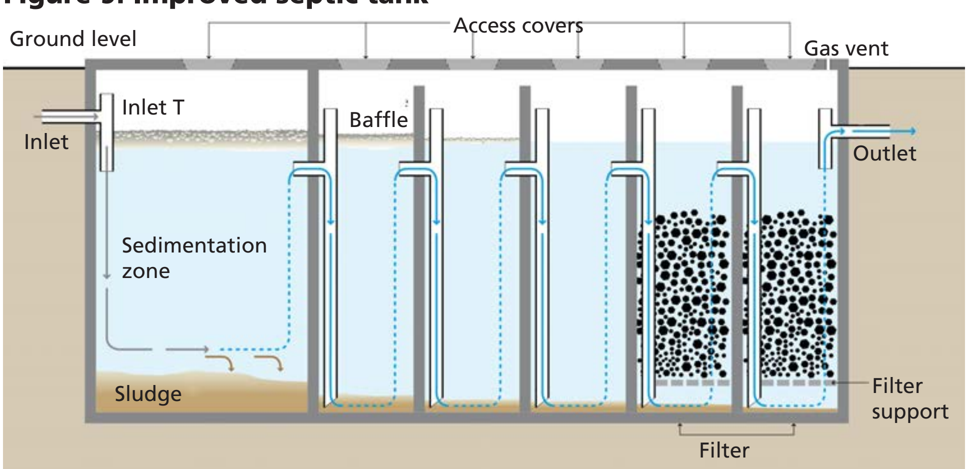
Operation and maintenance: Care should be taken not to discharge harsh chemicals into the septic tank. Scum and sludge levels need to be monitored to ensure that the tank is functioning well. Generally, septic tanks should be emptied every two to five years. This is best done by using a motorized emptying and transport technology, but manual emptying can also be an option with adequate PPE. Septic tanks should be checked from time to time to ensure

Figure 8: Two-chambered septic tank with filter



Source: Tilley et al., *Compendium of Sanitation Technologies*, 2016.

Figure 9: Improved septic tank



Source: Tilley et al., *Compendium of Sanitation Technologies*, 2016.

Table 5: Specifications for designing a twin pit

Type of pit	Number of users					
	Five		Ten		Fifteen	
	Diameter	Depth	Diameter	Depth	Diameter	Depth
Dry pit	900	1,000	1,100	1,300	1,300	1,400
Wet pit	1,000	1,300	1,400	1,400	1,600	1,500

Note: Depth from bottom of pit to invert level of incoming pipe or drain (all dimensions in mm)
Source: Strande et al. 2014.

Table 6: Sludge accumulation rates

Material used for anal cleansing	Effective volume in cum per capita per year*		
	Pit under dry conditions	Pit under wet conditions	
		With successive de-sludging intervals	
		Two years	Three years
Water	0.04	0.095	0.067
Soft paper	0.53	0.114	0.8

*Effective volume is the volume of the pit below the invert level of pipe or drain.
Source: Strande et al. 2014.

that they are watertight.[25]

4.1.2 Kumasi ventilated improved pit (similar to twin-pit system)

It consists of a superstructure (toilet) and treatment units (two chambers). The two underground chambers (pits) are provided to hold faecal sludge.

Specifications for designing a twin-pit

Twin pits are normally offset from the toilet and should be at least 1 metre from each other. A single pipe leads from the toilet to a small diversion chamber, from which separate pipes lead to the two underground chambers. The pits should be lined with open jointed brickwork. Each pit should be designed to hold at least 12 months' accumulation of faecal sludge. Wastewater is discharged to one chamber until it is full of faecal sludge. Discharge is then switched to the second chamber. Just before the second chamber is full of faecal sludge, the contents of the first pit are dugout, which have been reduced by an anaerobic process. Sizes of twin pits as per size of family and number of users have been provided in *Table 5: Specifications for designing of a twin pit.*[26]

The capacity of a twin pit is guided by the sludge accumulation rate. Sludge accumulation rate is a function of a wide range of variables, including water table, pit age, water and excreta loading rates, microbial conditions in the pit, temperature and local soil conditions, and the type of material used for anal cleansing.[27]

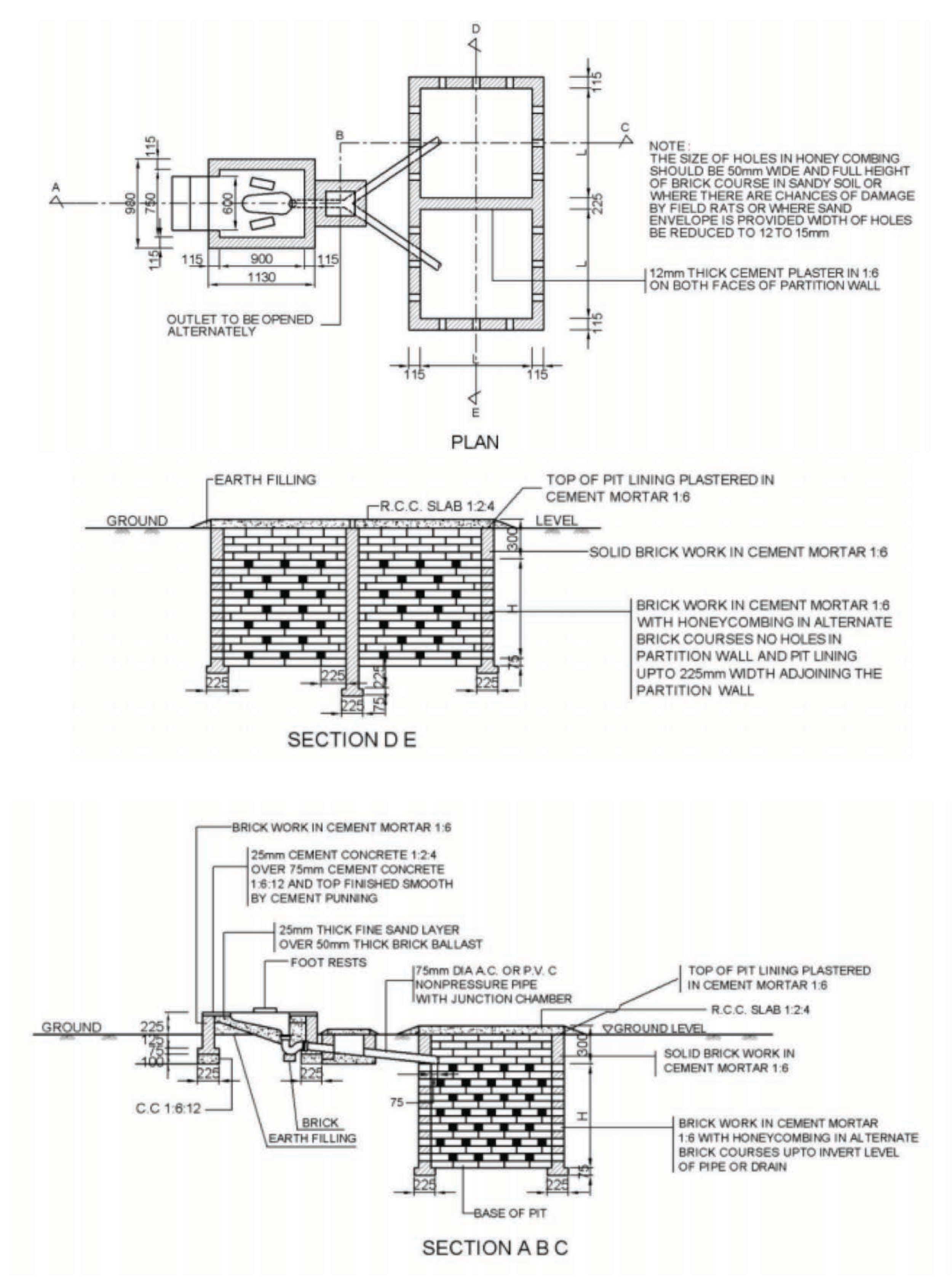
4.1.3 Bio-digester toilets

Bio-digesters are being advocated by the Ghanaian Ministry of Sanitation and Water Resources to provide efficient in situ treatment of black water from households, household clusters and institutional buildings where there is no sewerage network. Several private entities as well as by CSIR-Ghana supply bio-digesters in the market.

4.2 Faecal sludge quantification

The quantum of faecal sludge generated depends on a number of factors including number of users, number of toilets connected to a septic tank, and

Figure 10: Latrine with twin-pits



Source: Technical guidelines on twin pit latrines, World Bank, 1992..

volume of water used for flushing and ablution. The tank cleaning frequency increases if other sources of wastewater are connected to the septic tank (kitchen, bathrooms etc.). In general, the capacity of a septic tank ranges from 1–4 m^3 for houses; 5–15 m^3 for septic tanks of community or public toilets; and 10–100 m^3 for commercial places.

There are two ways to calculate the faecal sludge generation rate for a given city.

- Faecal sludge production method
- Faecal sludge collection method

Faecal sludge production method: There is no study of faecal sludge generation rate yet, but data from the United States Environmental Protection Agency (USEPA) manual states that the rate of faecal sludge generation is 230 litres per year per capita.[28]

Faecal sludge collection method: The volume of faecal sludge that is collected by private operators or government vehicles can be mapped to calculate the quanta of faecal sludge that is collected from a particular region. Another method to perform the calculation is by collecting data like average volume of containment systems and average frequency of desludging, which would eventually help us to calculate the average volume of faecal sludge that should be collected every day. The volume calculated by this method is more realistic. The calculations based on this method can be understood with an example.

Emptying and transportation

Solved example 1

Question: Calculate the total faecal sludge to be collected per day from a city if household septic tanks (on-site sanitation systems) are emptied once every three years and community toilets and public toilet septic tanks are emptied once in three months. Assume the emptying service is provided in 285 days in one year and faecal sludge generated per day from non-house establishments would be 5 per cent of the faecal sludge generated from households.

Answer:

Volume of faecal sludge generated from household septic tank (V_1):

V_1 = ([HH_{OS} * V_{HH}]/[3 * 285])
= (20,000 * 3,000)/(3 * 285)
= 70,175 litres or 70.175 KLD

Volume of faecal sludge generated from CTPT (V_2):

V_2 = ([PT * V_{PT} * 365]/[90 * 285])
= ([40 * 10,000 * 365]/[90 * 285])
= 5,692 litres or 5.7 KLD

Volume of faecal sludge generated from non-house establishments (V3):

V_3 = 0.05 * V_1
= 3,509 litres or 3.509 KLD

Total volume of faecal sludge to be collected per day (V_D)

V_D = V_1 + V_2 + V_3
= 70,175 + 5,692 + 3,509
= 79,376 or 79.38 KLD

At the end of a fixed time period, ideally two to three years, a containment system should be emptied of faecal sludge. The scheduled emptying should be done in order to facilitate treatment of faecal matter in the OSS. There are many benefits of regular desludging of OSS. These include increased efficiency of septic tank which eventually results in better discharge quality of the effluent. Septic tanks perform well when detention time in the tank is maximized. As accumulated sludge reduces available tank volume, the resulting decrease in detention time impacts the tank's function and ability to separate heavier solids from lighter fats and oils.

Emptying of containment systems is done both mechanically and manually. Manual emptying is clandestine, although it is acknowledged that it exists. Only a limited population relies on containment systems which are not approachable for emptying by mechanical emptiers. It is therefore possible that there are only a few manual emptiers. Through discussion with a resident in low income settlement and artisans it was inferred that they use unskilled labour rather than specialized manual emptiers to empty their pits, but the faecal sludge emptied is then disposed of in the local environment.

Other than manual emptying, mechanized methods include use of vacuum tanker. These are used for emptying of containment systems. Emptying service is mainly managed by private emptiers. A vacuum tanker operator charges emptying fee from the customer depending on the capacity of tanker requested by a customer. In Tema Metropolitan Assembly, the emptying charges are 350 Cedi for a 10 m^3 tanker, 400 Cedi (US $80) for $12m^3$ tanker and 500 Cedi (US $104) for >$12m^3$ capacity of the tanker.[29] Mechanized systems are usually accompanied by a driver and helpers.

Transportation is a very vital stage in the sanitation value chain and so are safety measures involved with it. Vehicles that carry faecal sludge, act as mobile sewer networks for OSS. Ideally, collected faecal sludge shall ultimately be discharged to dedicated treatment plants (see *Annexure 11: Methods, procedures and precautions for emptying OSS*).

Solved example 2

Question

For septic tanks of commercial places and public/community toilet, what is the number of vacuum trucks of 10,000 litres capacity required in City X?

Answer

Volume of faecal sludge generated or to be collected:

V_2 = 5,692 litres per day

V_3 = 3,509 litres per day

Since the minimum size of the septic tank is 10,000 litres, scheduled desludging of public toilets can be done every alternate day. For commercial places it needs to be done every third day. Hence if the utility can buy two trucks, there will always be a backup for emergency.

Solved example 3

Question

In City X, 70 per cent of the households dependent on on-site systems are accessible by medium-sized (5,000 litres) vacuum trucks but 30per cent of the households are inaccessible by such trucks and hence smaller Vacutugs (1,000–2,000 litres) or gulpers are required. The utility needs to buy vehicles of two sizes 1,000/2,000 and 4,000/5,000. Calculate the minimum no. of trucks needed for each size only to provide service to the household septic tanks. Assume one truck is able to do three trips per day and Vacutugs are able to do four trips per day and the emptying service is provided in 285 days per year.

Answer

Volume of faecal sludge generated or to be collected from households (V_1) = 70,175 litres/day as calculated in the previous question.

Assuming 70 per cent of the faecal sludge can be collected by the 5,000-litre-capacity truck

Number of 5,000 litres capacity trucks = (V_1* 70)/(100 * average volume of septic tank * number of trips)

= (70,175 * 70)/(100 * 3,000 * 3)

= 5.45 or 6 trucks

The remaining 30 per cent of faecal sludge would be collected by the 2,000-litre capacity Vacutug

Number of 2,000-litre- capacity Vacutugs

= (V_1* 30 * no. of trips per septic tank)/(100*Average volume of septic tank * number of trips)

= (70,175 * 30 * 2)/(100 * 3,000 * 4)

= 3.508 or 4 vacutugs

Suggested actions

Regulate charges for emptying*:* The charges to empty faecal sludge vary widely across the country, according to the urgency shown by the customer to get the containment emptied. ULBs can cap the fee charged by private operators, taking into consideration fuel costs, salary, and profit for the operator, with provisions of revising the fees from time to time. The charges for emptying can also be market-driven. Such actions can be implemented based on the learning from emptying practice in Senegal (see *Case study 1: Call centre: Senegal*).

Regulating and licensing of private emptiers: ULBs should regulate private emptiers by licensing them, which would help in streamlining of the process and checking faulty septic tanks, as well as inhibit environmental pollution.

Awareness campaigns: Awareness about the need to empty containments regularly is essential. Frequent advisories on appropriate use of chemicals and detergents in cleaning the bathrooms and toilets should be provided to owners of OSS. Benefits of regular desludging should be conveyed through mass awareness campaigns, IEC material distribution, electronic media etc. NGOs operating in a city should be consulted or hired for awareness campaigns.

Sensitization of private operators: Most private operators in this business are not aware about adverse impacts of unsafe disposal of the faecal sludge. Proper training of private operators towards faecal sludge management by local authorities, and understanding the issues and challenges faced by private operators so that they can be addressed, can limit illegal and unsafe disposal of faecal sludge.

Case study 1: Call centre—Senegal

Background

In 2011, the National Sanitation Office of Senegal (ONAS) decided to restructure the mechanical emptying sector with new technical and administrative organizational forms to be adopted in an inclusive and participatory manner. To this end, development of a call centre was seen as an effective method for improving services by facilitating better a relationship between clients and service providers. The process of developing and designing the call centre took two years, as care was taken to ensure the participation of all relevant stakeholders.

Faecal sludge management

- ONAS engaged with water and sanitation for Africa and innovations for poverty action for technology interventions.
- Initially, a pilot project was launched to assess the viability of the plan.
- An awareness campaign on the launch of call centre was launched.
- Training of truck operators was performed.
- Geo-referencing of trucks was done.
- The call centre provides each requirement for emptying as an auction which is sent through SMS as an update.
- The business from call centre applies to each truck and not individual businesses.
- Trucks have been segregated area-wise. Therefore, bids are sent to the individual trucks plying in that area.
- When an auction is provided, it calls for bids from individual trucks.
- At the end of the bidding period, the lowest bidder is notified.
- In the event that a customer reports on poor quality of service, the relevant operator is penalized in future bids, whereby the offer made is marked up with a fixed penalized amount of CFA Francs 2,000 (US $3.5), which would make the offer less competitive.

Progress of the initiative

- 138 emptying trucks are listed in the call centre platform database.
- The call centre model has resulted in a significant decrease in emptying fees. For example, in the Commune of Sicap Mbao, emptying fees declined by 18 per cent (from US $56 to US $46) between 2012 and 2016.
- Since the launch of the call centre, there has been an increase in the volumes of sludge delivered to treatment plants.
- The model could especially support low-income households struggling with emptying fees, while high-income households might continue to personally contract emptiers to control who is entering their premises.

Source: Faecal Sludge Management. IWA, 2014.

Record-keeping: Keeping accurate records regarding tasks and volume pumped is important for billing compliance and forms an integral part of any comprehensive faecal sludge management programme.

4.3 Faecal sludge treatment

Faecal sludge collected from various points needs to be disposed of at an appropriate treatment facility. The treatment methods can be conventional or non-conventional. Non-conventional methods are improved ones, recommended for countries where faecal sludge management does not exist. Effluent from septic tanks as well as faecal sludge needs treatment. Treatment of effluent and grey water is detailed in the next chapter.

Co-treatment with wastewater

Co-treatment simply means treating faecal sludge along with wastewater at a wastewater treatment plant. It is an option which can be considered in Ghana, provided the characteristics of the faecal sludge is known, it is diluted with sewage to avoid shock load, and the STP has enough capacity to take the extra load. Broadly, co-treatment can be carried out in two ways:

1. Faecal sludge directly mixed with sewage
2. Faecal sludge treated with the sludge of an STP

Faecal sludge directly mixed with sewage flows: If STPs are underutilized, adding faecal sludge into existing STPs can be a quick solution to the safe management of faecal sludge. Faecal Sludge can be added to the trunk sewer line either through sewage pumping stations or through a manhole adjacent to the STP. Faecal sludge can also be mixed with incoming sewage at the STP, right before the screening. The following aspects must be considered while mixing faecal sludge:

a) The quality, and not just quantity, of sludge, must be evaluated. Most biological wastewater treatment plants are designed and operated on the basis of solid content, BOD, COD and pH.
b) It must be ascertained beforehand whether the faecal sludge and sludge contain any toxic chemicals that destroy biological communities. The presence of trash, grit and trade and industrial sludge can be toxic and impact biological processes.
c) Consistent compliance of STPs might be an issue.

Certain guidelines indicate that low volumes of faecal sludge could be co-treated in municipal WWTPs. USEPA states that up to 3.6 per cent of the maximum plant design capacity load can be faecal sludge (i.e. from septic tanks). However, these recommendations are mostly based on biochemical oxygen demand (BOD), which does not account for the total organic and inorganic content present in faecal sludge or provide enough relevant information on the different biodegradable fractions. Hence, chemical oxygen demand (COD) measurements is recommended to be used since total COD can be subdivided into useful organic fractions to assess the design and evaluate the performance of biological wastewater treatment processes.[30]

Faecal sludge co-treated with STP sludge: Most STPs have space for sludge drying which can be used for solid–liquid separation. Sludge de-watering sites needs to be improved a bit by designing proper sludge drying beds. Geo-bags to de-water the faecal sludge or sludge can be developed as an alternative option to sludge drying bed. The liquid fraction from sludge or faecal sludge can be directed to the STPs. This is a much better option than directly mixing sludge into the STPs. Faecal sludge, after de-watering, and sludge from STPs can be treated together through co-composting, pyrolysis etc. This solution is feasible only in STPs in the vicinity of the target city, otherwise, sludge transportation cost will be prohibitive.

Faecal sludge treatment plant: The four main functions of faecal sludge treatment are solid–liquid separation, stabilization, de-watering or drying, and pathogen reduction. Potential end-uses are as soil conditioner, fuel (biogas) etc. Collected faecal sludge can be passed through a screen to remove unwanted solid wastes which might interrupt in the treatment process.

It is important to understand that in order to achieve complete treatment, a combination of two or three technologies is ideal. Research is bringing more technologies in the fray as time goes by. A brief description of the technologies is given below.

Settling-thickening (solid–liquid separation)

Settling-thickening technologies thicken and de-water faecal sludge. Solids settle to the bottom as the faecal sludge flows from one end of the pond or tank to the other. The liquid (effluent) flows through the outlet and requires further treatment. Some solids (for example, fats, oil and grease) float to the top and form a layer of scum. Example of these technologies include settling-thickening tanks or ponds, settlers, Imhoff tanks and septic tanks. Settling-thickening

Case study 2: Sanitation and Sewerage Management: The Malaysian Experience

Malaysia stands out in South East Asia as having made significant improvements in sanitation and sewerage management. The top-down strategy by the federal government, effectively over-riding the local governments, produced quick results. A holistic approach was adopted to manage centralised, community and on-site sanitation systems, which put in place strong regulatory frameworks and a strong driver with a clearly defined role, and tasked the private sector to do what it does effectively.

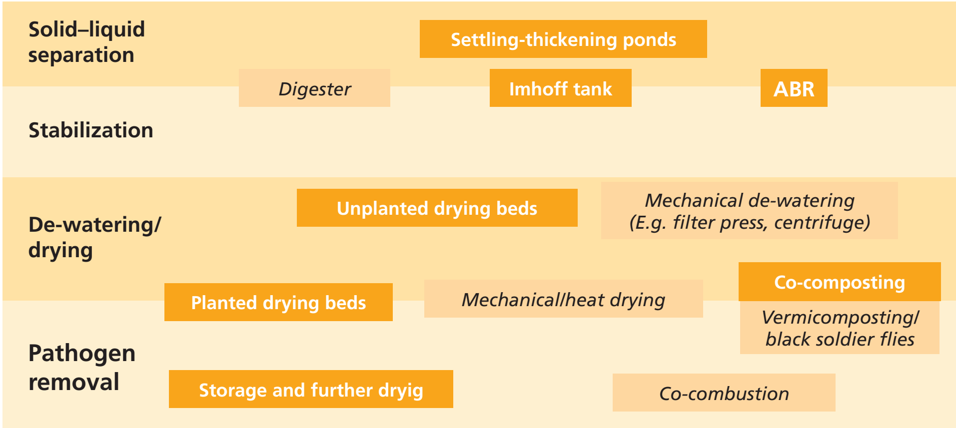
Co-existence of a range of sanitation systems The de-facto policies and philosophies of sewerage infrastructure development accepted the reality that a whole range of sanitation / sewerage systems will co-exist, and that through specific demand drivers, this range will evolve, shedding the simpler and less effective systems and upgrading to better systems up the sanitation ladder. The concession agreement stipulated the targets for the eventual mix of sewered and on-site (septic tank) systems for different categories of urban areas.

Factors that contributed to the success

- There was a very strong driver (the federal government) and political push for the whole process.
- While there was no written policy governing sanitation / sewerage, de-facto policies were recognised and institutionalised in laws, guidelines and procedures.
- Strong legislative arrangements gave legal basis
- to the initiatives. The Sewerage Services Act and its successor, the Water Services Industry Act and its various derivative legislation, provided a strong framework for the improvements.
- Roles and responsibilities of government, the regulator, operators, developers and others were clearly defined
- Federalisation resulted in focused funding allocation and massive investment in infrastructure improvements.
- Private sector participation helped develop guidelines, operating instructions and systems tobring the whole range of related activities, from planning, design, construction, operation and maintenance and overall management, to levels of excellence.
- Appropriate technologies were adopted with gradual upgrading giving time and space for learning and adaptation
- Internal monitoring and control together with stringent regulator oversight ensured everythingwas well controlled and weaknesses were identified and addressed
- Strong efforts by Indah Water Konsortium in particular (IWK) created awareness and enhanced communications among the community.
- Training and capacity building efforts, spearheaded by IWK, created a large pool of people with the expertise and skill to support the industry

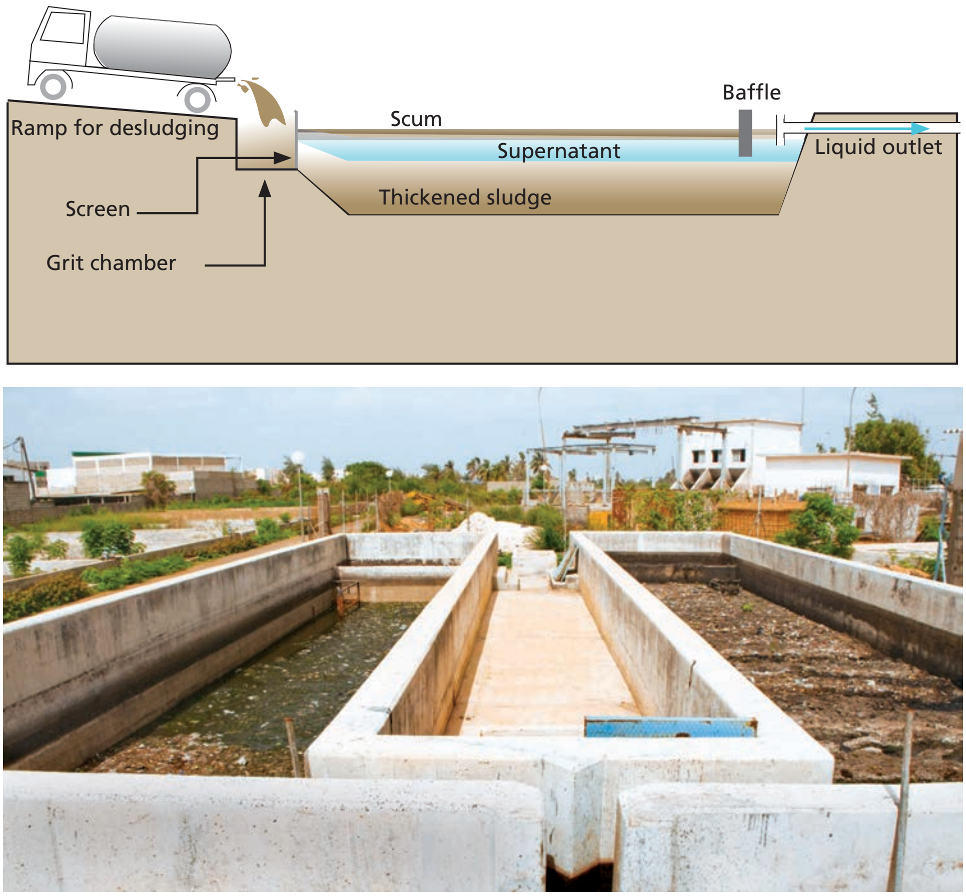
Source: FSM 4 case studies, adapted from http://www.susana.org/_resources/documents/default/3-2760-7-1493194800.pdf accessed on 17 July 2019

Figure 11: Treatment technologies based on their function



Source: Tilley et al., 2016

Figure 12: Sludge thickening pond



Source: Tilley et al, 2014

technologies operate semi-continuously. They often include two-lined ponds or tanks, while one is in operation, sludge thickens in the other. Faecal sludge is then pumped out every month for further treatment. Other than pumping, settling-thickening technologies require low amounts of energy.

Mechanical de-watering

Mechanical de-watering technologies include belt-filter press, frame-filter press, screw press and centrifuge. Mechanical forces de-water faecal sludge (for example, centrifugal force). Conditioners are often added to the faecal sludge before mechanical de-watering. Conditioners are products that help de-water the sludge more efficiently. Mechanical de-watering is fast (takes only minutes or a few hours) and requires less space, but it uses large amount of energy.

Case study 3: Faecal sludge treatment plant based on up-flow anaerobic sludge blanket with mechanical dewatering in Lavender Hills, Accra

The process begins from the discharge of the septage into discharge troughs. This flows by gravity through the screens and the integrated machines to remove debris and sand. The septage is then de-watered using a coagulant and then screw pressed. The bio-solids is collected and dried for further composting as organic manure. The effluent is then move into the upflow anaerobic sludge blanket tanks for further treatment (UASB). It is in these tanks that methane gas is generated. The effluent is then move into the anoxic and oxic tanks where nitrification and de-nitrification takes place respectively. The last stage is for the effluent to move into the sedimentation tanks. The clear water is finally pass through a UV system for disinfection before final discharge into the sea.

Mechanical de-watering unit in Accra

This effluent meets the EPA standards. Biogas, which comprises methane, carbon dioxide and hydrogen sulphide, is extracted from the UASB treatment process, after which it is cleaned for methane to generate electricity mainly to run the plant.

Facts and figures

- Design capacity of 2000 m^3/day
- Averagely 208 trucks visit the plant daily
- Plant available to users 24 x 7
- Production of compost for organic fertilizer
- Production of biogas for the generation of electricity
- An end-product of clear water that is used for irrigation, car wash, and aquaculture
- The plant has enhanced a cleaner, healthier and odour-free environment—Jamestown and its environs
- Solution promotes preventive healthcare
- Well-equipped laboratory
- Has a 5,500 m^3/day storage tank
- Has an odour-control capability
- Plant has four UASB tanks with a capacity of 1,700 m^3/day each

Lime stabilization

Lime stabilization is the process by which hydrated lime (calcium hydroxide) is added to faecal sludge to form a product that can be disposed of on land for use as a fertilizer. The process requires approximately 12–20 kg of hydrated lime for every 4,000 litres of faecal sludge. Once the lime and faecal sludge is mixed, the pH is raised to 12 and kept thus for a minimum of 30 minutes. This kills any pathogens present. The material can then be more easily handled for final disposal. Several readings of pH during the mixing process must be taken to determine the exact amount of hydrated lime required.[31]

There are two common ways to perform lime stabilization:

1. Adding lime directly to a vacuum truck—Lime can be added either before or after the faecal sludge is pumped out. The pump in the truck can then be used to mix the lime and faecal sludge. This method only works in case of stainless steel tanks.
2. Adding lime to the faecal sludge pit daily or weekly—The frequency of adding lime depends on the quantity of faecal sludge; if it is under 20,000 litres per week, adding lime weekly is sufficient; if it is over 20,000 litres per week, adding lime daily is required.

A simple earthen pit works well for lime stabilization. Typical pits are 4 x 3 x 1.5 m (length, width and depth), and have a capacity of 40,000 litres. Two pits are recommended for a long-term operation, to be used alternatively. Typically, the pits would be lined, but if the soil contains sufficient amount of clay, it may be compacted to prevent seepage and save the cost of lining.

Composting

Composting may be defined as the stabilization of organic material through the process of aerobic, thermophilic decomposition. During the composting process, organic material undergoes biological degradation to form a stable end product. Approximately 20–30 per cent organic solids are converted to carbon dioxide and water. As the organic material in the faecal sludge decomposes, the compost heats to temperatures in the range of 50–70°C and harmful pathogens are destroyed. The resulting humus-like material is suitable as a soil conditioner and source of nitrogen and phosphorus.[32]

Faecal sludge can be composted directly. The basic procedure for composting is as follows:

1. Faecal sludge is mixed with a bulking agent, (e.g. wood chips, sawdust) to decrease the moisture content of the mixture, increase porosity, and assure aerobic conditions during composting.
2. The mixture is aerated either by the addition of air (aerated static pile) or by mechanical turning (‘agitated’) for about 28 days.

The most common agitated method is windrow composting in which the mixture of faecal sludge or wastewater solids and bulking agent is pushed into long parallel rows called windrows, about 1–2 m high and about 2–4.5 m wide at the base. The cross-section is either trapezoidal or triangular. The mixture is turned over several times a week. Although specialized equipment has been developed for windrow composting, it is possible to use a front-end loader to move, push, stack, and turn the mixture.

Factors affecting the composting process include moisture (40–60 per cent) and oxygen (5–15 per cent) content; temperature (must reach 55–65°C); pH (6–9); and carbon–nitrogen ratio (30:1). For the operation to be smooth, there should be sufficient laboratory equipment to monitor these parameters during the compost process. Moisture can be added and turning can be increased based on monitoring results. The operator should measure temperature at least once every day by placing a thermometer into the mixture at various locations. Maintaining temperatures of 50–60°C for the compost period assures destruction of pathogens.

Co-composting

Co-composting is composting of faecal sludge along with the organic fraction of municipal solid waste. The organic fraction includes food waste, paper, yard waste (e.g. leaves and branches) cut or removed during landscaping. Co-composting is done in batches. Faecal sludge and other organic material are placed in piles or rows. Various parameters need to be controlled to ensure an optimal composting process, including temperature, moisture, carbon–nitrogen ratio and oxygen concentration. Co-composting takes several months and needs low amounts of energy. The process produces compost, a dark, rich soil-like material which can be used as a soil conditioner.[33]

Black soldier fly larvae

Black soldier fly larvae eat faecal sludge, and in doing so they reduce the volume and stabilize the sludge. They are rich in fat and protein and are fed to livestock as a source of protein. They do not need to eat once they can fly—they do not have a mouth—and they are therefore not vectors and do not spread pathogens. Black soldier fly larvae treatment is done in batches or semi-continuously. Faecal sludge is placed in a container with black soldier fly eggs

Figure 13: Co-composting of faecal sludge with organic waste

Source: Tilley et al., 2016.

Case study 4: Co-composting of faecal sludge and municipal organic waste in Sakhipur Municipality, Bangladesh

Each year, 6,500 metric tonnes of faecal sludge and 3,500 metric tonnes of household solid waste is generated. Almost 80 per cent of the faecal sludge from the pits or tanks is discharged directly to the environment, either following manual emptying or from overflowing pipes. The technology chosen for the co-composting plant is a three-step process: 1) Drying faecal sludge on unplanted drying beds; 2) Wastewater treatment through a constructed wetland, and 3) Aerobic decomposition (composting) of dried faecal sludge and organic solid waste. Thee treatment plants can treat 5,000 litres of sludge per day. Faecal sludge is collected from septic tanks and pit latrines using a 1,000-litre-capacity Vacutug owned by the municipality. It takes three to five trips to fill one bed, where faecal sludge is kept for 14 days and refilled in cycles. The plant has ten 9 m^2 beds, with a loading capacity of 3,000–5,000 litres each at a loading depth of about 20 cm, depending on the concentration of the liquid sludge. The base of the bed is lined with three layers of a gravel-sand filter material of different thicknesses and particle sizes.

The solid waste fed into the plant is collected by the municipality from households for a monthly fee of BDT 50 (US $0.60) a month. The co-composting plant handles 125 metric tonnes of solid waste a year, and organic components are screened during the separation process, and the inorganic part is recycled and used by industry. Every week, one composting process is initiated in the plant. The organic solid waste, dried faecal sludge and sawdust are mixed at a volume ratio of 3:1:1. Sawdust, purchased cheaply from nearby sawmills, is added to increase the solids content and balance the carbon to nitrogen (C:N) ratio.

Approximately 24 metric tonnes of compost is produced per year. The municipal authority sells the compost directly to local farmers for BDT 16.00 (US $0.20)/kg, and the farmers use the compost to produce a variety of vegetables. The compost is available in five package sizes: 1 kg, 3 kg, 5 kg and 50 kg. Farmers use the compost as soil conditioner locally and the feedback from the farmers is encouraging, and demand for the compost is high in and around the town.

Source: Bangladesh FSM Network 2018

Figure 14: Black soldier fly larvae

Source: http://farmerfredrant.blogspot.in/2010/06

or larvae. Other organic waste streams can be added as well to be co-treated. The larvae are harvested periodically to be fed to livestock.

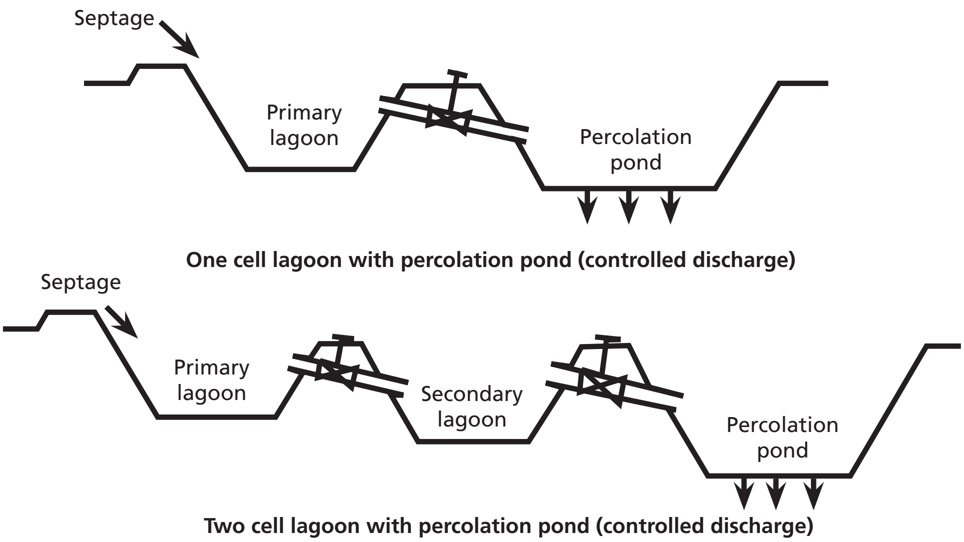
Pelletizing

De-watered sludge is processed into pellets by pressing it through a nozzle or plate. Pellets are dense, consistent in composition, and relatively easy to store, transport and market. Pelletizing can be used to enhance drying, for example, with the bio-burn process that can process pellets at 50 per cent moisture that can dry to 90 per cent without additional thermal energy. Other pelletizers de-water or dry sludge when they are combined with other technologies,

Figure 15: Pelletization

Source: JAEE, 2002.

Figure 16: Lagoon technology



Source: USEPA. (1994): Handbook: Faecal Sludge treatment and disposal. Cincinnati, Ohio: Municipal Environmental Research Laboratory.

such as thermal dryer in the LaDePa technology. Other pelletizing technologies require that the sludge is first dried, and then compressed into pellets with a binder. Pelletizing takes seconds and requires a low amount of energy, which varies with the technology used.

Lagoon

The simplest faecal sludge treating lagoon consists of two earthen basins arranged in series. The first or primary lagoon (which may or may not be lined, depending on the local geological conditions) receives raw faecal sludge. The supernatant liquid from the primary lagoon, which has undergone some clarification and possibly anaerobic digestion, is transferred into the second

Figure 17: Geo-tube bags

Source:http://www.tencate.com/apac/geosynthetics/product/dewatering-technology/dewatering-container.aspx

lagoon, or percolating pond, where it is allowed to infiltrate into the ground. It is also possible to have multi-celled lagoon systems with either surface discharge or land application of effluent.[34]

Geo-tubes, containers and bags are made from porous tubular containers fabricated with high strength woven geo-textiles (polyethylene material) mainly used for de-watering sludge. Geo-tubes have high durability, low maintenance, low energy or fuel consumption, and they do not require additives. These bags are all-weather and environment-friendly and trap most of the solids in faecal sludge.[35] The solids collected can then be transported to a landfill site for disposal or sent for recovery of nutrients and then used as a soil conditioner. Geo-tubes significantly reduce the operation and maintenance costs.[36]

4.3.1 Suggested actions

Characterization of faecal sludge: Currently, there is negligible information about the characteristics of faecal sludge desludged from containment systems of different agro-climatic regions of Ghana. Academic research institutions or accredited laboratories in Ghana should be consulted to determine the characteristics of faecal sludge characteristics. This will help in selecting the appropriate technology that suits the local and regional conditions.

Land allocation: Instead of one big piece of land, smaller pockets should be identified to establish decentralized faecal sludge treatment plants**.** The sites should be selected on the basis of the spatial spread of OSS in the city. One of the main objectives is to reduce the distance, vacuum trucks have to travel and, eventually, the cost of conveyance.

Pilot projects: ULBs can take up pilot projects under various programmes sanctioned by the government of Ghana. Pilot projects should be implemented by ULBs with minimum support from consultants. ULBs should own these projects. The implementation and results should be systematically documented for scaling up and replicating it in other parts of country. Organizations like CSIR-IIR can provide technical support in implementing pilot/model projects.

Case study 5: Gravity based biological septage treatment plant, Devanhalli—India

Background

Devanahalli town has a population of about 23,406 people. Most households depend on septic tanks and soakpits for sewage disposal. As per the municipal council, there are about 5,110 septic tanks. There is neither an underground sewerage connection nor any organized septage treatment facility in the area, which leads to washing of septage into existing open drains. The objective of this project was to establish a pilot independent septage treatment unit and treat sewage as per prescribed standards.

Septage management

Gravity-based biological treatment technology in an area of 650 sq. m has been used. The plant is mostly underground, completely covered and odourless. For treatment, septage passes through five different units: 1. A feeding tank with a screen chamber is the first unit which traps large solids. Screened septage enters the biogas settler (BGS), where it gets settled and liquid supernatant is formed on the top. 2. Sludge accumulated in the BGS moves to a stabilizing tank and the stabilized sludge is disposed of into sludge drying beds for dewatering. This dried sludge can be used as a soil conditioner. 3. The liquid supernatant from the BGS moves to a DWWT system which consists of two chambers of a settler, five chambers of an anaerobic baffled reactor, and one chamber of an anaerobic filter. After this, it is finally treated through a planted gravel filter bed. This treated liquid can be end used for gardening.

Devanahalli septage treatment plant

Source: www.cseindia.org

Capacity building programme and model projects: There is a major need for conducting training, workshops, exposure visits on faecal sludge and wastewater management for various stakeholders at all levels. Stakeholders include decision makers like senior government officials, bureaucrats, technical staff responsible for planning, designing, implementing and maintaining projects.

Resource recovery

Goal 6 of the 2030 Agenda for Sustainable Development is to 'ensure availability and sustainable management of water and sanitation for all'. Goal 6.3 acknowledges that the targets within each goal need to be implemented in an integrated fashion to ensure they support targets on increasing recycle and safe reuse of water. Goal 6.3 is interlinked to the Goal 2.3 (agricultural productivity), which meets United Nation's Millennium Development Goals. These goals state that the safe use of faecal sludge and wastewater in agriculture meets 'Goal 1: Eliminate extreme poverty and hunger' and 'Goal 7: Ensure environmental sustainability'. The use of excreta in agriculture can help

Solved example 4

Question

Assume that the peak load in a city X at any given day is less than 80 m^3. Calculate the number of treatment plants and design one treatment plant with unplanted drying beds, providing the size of the beds and numbers of beds required, given that average total solids content of septage is 20 g/l and maximum height of septage in one bed cannot exceed 30 cm.

Answer

The number of treatment plants, their capacity and site location is a site-specific question. The treatment plants should be strategically located so that the distance from the area with on--site sanitation dependence is minimized.

If we assume that on-site systems are prevalent all over the city, three treatment plants of 30 KLD each should be enough.

To design a plant based on unplanted drying bed, we should understand the sludge load (SL) and average total solids (TS) content of the septage.

SL = TS x Q x N

Where,

SL is sludge load (in kg TS/year)
TS is average total solids content (in kg/m^3)
Q is incoming septage per day (m^3/day)
N is number of delivery days (days/year)
SL = 20 x 30 x 285
= 171,000 Kg TS/year

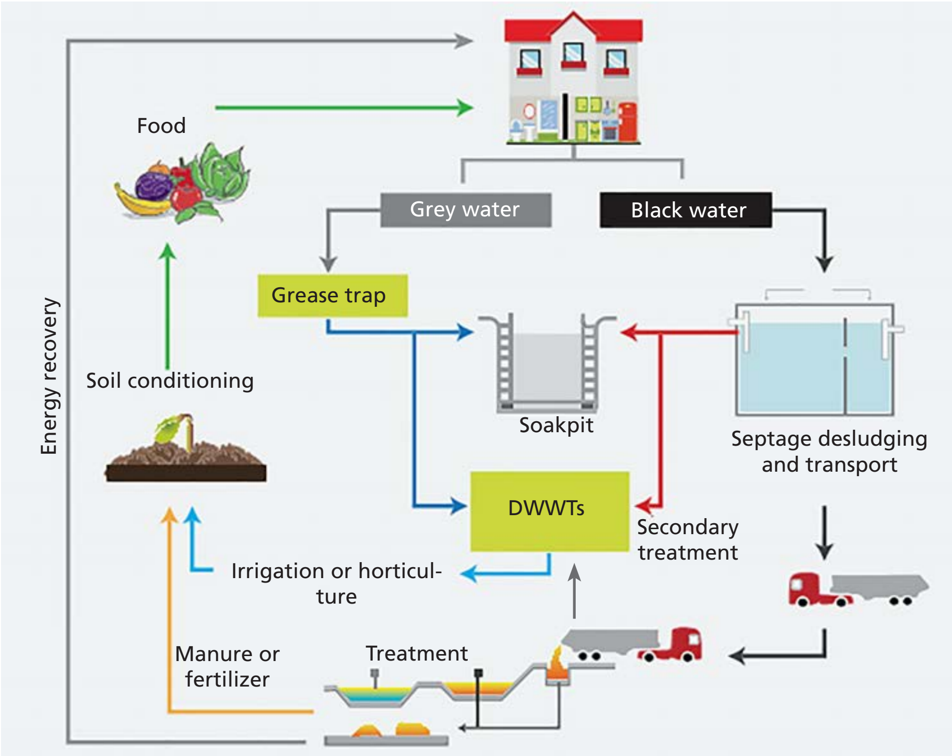
Sludge loading rate (SLR) of 200 kg/m^2/year is recommended
Hence total area required for drying bed would be:
Total bed area = SL/SLR = 171,000/200 = 855 m^2

Volume of septage delivered is 30 m^3 and maximum depth allowed is 0.3 m.
Area of one bed assuming all the load for one day would be discharged in one bed only.
Area of one bed = 30/0.3 = 100 m^2
Total number of beds required = 855/100 = 8.55 or nine beds

If the septage is delivered five days per week and the time taken for de-watering is approximately two weeks, then it is better to have 10 beds of 100 m^2 each with working depth of 30 cm, so that 30 m^3 of septage can be discharged to one bed every day. The de-watered sludge should be removed for further processing.

communities grow more food and decrease use of precious water and nutrient resources. However, it should be done safely to maximize public health gains and environmental benefits. In 2006, the World Health Organization (WHO) provided guidelines on safe reuse of wastewater, excreta and grey water.[37] In 2018, WHO has provided guidelines on sanitation and health. Developed in accordance with the processes set out in the WHO Handbook for Guideline Development, the guidelines provide comprehensive advice on maximizing the health impact of sanitation interventions. The guidelines summarize the evidence on the links between sanitation and health, provide evidence-informed recommendations, and offer guidance for international, national and local sanitation policies and programme actions. The guidelines also articulate and support the role of health authorities in sanitation policy and programming to help ensure that health risks are identified and managed effectively.

Figure 18: Closing the loop



Source: Introduction to preparation of CSP, GIZ-CSE, 2016.

Reuse of faecal sludge refers to the safe and beneficial use of human excreta, i.e. faeces and wastewater from OSS. Considering the nutrients, organic matter and energy contained in faecal sludge, it can be used as a soil conditioner or fertilizer in agriculture, gardening, aquaculture or horticultural activities. Other uses include a fuel source, building material or for protein food production. Closing the loop will not only help in reducing fresh water and chemical fertilizer demand but also be a source of revenue, in other words, an all-round improved business model.

Faecal sludge contains nutrients such as nitrogen, phosphorus and potassium as well as micro-+nutrients like sulphur and organic matter that can be recovered. Faecal sludge and domestic wastewater (sewage) have traditionally been used in agriculture. They are still used in agriculture to this day, but the practice is often carried out in an unregulated and unsafe manner in developing countries. WHO's 2006 guidelines established a framework on how this reuse can be done safely by following a 'multiple barrier approach'.

'No higher quality of water should be used for a purpose that can tolerate a lower grade'

UN Council Resolution 1958

The type of reuse should decide the level of treatment. The degree of treatment required for excreta-based fertilizers before they can be safely used in agriculture depends on a number of factors; a number of barriers may be necessary. Such barriers include selecting a suitable crop, farming method, method of applying fertilizer, education etc.[38] However, health concerns are a major challenge for such approaches. Proponents operate in fragmented and unsupportive policy environments that are often weakly linked to health. They also need to overcome negative public perceptions about the risks associated with the use and disposal of human waste. A tool by WHO, Sanitation Safety Planning (SSP) can help sanitation system operators maximize health benefits and minimize health risk of their system. SSP takes into consideration all steps of the chain, from sanitation waste generation (e.g. in the toilet) to the waste's final use or disposal. For reuse in agriculture, which produces a food product, SSP goes from 'toilet to farm to table'.

For de-watered faecal sludge or sludge to be used as a fertilizer in agriculture applications, it should satisfy the criteria of Class-A bio-solids of USEPA: A faecal coliform density of less than 1,000 MPN/g total dry solids Salmonella; specific density of less than 3 MPN/g per 4 g of total dry solids, helminth egg concentration of <1/g total solids and E coli of 1,000/g total solids in treated faecal sludge for use in agriculture.[39]

If faecal sludge is properly treated, in can be used for agricultural purposes, but should not be used on food crops intended to be eaten raw, unless stringent controls are in place. The Department of Health Regulations of Philippines has put in place the following regulations for reusing faecal sludge as compost for food crops:

Requirements of land application
According to USEPA guidelines for bio-solid treatment processes that significantly reduce pathogens, if land application for food crops is to be practised, one of these methods must be used:

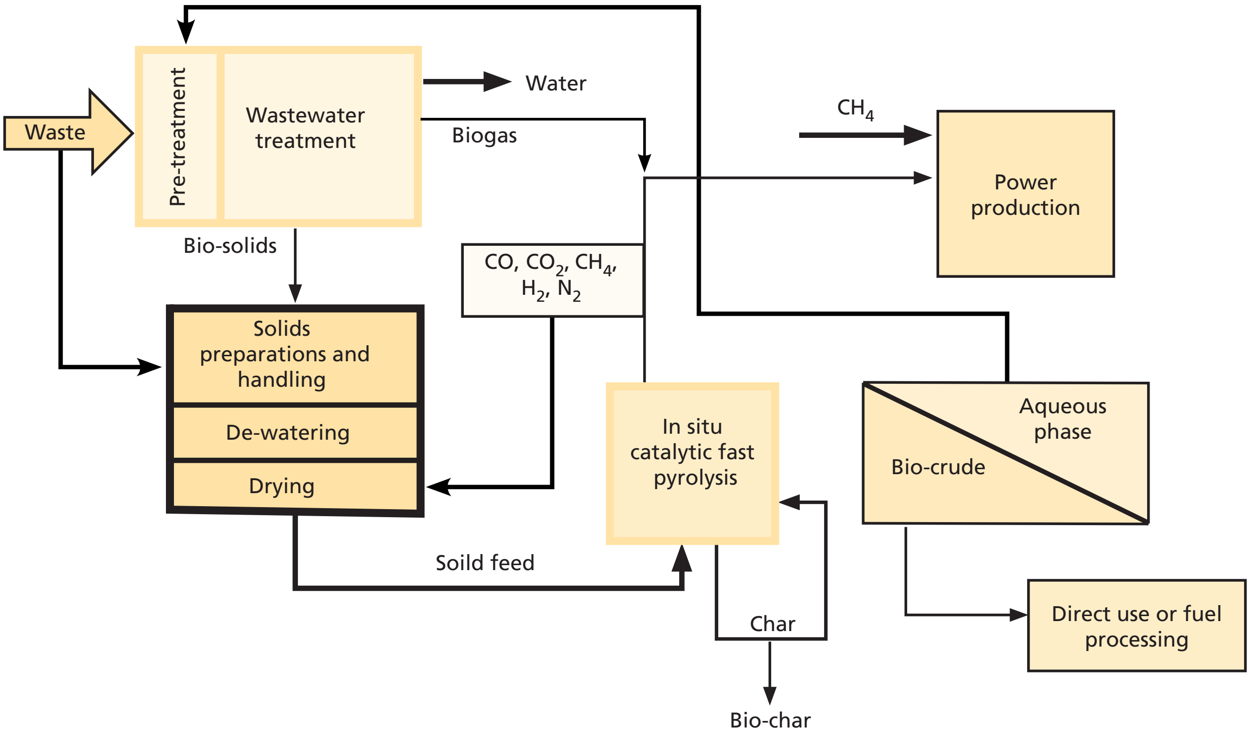
- Aerobic digestion between 40 days at 20°C and 60 days at 15°C;
- Anaerobic digestion between 15 days at 35–55°C and 60 days at 20°C;
- Air drying for at least three months; at least two months should have daily temperatures above freezing levels;
- Compost with temperatures greater than 40°C for five days. The temperature must be greater than 55°C for four hours every day; and
- Lime stabilization by adding sufficient hydrated lime to raise the pH to more than 12 for 30 minutes.

If agricultural reuse is intended, testing to verify the appropriate pathogen reduction is required. These methods have been recognized to reduce the number of helminth eggs to levels that are determined to be acceptable by the WHO for the purpose of land application for food crops. While a standard for the concentration of helminth eggs in bio-solids has not been codified into law by the Philippines Department of Health, WHO guidance on acceptable limits of these parasitic organisms exist. These are as follows:

For several reasons, nematodes are indicators' choice for testing for the presence of helminths in bio-solids destined for agricultural reuse. The WHO 1989 guidelines of one nematode egg per litre of treated wastewater (or faecal sludge) used for vegetable irrigation, and an average manuring rate of 2–3 tonnes per hectare per year should be followed.

Testing for nematode eggs is a relatively simple procedure that should be used to check the treatment efficiency and acceptability of bio-solids prior to land application. This should become an integral component of any bio-solids programme that reuses the treated product as a soil amendment or conditioner for agricultural purposes.

Figure 19: Catalytic fast pyrolysis



Source: *Catalytic Pyrolysis of Human Faeces for Biofuel Production*, Jeff Piscik, 2017..

Catalytic fast pyrolysis

One of the emergent reuses of faecal sludge is as biofuel. Biofuel can be obtained using catalytic fast pyrolysis, in which faecal sludge enters the wastewater treatment system, waste is de-watered while solids are separated and dried in a different unit. This dried waste or bio-solid is sterilized at a high temperature, producing methane, bio-crude and char. The methane can be used for production of power, while bio-crude can be processed further. The char produced from this technology can also be processed further and converted into bio-char (see *Figure 19: Catalytic fast pyrolysis*).

Table 7: Summary of established end-use products

Treatment product	Resource recovered	End use technology or product	Technology description	Pathogen level in end use product
Untreated sludge—buried	Organic matter Nutrients	Soil conditioner Fertilizer	Untreated sludge buried and used to grow trees (e.g. arborloo or deep row entrenchment)	Low to high depending on absorption characteristics and travel time. The untreated sludge can contain a high level of pathogens, but once buried they may be adsorbed into soil and inactivated over time.
De-watered sludge	Organic matter	Soil conditioner Fertilizer	De-watered sludge applied to land	High
De-watered sludge	Energy	Incineration	Burning of sludge generates heat for cement kilns.	Low. Ash produced is free of pathogens.

Treatment product	Resource recovered	End-use technology or product	Technology description	Pathogen level in end-use product
Dried sludge	Energy	Solid fuel	Pellets, briquettes, powder burned for fuel	Low but only after conversion by pyrolysis to a pellet, briquette or powder
Dried sludge	Materials	Building materials	Used in the manufacture of cement, bricks and clay-based products	Low but only after being subjected to high manufacturing temperatures
Compost (powder or pellets)	Organic matter Nutrients	Soil conditioner, fertilizer	Compost, powder or pellets applied to land	Low
Plants	Food	Animal fodder	Plants removed from planted drying beds or wetlands and fed to animals	Low in plants removed, but care needed when harvesting, as sludge and/or effluent may contain medium to high level of pathogens
Effluent	Nutrients, water	Irrigation water	Treated effluent applied to land	Treated effluent applied to land
Effluent	Water	Surface water recharge	Treated effluent disposed or discharged into rivers, lakes or oceans	Low to high depending on treatment technology.
Untreated effluent	Water	Groundwater recharge	Untreated effluent disposed or discharged into the ground via soak pit or leach field	Low to high depending on absorption characteristics and travel time. The untreated effluent can contain a high level of pathogens, but once in the ground they may be adsorbed aerobically into soil.

Source: Guidelines on Sanitation and Health, WHO, 2018.

Key points of this chapter

This chapter details:

- The precise design of on-site sanitation technologies
- The methodology for emptying and transportation of faecal sludge
- Personal protective equipment for safe emptying and transportation
- Low-cost and affordable methods and technologies at dedicated treatment plants to separately treat faecal sludge generated from households, community and public toilets and institutions.
- Electro-mechanical technologies for treatment of faecal sludge at a centralized scale.

5. Designing and implementation: Wastewater management

5.1 Decentralized wastewater management

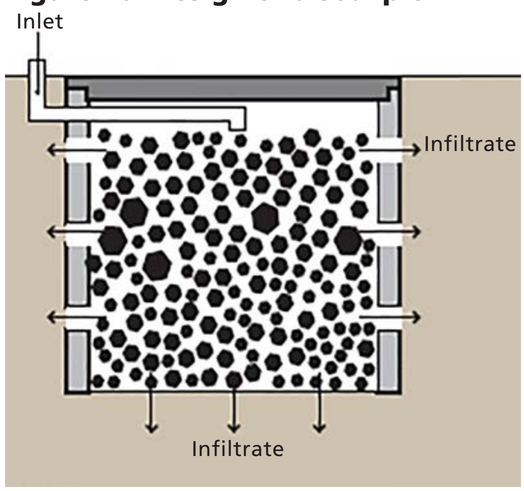
There are three types of wastewater streams:
1. The effluent or supernatant that drains out of the septic tank;
2. The effluent separated out from the faecal sludge after de-watering; and
3. The effluent or wastewater generated from kitchens and bathrooms.

These effluents need treatment to meet reuse or discharge standards. The first type can be tackled in following three ways:
a) **Discharged into a soak pit or soakaway**: This option can only be used if there is enough land available at the household level and the water table is low (more than 10 m deep) throughout the year. Four or five septic tanks can be connected to a common soak pit as well.
b) **Conveyed to the nearest trunk sewer via small bore or solids-free sewer**: Effluent from septic tanks of a community or society can be conveyed using a small bore or solid free sewer to the nearest trunk sewer. This option can only be used if there is an existing STP with spare capacity.
c) **Conveyed to the DWWTs**: Effluent from septic tanks/fully lined tanks of a community or society can be conveyed using a small bore or solid-free sewer to a decentralized wastewater treatment plant. The treated water can be reused for horticulture, toilet flushing, car wash etc.

Soak pit or soak away

A soak pit, also known as soak away or leach pit, is a covered, porous-walled chamber that allows water to slowly soak into the ground. Effluent from septic tanks is discharged into an underground chamber from where it infiltrates into the surrounding soil. These pits can be lined with semi-permeable walls or can be unlined and filled with rocks.[40]

Figure 20: Design of a soakpit



Source: Tilley et al., 2016.

Small-bore sewer

A small-bore or solids-free sewer is a network of small-diameter pipes that convey pre-treated and solids-free wastewater (such as septic tank effluent) to a treatment facility for further treatment, or to a discharge point. Without solids, the diameter of the sewers can be much smaller than conventional sewers, the recommended pipe diameter is 75 to 100 mm. They can be installed at a shallow depth, at least 300 mm, and do not require a minimum wastewater flow or slope to function. Thus, construction costs are lowered. Solid-free sewers can be built for new areas or where soil infiltration of septic tanks effluents (e.g. via leach fields) is not appropriate anymore (i.e., densely populated areas or clogging of sub-surface). Although solid-free sewers require a constant supply of water, less water is needed compared to conventional sewers because self-cleansing velocity is not required.

Solved example 6

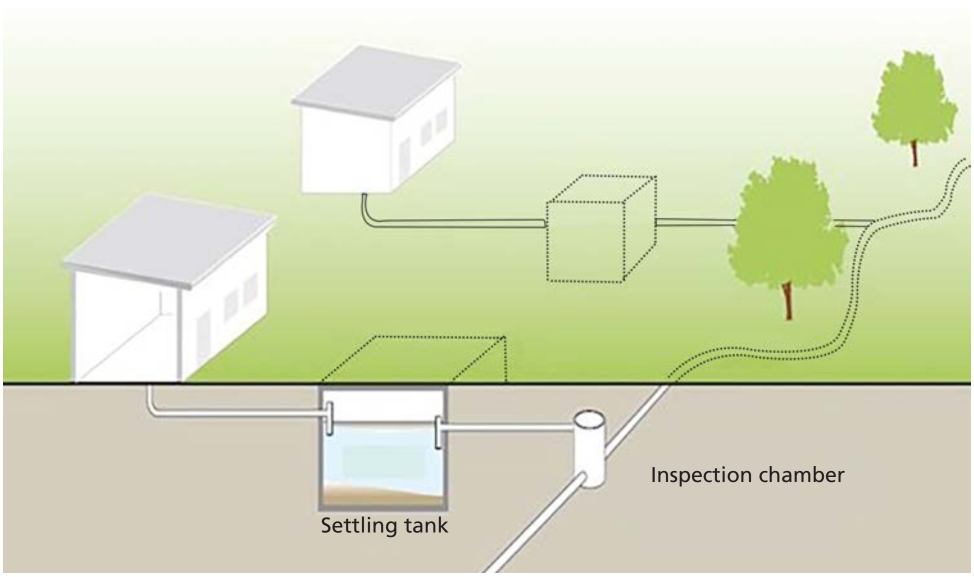
Question: Designing a soakpit

Answer:
To calculate the area of the soakpit that does not include the base.
WA = DF/SIR
e.g. WA = 540 L/50 L/m^2 = 10.8 m^2
WA = Wall area
DF = Daily flow
SIR = Soil infiltration rate

To calculate pit dimensions below inlet pipe.
D = WA / π x PD
e.g. D = 10.8/3.14 x 1 = 3.4 m
D = Depth in meters
PD = Pit diameter in metres
π = 3.14

Add depth of inlet pipe or 0.5 m whichever is the highest.

Figure 21: Solids-free sewer or small bore sewer



Source: Tilley et al., 2016

Operation & maintenance: Trained and responsible users are essential to avoid clogging by trash and other solids. Regular desludging of the septic tanks is critical to ensure optimal performance of the sewer. Periodic flushing of the pipes is recommended to insure against blockages. Special precautions should be taken to prevent illegal connections, since it is likely that interceptors would not be installed and solids would enter the system. The sewerage authority, a private contractor or user committee should be responsible for the management of the system, particularly, to ensure that the interceptors function optimally. Septic tanks/fully lined tanks need to be emptied periodically so that solids do not enter the sewer. The network should also be flushed once a year for smooth operation of the sewers.

Decentralized wastewater treatment

DWWTs is an approach where instead of having one big conventional STP in the outskirts of a city, many smaller STPs are developed within the city. Grey water can also be treated along with the effluent. The main advantage of such an approach is that sewage is not conveyed or pumped long distances and the possibility of local reuse of treated water increases manifold. These systems generally range from a capacity of 5 KLD to 1 MLD and should be installed at faecal sludge treatment units as well, to take care of the effluent after dewatering. The type of reuse should decide the level of treatment. Details of case studies can be found at https://www.cseindia.org/mount/home.

The DWWTs is a combination of different systems such as a settler or biogas digester, anaerobic baffled reactor, planted gravel filter bed (horizontal or vertical) and polishing pond or vortex system. These systems are based on natural wastewater treatment techniques and are designed in accordance with different parameters such as the characteristics of wastewater, quality of treated wastewater to be achieved, and site and technical specifications. In these systems, both aerobic and anaerobic treatment processes occur. DWWTS applications are based on four basic treatment modules:

1. Primary treatment includes pre-treatment and sedimentation in settlers or septic tanks
2. Secondary anaerobic treatment in baffled reactors
3. Tertiary aerobic or anaerobic treatment in planted gravel filter beds
4. Aerobic treatment in polishing ponds

(see *Annexure 13: Operation and maintenance for decentralized wastewater treatment systems*).

Constructed wetland

A constructed wetland is a large gravel and sand-filled horizontal or vertical sub-surface channel that is planted with aquatic vegetation As wastewater flows through the channel, the filter material sieves out particles and attached micro-organisms degrade organic material. The water level in a horizontal sub-surface flow constructed wetland is maintained at 5–15 cm below the surface to ensure sub-surface flow. Horizontal flow constructed wetlands (CW) are relatively inexpensive to build where land is affordable and they can be easily maintained by the local community as they require no high-tech spare parts, electrical energy or chemicals. It has been established that a horizontal filter bed area of about 2 m^2 per person equivalent is sufficient for the complete secondary and tertiary treatment of wastewater, including the removal of pathogenic germs.

Waste stabilization pond

Waste stabilization ponds (WSPs or stabilization ponds or waste stabilization lagoons) are ponds designed and built for wastewater treatment to reduce the organic content and remove pathogens from wastewater. These are man-made depressions confined by earthen structures. Wastewater or ‘influent’ enters on one side of the waste stabilization pond and exits on the other side as ‘effluent’, after spending several days in the pond, during which treatment processes take place.

WSPs are used worldwide for wastewater treatment and are especially suitable for developing countries that have warm climates. They are frequently used to treat sewage and industrial effluents, but may also be used for treatment of municipal run-off or storm water. The system may consist of a single pond or several ponds in a series, each pond playing a different role in the removal of pollutants. After treatment, the effluent may be returned to surface water or reused as irrigation water (or reclaimed water) if the effluent meets the required effluent standards (e.g. sufficiently low levels of pathogens).

Waste stabilization ponds involve natural treatment processes which take time because removal rates are slow. Therefore, larger areas are required than for other treatment processes with external energy inputs. Waste stabilization ponds described here use no aerators. High-performance lagoon technology that does use aerators has much more in common with the activated sludge process. Such aerated lagoons use less area than is needed for traditional stabilization ponds and are also common in small towns.

Electro-mechanical or packaged sewage treatment plants
Space constrained MMDAs can go for energy-intensive small-scale STPs, based on up-flow anaerobic sludge blanket (UASB), sequential batch reactor (SBR), membrane bio-reactor (MBR), moving bed biofilm reactor (MBBR), activated sludge process (ASP), etc. Generally, these systems are able to meet discharge standards. These systems occupy less space but are capital-intensive. Their operation costs are also high because they consume large quantities of energy.

Key points of this chapter

- Wastewater generated from households, community and public toilets, institutions and faecal sludge treatment plants can be treated on a decentralized scale.
- Small bore sewer system can be installed to carry wastewater from the point of generation to decentralized treatment plant.
- DWWT is a nature-based treatment technology which requires low or no electricity and can be operated and maintained by a gardener.

6. Institutional and regulatory framework and governance

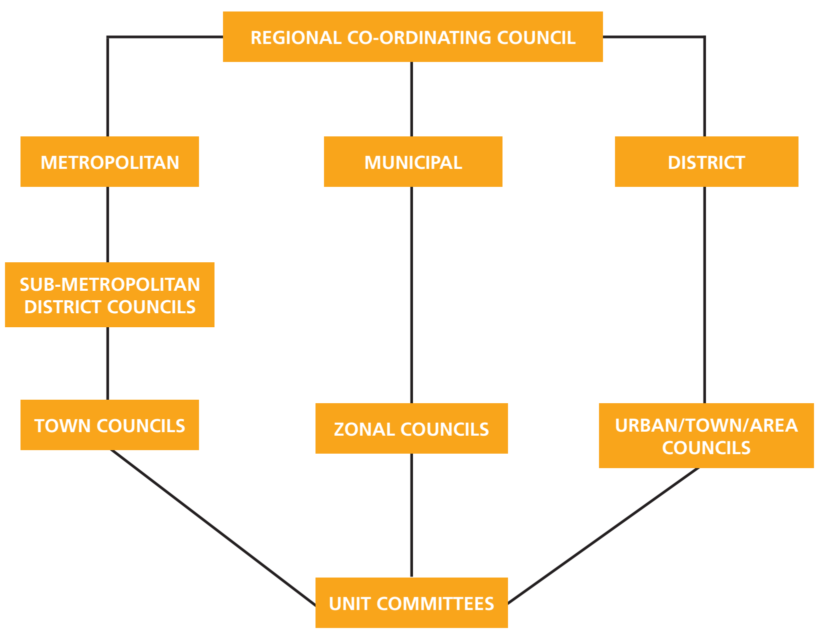
The Republic of Ghana is a unitary state divided into ten administrative units or regions, each headed by a regional minister appointed by the President. The principal units of the regions are the District Assemblies (DAs), constituting the local government.

Between the DAs and the central government are the Regional Coordinating Councils (RCCs). The RCCs are made up of the representatives from each of the District Assemblies in the region and from the regional House of Chiefs. The role of these bodies is to coordinate policy implementation by the DAs.

The DAs have deliberative, legislative and executive functions and are the planning authority for the districts. They exercise political and administrative authority in the district as well as to provide guidance, give direction and supervise all other administrative authorities in the district. DAs consist of elected and appointed representatives from within the defined geographical area of the district. The DAs are headed by the District Chief Executive (similar to a Mayor), appointed by the government and approved by the members of the Assembly.

Ghana has a well-defined legal and policy framework for sanitation services. The country's legal framework clearly assigns the Metropolitan Municipal Development Authorities the responsibility to prepare infrastructure development plans for sanitation and implement them. Till 2016, responsibilities of the water and sanitation sectors were divided between the Ministry of Water Resources (for water services) and Environmental Health

Figure 22: Structure of local government system



Source: National Environmental Sanitation Strategy And Action Plan, 2010–15.

Table 8: Agencies' responsibility towards safe and sustainable integrated wastewater and faecal sludge management

<table>
<tr><th>Sector</th><th>Planning and implementation</th><th>Service delivery</th><th>Policymaking</th><th>Regulation</th></tr>
<tr><td>Water supply</td><td>NDPC and GWCL</td><td>GWCL and CWSA</td><td rowspan="4">MSWR</td><td>MSWR, CWSA,</td></tr>
<tr><td>Sewage management</td><td>NDPC, TCPD and MMDAs</td><td>MESTI, MWD, MMDAs, CWSA</td><td></td></tr>
<tr><td>Access to toilet</td><td>MLGRD, NDPC and MMDAs</td><td rowspan="2">MMDAs and CWSA</td><td>MSWR</td></tr>
<tr><td>Faecal sludge management</td><td>NDPC and MMDAs</td><td></td></tr>
</table>

Source: Compiled by CSE

and Sanitation Directorate (EHSD) under the Ministry of Local Government and Rural Development (MLGRD) (for sanitation services). EHSD was in charge of policy formulation and implementing national level activities. Regulatory functions were shared by EHSD, Ghana Environmental Protection Agency (EPA) and the MMDAs, under the oversight of the Ministry of Environment, Science and Technology (MEST).

The Ministry of Education (MoE) is responsible for school sanitation and is jointly responsible with the Ministry of Health (MoH) for sanitation and hygiene education. The Ministry of Environment, Science and Technology ensures that sector activities are consistent with environmental policies and objectives.[41]

6.1 Governance and institutional framework—Effective facilitation

The Ministry of Local Government and Rural Development (MLGRD) is responsible for overseeing the Metropolitan, Municipal and District Assemblies (MMDAs), which are responsible for sanitation at the local level.

Ministry of Sanitation and Water Resources (MSWR), set up in 2017, deals with Ghana's priority of water and sanitation, which was further emphasized with the new Government under H.E. Nana Akufo Addo. This ministry is a merger of the Environmental Health and Sanitation Department (EHSD) under the Ministry of Local Government and Rural Development (MLGRD) and the Water Directorate of the Ministry of Water Resources Works and Housing (now the Ministry of Works and Housing).

The Ministry of Works and Housing has the Hydrological Services Department (HSD), which is responsible for primary (large) drains and water infrastructure. It deals with programming, coordination of coastal protection, major drainage works, monitoring and evaluation of surface water bodies with respect to floods throughout the country.

The National Development Planning Commission (NDPC) is responsible for planning and monitoring of all development activities. The medium-term development plan of the country has a number of focus areas for various development targets, including sanitation. NDPC provides guidelines for the development of the MMDAs' medium-term plans for sanitation known as District Environmental Sanitation Strategy Action Plans (DESSAPs), as presented below.

At the local level, MMDAs are responsible for implementing the sanitation policy and strategy. As decentralized entities, they plan their activities based on available resources and priorities. MMDAs have sub-committees in charge of planning and identifying priority areas, including the Development Planning Sub-committee, Social Services Sub-committee and Works Sub-committee, among others.

MMDAs have recently been mandated to prepare District Environmental Sanitation Strategy and Action Plans (DESSAPs) as strategies for tackling sanitation and the local level. As the elaboration of DESSAPs became one of the indicators for receiving funds under the DDF, many MMDAs have produced such plans.

Metropolitan and Municipal Assemblies (MMAs), which have large urban areas, have set up Waste Management Departments. MMDAs usually have Environmental Health Units. The Waste Management Department and the Environmental Health Units are responsible for implementing sanitation activities. The MMDAs' Waste Management Departments are usually tied to the operations of municipal facilities, while Environmental Health Units are more involved in the enforcement of environmental regulations and health and hygiene promotion activities.

The Community Water and Sanitation Agency (CWSA) of the MWRWH is the lead facilitator of the water supply in rural communities and small towns, and plays important roles in sanitation and hygiene promotion in rural areas.

The Ministry of Environment, Science, Technology and Innovation (MESTI) is the principal environment ministry responsible for the formulation and coordination of policies covering the environment, and environmental sanitation in regulation and provision of technical standards and manuals.

CWSA has produced a set of documents for the rural water sub-sector in collaboration with key stakeholders. The documents are to help provide an environment that ensures a harmonized approach to providing water and sanitation service delivery. National Community Water and Sanitation Strategy (NCWSS), the Project Implementation Manual (PIM), the District Operational Manual (DOM), the Framework for Assessing and Monitoring Rural and Small Town Water Supply Services in Ghana and its How-To-Do Guide are important guiding documents to be referred.

The Public Utilities Regulatory Commission (PURC), amongst others, is the regulator for water supply. Its mandate is to protect the interests of both consumers and providers of utility services. It also sets tariffs.

Ghana Water Company Limited (GWCL) is a utility company, fully owned by the state. The company is responsible for potable water supply to all urban communities in Ghana.

Ghana Education Services (GES): The Ministries of Education and Health provide directives for a school health system to promote an integrated health education and health delivery, which includes the promotion of WASH activities. The Government established the School Health Education Programme (SHEP) as a unit of Ghana Education Service (GES).

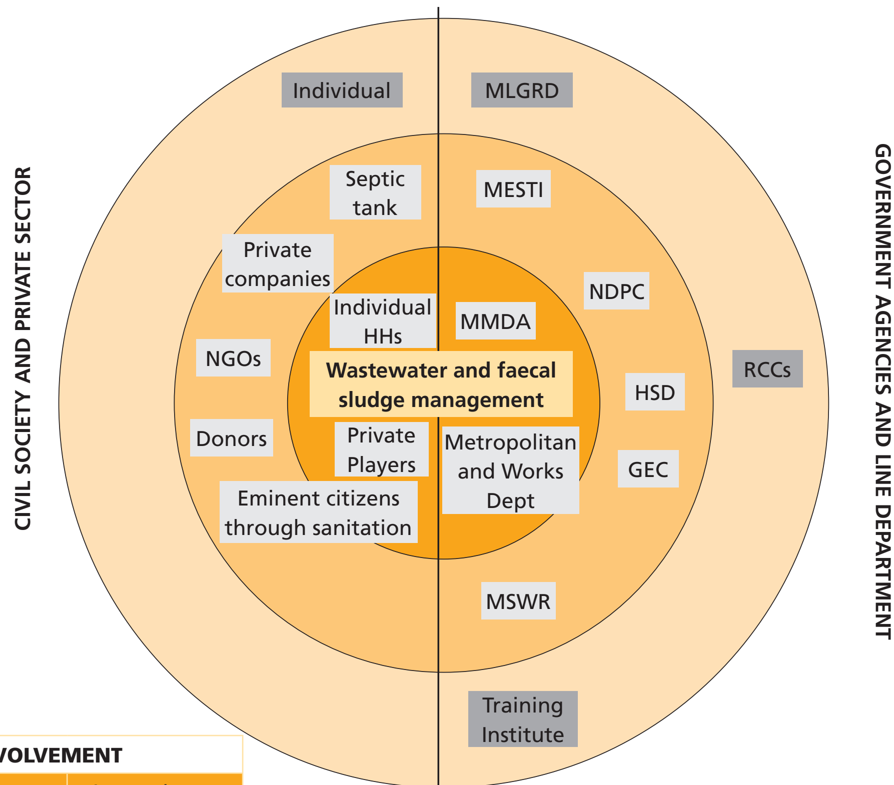
Centre for Science and Environment (CSE): Centre for Science and Environment has had a significant presence in Ghana in the field of training and research on sanitation for the last three years. Since 2015, CSE has held Indo-Africa Workshops, trainings on DWWTs and faecal sludge management, media workshops and has prepared a comprehensive report, *SFD Report for Tema Metropolitan Assembly*.

Council of Scientific and Industrial Research-Institute of Industrial Research (CSIR-IIR) is Ghana's foremost industrial research and development Institute with unique combination of applied research and scientific instrumentation. The primary function of CSIR-IIR is to drive national development and global competitiveness in industry through scientific and technological research. This function forms part of CSIR's vision that seeks to use the transforming power of science and technology for wealth creation.

Non-governmental organizations: There are about 50 (small and large) organizations working in WASH-related activities. The Ghana Coalition of NGOs in the Water and Sanitation Sector (CONIWAS) acts as an umbrella organization for many NGO's in the WASH sector. There are also some Dutch NGOs active in the WASH Sector in Ghana: for example the Dutch WASH Alliance (Simavi, WASTE, RAIN Foundation, ICCO and AKVO), IRC Ghana and SNV.

Development partners: Multilateral organizations in Ghana cover various sectors and activities in the WASH sector: UNICEF, World Bank, African Development Bank, UN-Habitat and the WHO (World Health Organization).

Figure 23: Stakeholder group involvement—Roles and responsibilities for safe and sustainable integrated wastewater and faecal sludge management



INVOLVEMENT	
HIGH	Direct role
MEDIUM	Indirect role
LOW	Supporting role

Source: Compiled by CSE

Table 9: Roles and responsibilities for safe and sustainable integrated wastewater and faecal sludge management

Functionaries	Asset ownership	Function		
		Planning and construction Phase	Operation and maintenance phase	Regulatory
Households/ users	• IHHTs, OSS like septic tanks, twin pits etc. • Connection for grey water from HH to the sewer	• Express needs for the services • Nominate representative to the beneficiary group/committee • Electing district assembly members	• Correct usage • Tariff payment • Reposting faults	• Reporting malpractices during collection, conveyance and disposal
Beneficiary groups/ committee	• Shared/compound toilets, public toilets, OSS units like septic tanks, pits etc. • Connection for grey water from facility to the sewer	• Express interest and decide on measures for use of resources	• Proper handling of resources • Monitoring and reposting of quality	• Reporting malpractices during collection, conveyance and disposal
Sub-metropolitan, zonal/urban/ area councils	• Conveyance vehicles • Localized grey water conveyance and treatment units	• Formulate request for assistance • Participate in technology selection • Participate in fixing roles and responsibilities of the councils • Inform and consult the community/beneficiary group/ committee • Coordinate with the beneficiary groups/committee • Accept and assume the admin and financial responsibilities • Participate in contracting, supervision, commissioning • Take charge of the system	• System management including handling finances (e.g. tariff collection) • Administration, supervision, coordinating with contracting and supervising operator and consultant, dealing with users (e.g. securing proper usage) • Monitoring and reporting • Initiate complementary activities	• Reporting malpractices during collection, conveyance and disposal
Ministry of Water Resources and Sanitation (MSWR)	-	• Participation in zone selection • Consultation and support on request • Approval of major policy decisions • Approval of council area selection • Approval of benchmarks decision	• Support in all activities (on request) • Receiving information on performance of the system, but on active role in O&M	• Recommend the regulations to be adapted at the district level, in the faecal sludge by-law.
Metropolitan, Municipal and District Assemblies (MMDAs)	• Conveyance vehicles • Grey water collection and treatment infrastructure • Centralized treatment facilities	• Establish sanitation unit including suitable staff • Planning and management (monitoring, supervision etc.) of all activities dependent on capacities • Facilitation and enabling (capacity building) of entire project process • Support to and through partner to all stakeholder • Progress reposting (to donor agency) • Supervision • Provide required legal framework • Provide political support • Carry out project design including technology options, detailed planning, supervision etc. according to ToR • Supervision	• Monitoring and supervision propose amendments if required • Technical support on request to service providers • Organize meetings of stakeholders, awareness generation activities and facilitate operation and maintenance • Facilitate/support project partner in its role and responsibilities to achieve sustainable O&M system • Provide required capacity building • Advise on complementary activities. • Secure proper O&M • Encourage replication • Provide access to funding for replication. • Prepare O&M schedule and manuals • Provide technical assistance and trainings • Participate in monitoring of system	• Setting tariffs/user fees at the district level • Formulation of faecal sludge by-laws • Monitoring the private operators regarding the compliance of the by-laws. • District level monitoring for all the councils and committees • Project monitoring • Suggesting corrective measures, wherever necessary • Enable regulatory bodies to carry out the performance monitoring

Source: Compiled by CSE, 2019.

Besides the Netherlands, the following bilateral donors are also active in WASH: Canada, USAID, KOICA and JICA.

Private sector actors: Presently private actors in the WASH business are active mainly in engineering, design and construction of infrastructure (for water supply, drainage and wastewater), drilling of boreholes and waste management (Zoomlion is the biggest local waste management company). Other local companies are engaged in bottling of drinking water, including sales of sachet of water and the treatment of waste generated (Safi Sana).

The international comparative review of sanitation bodies revealed that no single agency has the mandate to carry out all the activities proposed by the MSWR. Therefore, it proposed that a national body should be formed in order to prioritize sanitation service delivery. This will be called the National Sanitation Authority (NSA). The authority will coordinate and manage the policies of the ministry, play a regulatory role in the sanitation industry and help strengthen the work of environmental health professionals. Following are the roles and responsibilities proposed for the NSA:

- Funding and capacity building of MMDAs to deliver faecal sludge service
- Take on a primarily regulatory role
- Coordinate and manage the policies of the ministry and help strengthen the work of environmental health departments
- Collaborate with assemblies to deal and help to implement the policies of the ministry and play a supervisory role in all activities that are related to FSM
- Periodic monitoring of activities

6.2 IEC and capacity building framework

The main challenge facing the sector is institutional strengthening and capacity enhancement. The strategies for capacity development in the short-term include institutional strengthening focused on the establishment of the Environmental Health and Sanitation Directorate (EHSD) to enable it effectively facilitate implementation of strategies by MMDAs.

Capacity-building and awareness activities should be undertaken on a regular basis for users, government bodies or private entrepreneur on various attributes of IWFM including appropriate design and technology, de-sludging of septic tanks, collection mechanism, transportation, disposal and the treatment of faecal sludge and wastewater.

Recirculate

Driving eco-innovation in Africa: capacity-building for a safe, circular water economy

Lancaster University and LU Ghana are working together along with African businesses and researchers to develop and deliver safe and sustainable water use.

Through a series of interactive workshops hosted by LU Ghana in Accra, Recirculate brings together researchers, businesses, and policy makers from different countries and a wide range of disciplines to facilitate knowledge exchange and engagement to really make a difference.

Lancaster University and LU Ghana are working together along with African businesses and researchers to develop and deliver safe and sustainable water use.

In addition to above regular handholding of the different levels of ULBs, staff should be trained on aspects of safe collection, treatment and disposal. Standard septic tank design, periodic inspection and de-sludging of faecal sludge, design of a decent facility, tender details for engaging licensed transporters, safety standards should be enabled.

It is important to undertake IEC activities for users and civil society organizations/representative like RWAs, community organizers, self-help groups and the general public, masons on matters related to health hazards associated with improper collection and treatment of waste, and the ill-effects of sewage discharge into fresh water/storm water drains etc. Local bodies should also be involved in the IEC and capacity building activities of private vendors on aspects like safety norms for proper collection and transportation of sewage including vehicle design, process of de-sludging, safety gears and safe disposal at the nearest treatment facility (see *Annexure 14: Regulations for FSM*).

Research institutions like CSIR should help in developing the capacity building programmes for relevant stakeholders and provide hand-holding support for implementation of model projects on water and wastewater management.

6.3 Regulatory framework

The local government authorities such as the Metropolitan, Municipal and District assemblies have a major role to play to ensure a policy and regulatory environment that enables sustainable planning and management for IWFSM towards an improved and environmental health.

At the national level, there are several key acts, rules and standards like the Local Government Act (Act 462), Community Water and Sanitation Agency Act 1998, National Environment Sanitation and Action Plan (NESSAP) 2010, Strategic Environment Sanitation Investment Plan (SESIP 2012), Environmental Protection Agency (EPA) Act, 1994 (Act 490)

In absence of any specific legal provisions related to wastewater and faecal sludge management, the MMDAs can be guided by CSIR, NSA and MoSWR to formulate their by-laws and rules for management of wastewater and faecal sludge in their domain. In addition, the Ministry of Local Government and Rural Development would need to review the building regulations to ensure proper construction of adequate on-site sanitation facilities, which in turn need to be disseminated to the construction industry and local masons. The by-laws and rules should address design, construction, operation and maintenance of sanitation systems along the entire sanitation value chain: methods of approval of building plans, or retro-fitting existing installations, tariffs for sanitation management, penalty clause for violation of rules, laws, regulations, issuance of permit/license to private operators providing services (see *Annexure 15: Regulation for FSM*).

Key points of this chapter

- To establish IWFM, the roles and responsibilities are fairly shared among households, local government, institution and ministry.
- A national body should be formed to prioritize sanitation service delivery.
- Capacity-building and awareness activities should be undertaken for users, government bodies, NGOs and private entities associated with sanitation activities.
- In absence of any specific legal provisions related to wastewater and faecal sludge management, the MMDAs can be guided by CSIR, NSA and MoSWR to formulate their by-laws and rules for management of wastewater and faecal sludge in their domain.

7. Financial framework

Mainstreaming IWFM when compared with conventional sanitation solutions is more cost effective. The infrastructure of IWFM is designed based on the current and near future demand unlike sophisticated conventional system which is designed for 30 years. Another major advantage of IWFM is that it requires low water supply of up to 70 LPCD unlike conventional system which requires minimum 100 LPCD.

7.1 Current scenario of funding for WASH projects in Ghana

According to a report by IMANI in 2014, sanitation investment in Ghana was less than 0.1 per cent of its Gross Domestic Product (GDP). In 2015, it went up to 0.2 per cent of GDP, which is still less than the 0.5 per cent of GDP that Ghana signed up to. According to an assessment done by CONIWAS, a coalition of CSOs in sanitation, a major concern is the difficulty in tracking how much of this already poor allocation has actually been spent in the field towards enabling access to improved sanitation.[42]

TrackFin, which Ghana has been implementing since 2014, provides indicative figures on public expenditure on sanitation. It estimates that domestic public expenditure on sanitation (excluding households) amounted to GH¢ 49 million (US $11.3 million) in 2014. By comparison, Ghana's commitment to the Sanitation and Water for All High Level Meeting was to allocate 0.5per cent of GDP (at least US $150 million per annum) to sanitation. The bulk of national expenditure (US $466 million) came from households, mostly for expenditure on pay-per-use public toilet facilities.[43]

The budgetary allocation to the sector between 2014 and 2018 showed an average GH¢ 255.8 million annually, while the actual release over the period had been consistently less than 50 per cent. In this period, budgetary allocation increased marginally from GH¢ 239.9 million in 2014 to GH¢ 294.4 million and GH¢ 305.7 million in 2015 and 2016 respectively. This was, however, reduced considerably to GH¢ 255.5 million in 2017 and further down to GH¢ 183.6 million in 2018.[44]

The budgetary allocation to the sanitation sector must be increased significantly over a sustained period. It should be in line with the eThekwini declaration of up to 0.5 per cent of the GDP for basic sanitation and hygiene and the international commitments in the Sanitation and Water for All (SWA).

Under the Open Defecation-Free (ODF) agenda of constructing one million household toilets, an estimated 30,000 had been completed in 2018, out of 200,000 target. In addition to that a Corporate Ghana support for ODF have raised funds for 100,000 toilets.

In recent years, donor funding for urban sanitation has increased. The World Bank is supporting the Government of Ghana to implement a sanitation project (with a faecal sludge management component) for low-income areas of Accra. The Dutch Embassy is also supporting several urban sanitation projects. Most donor-funded interventions have so far focused on large cities with population of over 200,000. In line with Ghana's policy, recent programmes give prominence to private-sector participation. However, donors are testing multiple and sometimes conflicting approaches. For example, the World Bank and the Dutch Embassy are supporting the provision of both indirect and direct subsidies to households, while other donors are relying on solely software approaches, such as urban CLTS.

The Greater Accra Sustainable Sanitation and Livelihoods Improvement project aims to increase access to safe and sustainable sanitation to residents of the Greater Accra Metropolitan Area (GAMA) by targeting the urban and peri-urban poor residents. The project provides domestic- and municipal-level sanitation infrastructure, supports skill development and livelihood improvement, and enhances the capacity of sanitation service providers and the participating local government authorities to better deliver and manage climate resilient sanitation services within GAMA. The Project is estimated to cost US $53.86 million, of which the African Development Fund contribution is US $48.85 million and the remaining US $5.01 million are Government of Ghana and beneficiary contributions. The expected duration of the project is five years starting from 2017.[45]

The World Bank had declared the progress of implementation of the project satisfactory—the Ministry and the Community Participation Unit (CPU) have increased the number of household toilets by more than 9,300, representing a 750 per cent increase, and started household water connections in low-income communities. The World Bank has approved two International Development Association credits of $85.7 million for the Secondary Education Improvement Project (SEIP) and the Sustainable Rural Water and Sanitation Project (SRWSP).

A 6 million euro fund aimed at providing increased access to finance for micro, small and medium enterprises (MSMEs) in households across the country to address water, sanitation and hygiene problems, has been launched in Accra. The revolving fund—called Catalysing WASH from Possible to Profitable (P2P)—initiated by SNV in collaboration with Fidelity, is one of the largest financial facilities developed towards the management of water, sanitation and hygiene (WASH) issues. The project is meant to help households and SMEs to address financial gaps in the development and provision of water and sanitation facilities. Among other things, loans will be disbursed to over 3,000 households and MSMEs over a five-year period. In addition, over 500 MSMEs in the WASH sector will benefit from pre- and post-loan business support to facilitate loan acquisition and repayment.[46] The fund, launched under the theme 'P2P: Creating Access to Finance and Technical Assistance', is expected to serve as a model for a finance and private sector driven approach to water and sanitation in Ghana.[47]

Sanitation has been at the bottom of the government's priorities, whether at national level or local level. Perhaps this lack of prioritization (and therefore inadequate funding) mirrors insufficient demand among urban residents for improved services, partly due to an entrenched reliance on and acceptance of public toilets. A major hurdle to overcome is the high cost of improved facilities (toilet superstructure + septic tank) in urban areas, which ranges from US $230 to US $1,000 depending on the technology. However, alternative, cost-effective and decentralized solutions still need to be encouraged by policy makers. More research on demand factors is needed to inform policy going forward, including investment costs, the role of women and vulnerable groups in influencing decisions, and the potential of innovative low-costs solutions.

Sanitation has not been a public funding priority and households bear the bulk of the costs. Currently, majority of the fund is pumped into solid waste management projects and providing access to toilets, whereas the funds allocated for liquid waste management is underutilized.[48] This may be due to various reasons like lack of technical and human resource capacity and financial resources. This guideline suggests non-conventional approaches which can be sustainable and financially viable solutions to achieve the goal of SDG.

7.2 Financial framework—The viability and sustainability instrument

The financing framework goes hand-in-hand with the procurement framework, wherein both should take into account the sustainability of the wastewater and faecal sludge management project for all stakeholders. The framework is set by the detailed assessment of three critical and interrelated aspects:

Risk assessment and management—A detailed risk assessment is critical to define the financial and procurement framework. The risk assessment and its management should lay the foundation of the responsibility sharing between stakeholders involved. Refer to National Policy on public–private partnership for improving PPP decision making processes, Ministry of Finance and Economic Planning, Government of Ghana for more details on risk assessment and management.[49]

Investment costs and financial structure—Non-conventional wastewater and faecal sludge treatment projects incur a less to moderate capital investment that should be contributed by all the stakeholders in order to ensure the sustainable burden on all. Detailed financial modelling and sensitivities shall be carried out to see the impact of various financial structures on the affordability of the tariffs that shall be the most defining parameter for the financial structuring of the projects. Before arriving at investment cost and financial structure for the project, detailed assessment of the following parameters is recommended:

- Initial CAPEX—Investment for infrastructure establishment like procurement of gap filing vacuum tankers required for respective MMDAs, construction of treatment plants, connection to households etc. is the key component of investment costs. It is used as baseline cost or initial CAPEX for financial structuring. Initial CAPEX further constitutes of respective department share and private operator share. Ministry of Sanitation and Water Resources in collaboration with World Bank is the key funding agency that can provide a share grant to the project for implementation of IWFM projects by MMDAs. Also, MMDAs can take a concessional loan from any state financial institution.
- Replacement Investment—Investments made for replacement of plant and machinery, vehicles etc. at the end of their economic lives. These aren't loaded on the initial CAPEX but are generally considered as O&M expense of the private operator.
- Incremental Investments—Investments made in setting up infrastructure, plant & machinery, vehicles etc. due to increased demand over the project life. These are considered as incremental investments over the project life and hence have no bearing on the initial CAPEX.

Recovery of O&M cost—While MMDAs are obligated to provide quality services to the users, the modality of providing services—by themselves or through PPP—will have an impact on the O&M cost incurred by the ULBs. For the recovery of O&M cost, payment of tariffs to private operator, the principle of 'water user pays' and 'polluter pays' can be established.

Cost-recovery mechanisms

Full public funding of IWFM will lead to severe stress on the Ministry and MMDAs. This will also engender a lack of accountability and responsibility among the MMDAs to generate revenue for faecal sludge/sewage management. This is possible through increased taxation and private participation. Apart from levying direct user charges on citizens for wastewater management services, sanitation tax/charge as surcharge on property tax under the Municipalities Act could also be levied. Periodic revisions of taxes, sale of treated faecal sludge for agriculture or other purposes are some ways of mobilizing adequate fund for the O&M.

Investment options for infrastructure

Sanitation improvements are generally dependent on a mix of government funding, external assistance and increased user charges to meet the capital as well as O&M expenditure. One of the major sources of public funding for the sanitation programme can be various programs and schemes, used to create a database for toilets and septic tanks, procurement of vacuum tankers and construction of faecal sludge treatment facilities and such other components. Further, funds are available to the MMDAs for planning & preparation of feasibility reports/DPRs, etc., and conducting IEC activities under various government schemes and programmes.

There is a need to ring-fence the usage of funds, ensure scalability in fund usage and leverage on additional source of funds, to ensure good accountability and transparency of fund usage to finally provide quality services to the citizens. (see *Annexure 16: Strategies to fill gap between investments and quality of services*).

Considering the current situation, most MMDAs might not develop and operate capital-intensive conventional, engineered wastewater treatment projects on a *suo moto* basis as they lack the technical knowhow, financial resources and human resources required to implement these projects. Therefore, engaging a private operator via any outsourcing model is viable option to leverage on their technical capacity and financial capability.

7.3 Procurement framework—the efficiency and sustainability instrument

To address the gap between the current and optimum levels of sanitation management services, various procurement strategies can be adopted. These procurement strategies should be framed for meeting the ultimate objective of providing quality, sustainable and economical urban services to citizens.

Conventional approach—This has been the traditional method followed by municipalities for procuring the equipment, machinery, and vehicles by themselves. However, sanitation being a technology and O&M intensive business, ULBs lack the technical and operational capacity and hence fail to provide quality services on a day to day basis, resulting in a loss of initial investments made.

Functional privatization—Most prevalent PPPs fall under this structure. A private operator is engaged through a permutation of any of the key responsibilities—design, building, finance, operations and own—for a certain period, with the transfer of assets to government happening at the end of the concession period.

Key procurement considerations

1. **Concession period—**This should be based on the economic lives of the infrastructure, technology, vehicles etc. The choice of concession period should ensure that the economic lives of infrastructure, technology, or vehicles is almost over to ensure that these have been utilized for their complete economic lives and that there is no legacy transfer of facilities to ULB or private operator, in-case a new private operator is engaged for provision of wastewater management services.

2. **Selection criteria—**The generally practised bidding criteria includes:
   a. Quality and cost-based selection (QCBS) wherein a great consideration is given to the technology and technical part of the private operator's bid. The bidding parameter is based on the mix of scores in technical bid and financial bids based on a stated formula in RfP. The private operator with the highest score is awarded the project even when his financial bid isn't the lowest. This model is generally applied to technology-intensive projects.
   b. Least-cost selection (LCS) wherein a consideration is given to the price discovery and no consideration is given to the technology and technical part of the bid. This model is generally applied in projects where technology and processes are quite standardized and cost recovery is the only objective. For instance, in nature-based wastewater and faecal sludge treatment, private operators with the minimum financial bid wins the project.
   c. Hybrid LCS wherein a key consideration is given to both technology and price recovery. A minimum bar in terms of scoring on technology and technical bid is kept and only those bids that meet the minimum score are considered for competing on financial bids. At this stage, the private operator with the minimum financial bid is awarded the project

3. **Bidding parameter—**The choice of bidding parameter is depended on two key factors—CAPEX/O&M nature of the project and then on whether the demand risk is transferred to the private operator or not.
   a. Traditionally VGF has been used as bidding parameter in PPP projects but considering the O&M intensive and long-term nature of waste water projects, VGF as bidding parameter fails to serve the purpose. VGF is apt as a bidding parameter for road sector or civil infrastructure construction which are CAPEX intensive and minimal O&M. Hence, a performance based bidding parameter should be used for wastewater and FSM related projects.
   b. Further, the choice between the annuity model (annual payment) and a quantity linked model is dependent on demand risk transfer between private operator and ULB.
      I. In annuity model, a fixed payment is given to the private operator and the ULB takes the demand risk
      ii. In quantity linked bidding parameter (such as tipping fee) can be linked to either input quantity of waste water or output quantity of treated waste water.

Generally, quantity-linked bidding and a payment parameter brings in more transparency and accountability on behalf of private operator and also allows the private operators to leverage on their O&M strength as well as focus on sustainable technological solutions.

7.4 Alignment of gender inclusion and budget with sanitation service delivery

Gender budgeting and earmarking of adequate funds: preparation of budgets using a gender budgeting approach, shall be institutionalized at MMDAs. The ministry shall facilitate this process by ensuring that the state's fiscal policies and administrative procedures are structured such that the address the specific needs of women, girls, transgender and physically disabled and result in maternal, child and adolescent health indicators along with addressing gender inequality.

Key points of this chapter

- The domestic public expenditure on sanitation is supposed to be 0.5 per cent of the GDP but Ghana was able to spent only 7.5 per cent of allocated budget.
- The World Bank and the Dutch Embassy are supporting several urban sanitation projects by providing direct and indirect subsidies to households.
- The majority of funds is pumped into solid waste management projects and providing access to toilets, whereas the funds allocated for liquid waste management is underutilized.
- A hybrid least-cost selection model can be considered for financial bidding.

8 The way forward

The IWFM guidelines is a technical document that will help Metropolitan, Municipal and District Assemblies in Ghana to develop guidelines and implement the District Environmental Sanitation Strategy and Action Plan (DESSAP). DESSAP is to be prepared by district-level actors (Waste Management Department, Town Planning Department, Community Water and Sanitation Authority etc.) facilitated by regional-level actors, which feed into the national-level NESSAP.

The format of DESSAP only helps in understanding the gaps in sanitation provision and ends up projects being proposed in an ad hoc manner. For example, FSTPs have come up at various locations in Ghana without the demand for emptying being evaluated or liquid waste of the target area being taken care of.

There is a lack of guidelines document owned by local government that can help the practitioners to plan and implement faecal sludge and wastewater management. The IWFM guidelines is proposed to fill this gap. It will act as a bridge between action plans proposed under DESSAP and the implementation of projects on the ground. It will also provide direction to practitioners to plan and implement projects that are low cost, nature based, equitable and sustainable.

CSIR and CSE have taken the initiative to work in this area. They have agreed to conduct joint research to improve and strengthen sanitation in Ghana as a part of technical and advisory support. CSE and CSIR will support associated institutions in planning, designing and implementing model projects to showcase effective and affordable faecal sludge and decentralized wastewater treatment for local reuse. CSE will help strengthen CSIR (and associated institutions) staff's technical capacities by conducting training, workshops, consultation and meetings on water management, wastewater technologies and faecal sludge management.

A consultation workshop will be conducted, where this draft document will be reviewed by relevant stakeholders. The feedback of participants will be recorded and relevant suggestions will be incorporated to finalize the document.

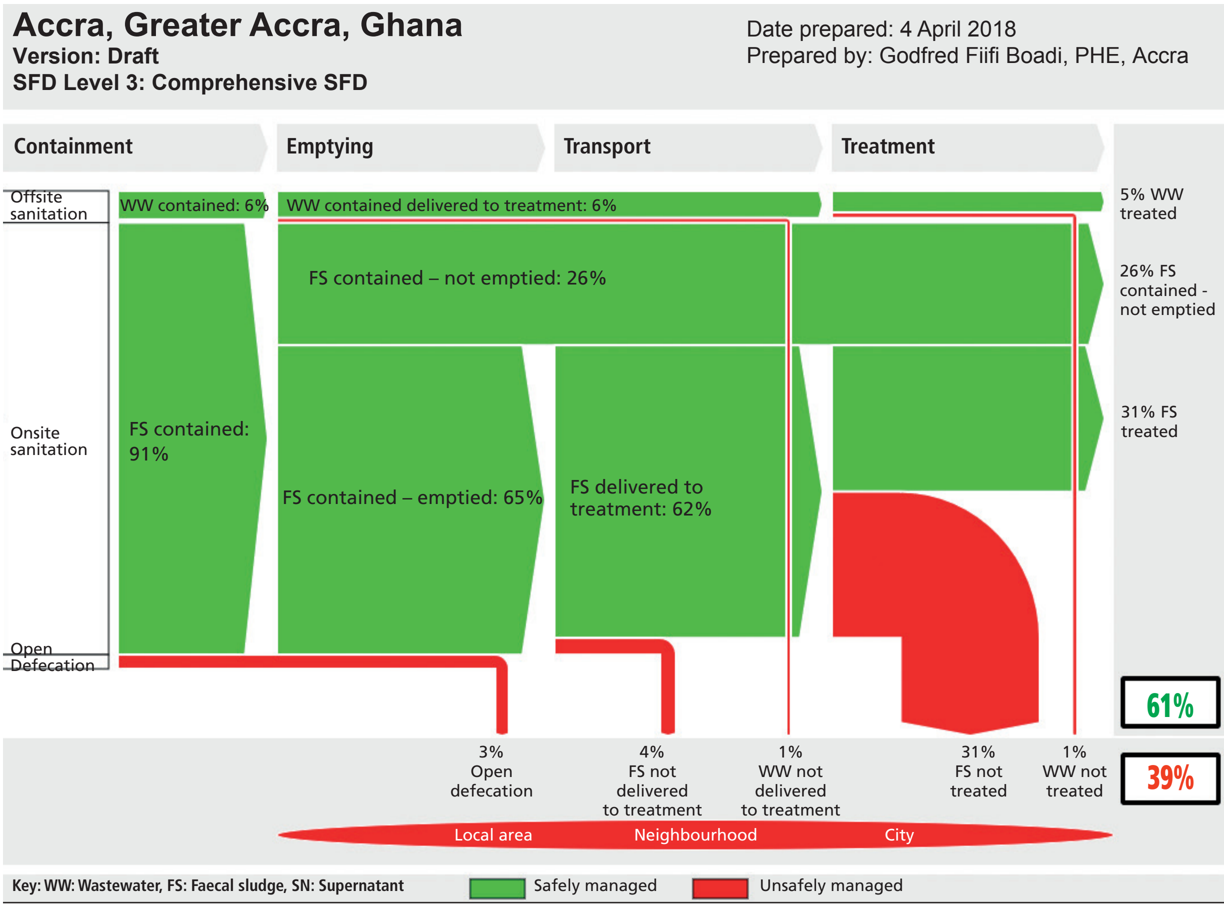
Table 10: Tentative list of organizations for workshop

Organization
Representatives from CSIR –IIR, Water and Policy research
Ministry of Sanitation and Water Resources
Environment Health and Safety Department
Community Water and Sanitation Agency
Environmental Protection Agency
IRC Ghana
World Bank
KNUST
Tema Metropolitan Assembly
Ga Municipal Corp.
Sewerage System Ghana Limited
Private company Zoomilion

Annexures

Annexure 1: Shit Flow Diagrams of three metropolitan assemblies

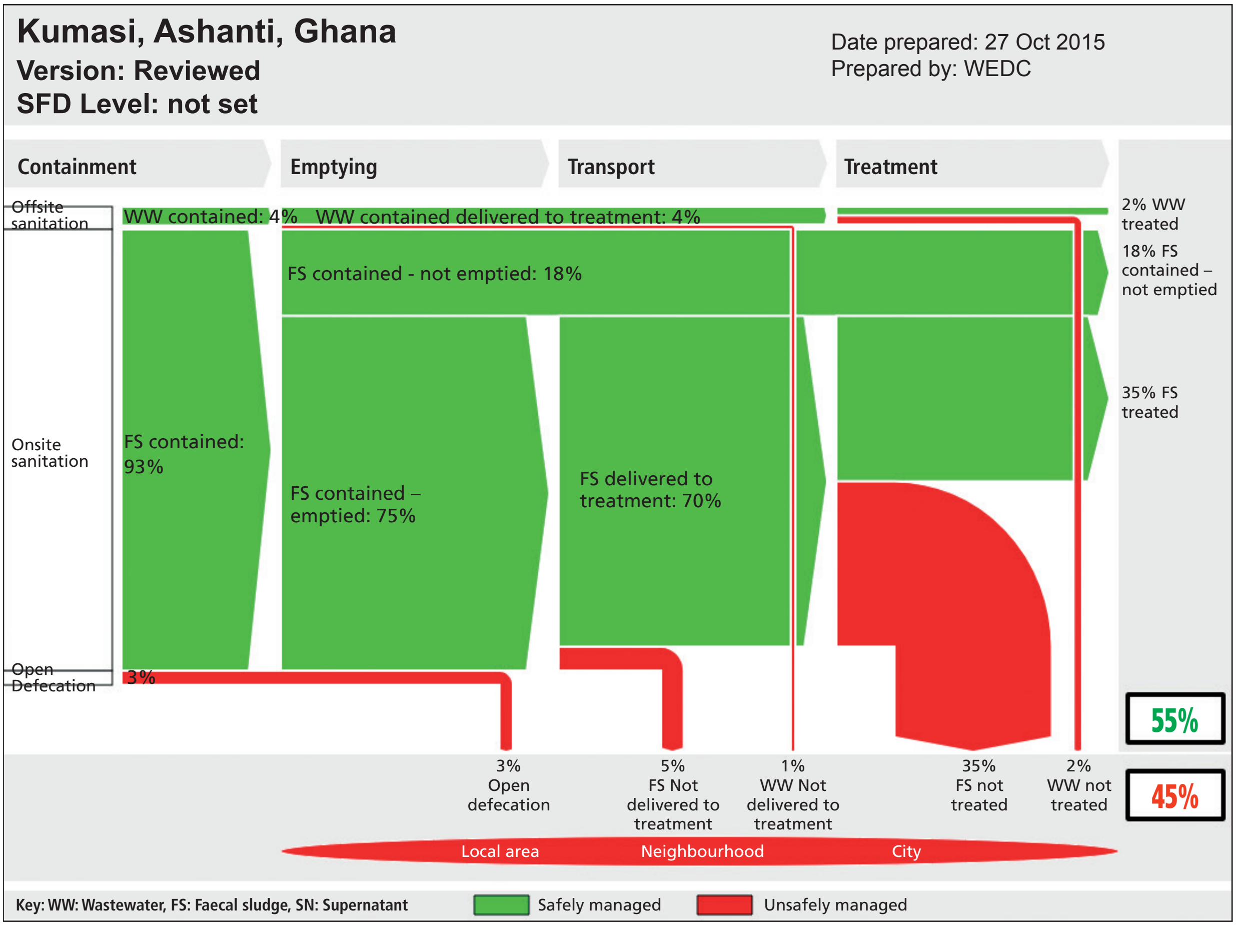
a) Draft SFD Graphic of Greater Accra



Source: Godfred Fiifi Boadi

The SFD graphic of Accra represents that 6 per cent of the population is connected to the sewer network. The treatment plants are able to treat wastewater of 5 per cent of the population. Of 91 per cent of the population dependent on OSS, 65 per cent's excreta generated in city is emptied safely. However, only 31 per cent of the FS is treated at the treatment facility while the remaining is discharged untreated—26 per cent of the FS is not emptied and remains in OSS and 4 per cent of the population defecates in open. Overall, excreta of only 61 per cent of population in city is safely managed.

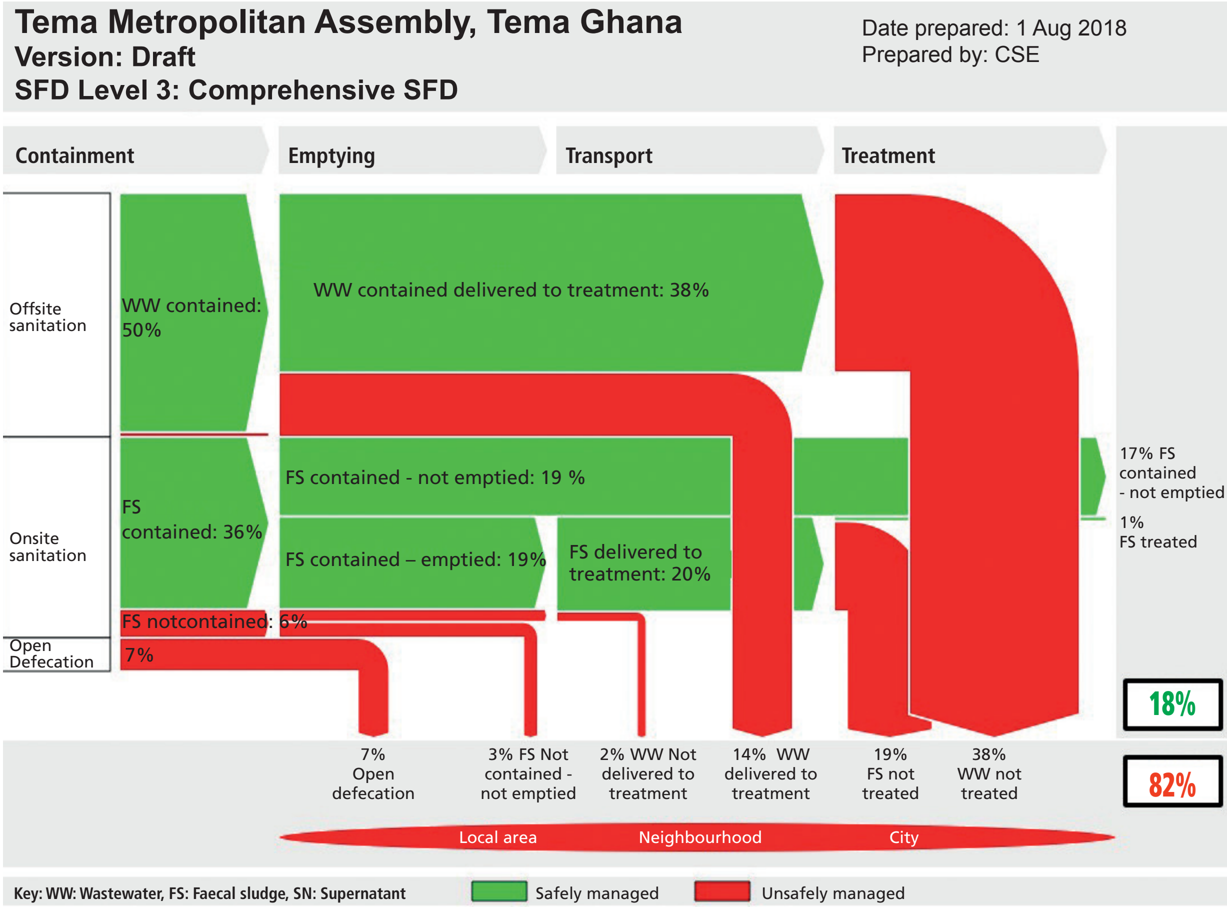
b) Draft SFD Graphic of Kumasi city



Source: SuSanA

About 4 per cent of the population is connected to sewer network. The treatment plants receiving wastewater from these connections treat half of it. About 93 per cent of the population is dependent on Onsite Sanitation Systems (OSS). Faecal sludge generated from 75 per cent of the population is emptied safely. However, only 35 per cent gets treated at the treatment facility while the remaining is discharged untreated; 18 per cent of the FS is not emptied and remains in OSS. The remaining 3 per cent of the population defecates in open. Overall, excreta of only 55 per cent of population is safely managed.

c) Draft SFD Graphic of Tema Metropolitan Assembly



Source: SuSanA

Fifty per cent of the population is connected to a sewer network. Wastewater of 38 per cent of the population is delivered to the treatment facility but it is discharged without any treatment directly into sea. Forty-two per cent of the population is dependent on OSS of which faecal sludge of 19 per cent population is emptied safely and transported to treatment plants. However, only 1 per cent of the FS is treated at the treatment facility while the remaining is discharged untreated. Seventeen per cent of the population doesn't get their containment systems emptied; 7 per cent of the population defecates in open. Overall, excreta generated from 18 per cent of the population is safely managed.

According to a World Bank report, 53 per cent of the population of the country is urban population.[50] The population of three major cities Accra, Kumasi and Tema represents around 30 per cent of Ghana's urban population. Excreta of 16 per cent of the population (combined population of three major cities) is safely managed. The remaining 84 per cent population's excreta is unsafely managed. Combining the sanitation status of these three assemblies, it is concluded that faecal sludge of almost 70 per cent of the population dependent on OSS is emptied and transported to treatment facilities or earmarked disposal sites, but due to inoperative condition of many facilities, the collected FS does not get treated. Resulting in FS of 55 per cent of the population dependent on OSS getting discharged untreated into the environment. The remaining 30 per cent either remains in the containment or does not get delivered to the earmarked site.

Annexure 2: Inventorization of STPs in Greater Accra region

Sl. No.	STP	Type of STP	Condition	Installed Capacity (m3/ day)
1	Southern Fried Chicken	Biodigester	Functioning*	Unknown
2	West Hills Mall	Aerobic	Functioning*	250
3	Septage Treatment Facility	Stabilisation Pond	Malfunctioning	200
4	Tema Sewage Treatment Plant	Stabilisation Pond	Abandoned	Unknown
5	Ghana Airport Company Ltd	Activated Sludge	Functioning*	1,000
6	Golden Tulip Accra	Aerobic	Functioning*	80
7	Accra Mall	Aerobic	Functioning*	120
8	Legon Sewage Treament Plant	Stabilisation Pond	Functioning	6,400
9	Jamestown Treatment Plant, Mudor	Trickling/Filter Oxidation	Malfunctioning	18,000
10	La Palm Royal Beach Hotel	Activated Sludge	Functioning*	Unknown
11	Labadi Beach Hotel	Activated Sludge	Functioning*	Unknown
12	Fiesta Royale Hotel	Biodigester	Functioning*	1.7
13	African Regent Hotel	Biodigester	Functioning*	20
14	Kofi Annan International Peacekeeping Training Centre (KAIPTC)	Biokube	Functioning	75
15	Ghana International Trade Fair Centre	Activated Sludge	Malfunctioning	Unknown
16	37 Military Hospital	Activated Sludge	Functioning*	1,000
1 7	Accra Psychiatric Hospital	Biodigester	Malfunctioning	Unknown
18	Korle-Bu Teaching Hospital	Activated Sludge	Abandoned	Unknown
19	Lavender Hills	UASB	Functioning	2,000
20	Mudor Treatment Plant	UASB	Functioning	18,000
21	Kotoku Treatment Plant	UASB	Functioning	1,000

Source: Inventorization of STPs in Greater Accra region EPA, Ghana 2015.

Annexure 3: N'gor Declaration

African regional commitments: The Ngor Declaration

Developed by African Ministers responsible for Sanitation and Hygiene at AfricanSan 4, Senegal in May, 2015 - **Vision: Achieve universal access to adequate and sustainable sanitation and hygiene services and eliminate open defecation by 2030.**

To realise the vision, governments commit to:

1. Focus on the poorest, most marginalised and unserved aimed at progressively eliminating inequalities in access and use and implement national and local strategies with an emphasis on equity and sustainability.
2. Mobilise support and resources at the highest political level for sanitation and hygiene to disproportionately prioritise sanitation and hygiene in national development plans.
3. Establish and track sanitation and hygiene budget lines that consistently increase annually to reach a minimum of 0.5% GDP by 2020.
4. Ensure strong leadership and coordination at all levels to build and sustain governance for sanitation and hygiene across sectors especially water, health, nutrition, education, gender and the environment.
5. Develop and fund strategies to bridge the sanitation and hygiene human resource capacity gap at all levels.
6. Ensure inclusive, safely-managed sanitation services and functional hand-washing facilities in public institutions and spaces.
7. Progressively eliminate untreated waste, encouraging its productive use.
8. Enable and engage the private sector in developing innovative sanitation and hygiene products and services especially for the marginalised and unserved.
9. Establish government-led monitoring, reporting, evaluation, learning and review systems.
10. Enable continued active engagement with AMCOW's AfricaSan process.

We further call on:

- **All people living in Africa**, especially the youth, to utilise and maintain sanitation and hygiene services with propriety and dignity.
- **African Ministers' Council on Water (AMCOW)** to prioritise and facilitate adequate resourcing for sanitation and hygiene by mobilising dedicated, substantive new sources of financing.
- **AMCOW** to facilitate the establishment and management of systems and processes for performance monitoring and accountability against the Ngor Declaration.
- **Training institutions** in Africa to strengthen local capacity to deliver appropriate services in line with demand.
- **Research institutions in Africa** to strengthen the evidence base and develop innovative locally appropriate solutions.
- **Civil society** in Africa to forge a cohesive, coherent and transparent vision and strategy to work with all stakeholders to achieve the Ngor declaration.
- **Traditional institutions, religious leaders and faith based organisations** to strongly support equitable sanitation and hygiene activities in their communities.
- **The private sector** to increase its engagement in the entire sanitation and hygiene value chain to improve innovation and efficiency.
- **Development banks, donors and partners** to increase their support to government led efforts for universal access to sanitation and hygiene and to match this financial support with responsible and accountable engagement.

Annexure 4: Key determinants for IWFM

Key determinants	Defining elements	Rural area	Township	Urban area
Settlement based	Community size	Less than 10,000	10,000–50,000	More than 50,000
	Population density (persons per hectare)	Less than 100	100–200	More than 200
	Water supply service	Well, hand-pump	Public stand post and house connection	House connection
	Water consumption (lpcd)	Less than 50	50–100	More than 100
	Sewage generation (m^3/hectare/day)	Less than 5	5–20	More than 20
	Treatment/technology options	Dry on-site sanitation system like KVIPs or composting latrines, Bio-digester toilets or Eco San toilets This aspect is also dependent on physiography of the settlement.	On-site sanitation (Pit or septic tank connected to soak pit); if groundwater pollution risk is low and water consumption is through piped water supply only In case of high risk of groundwater contamination Small bore sewerage system and FSSM or Simplified sewerage and decentralized STP	Centralized sewerage system Pocket-wise solid-free sewer and decentralized wastewater treatment plant for grey water and supernatant; and FSTP for faecal sludge
Physiography based	Soil type	If the soil permeability is low it may not be enough to accommodate the effluent flow rate from on-site sanitation systems and effluent will flow to the ground level. In this case off-site sanitation needs to be considered Laying of conventional sewers in rocky topography is technically challenging and adds to significant escalation in construction cost		
	Topography altitude terrain	Influence the construction techniques and cost: In areas of rocky ground, deep trenches for conventional sewerage is difficult and costly affair. But non-conventional sewers can be laid at shallow depths (40cm) Influence technology options due to altitudes: Based on the altitude the treatment technological process and methods are modified.		
	Risk of groundwater contamination	On-site sanitation facilities may cause groundwater contamination where there is an inadequate separation between the facility and the groundwater table: if depth of unsaturated zone is less than 2 metres and the hydraulic load exceeds 50 mm per day, groundwater contamination may occur. This is especially important if shallow wells for potable supplies exist within a distance of 10 times the horizontal groundwater flow velocity. If this is the case, advanced on-site treatment or off-site treatment should be applied. However, if unsaturated zone beneath the facilities is greater than 2 metres, and the hydraulic loading does not exceed 50 mm/day, the risk is minimized. If the above information is not easily available then the risk of groundwater contamination can be substantially estimated from the link below. https://sfd.susana.org/risk-groundwater		
Existing and required infrastructure	Asset ownership	If a community already has well designed and fully functional septic tanks or fully lined tanks, and the soil can no longer accept the septic tank effluent—resulting in a need to centrally collect the effluent, then settled sewerage is more likely to be cheaper than simplified sewer.		
	Land availability	Availability of land is a municipal subject for construction of infrastructure. Whether the private land would be available for laying of simplified sewer becomes the subject of community acceptance along with maintenance of the sewer.		

	Cost of systems and affordability of the target community	The target community's ability to afford the wastewater and faecal sludge management system is an important factor in selecting a strategy. Any long-term policy to provide a service must be based on expected revenue that can be generated. It is normally accepted that a family should pay no more than 2 per cent of its income on sanitation. It should be noted, however, that a community's ability to pay is not the same as its willingness to pay. In communities where sewerage is a high priority, there may be a willingness to contribute a higher percentage of income than 2 per cent, and vice versa. It may be advised to first address communities with known abilities and willingness to pay the tariffs.
	Social considerations and institutional capacity	Institutional capacity and the availability of skilled labour and management, is an important factor to consider. Wastewater and faecal sludge schemes are implemented, operated and maintained by institutions. Often an institution exists before the implementation of a new scheme and it is expected to carry out the task. The availability of skilled labour to operate the scheme should be considered. In case of community based systems, low-maintenance and low-tech solutions should be considered as they are more tolerable to operation and management breakdown.

Source: Compiled by CSE, 2019.

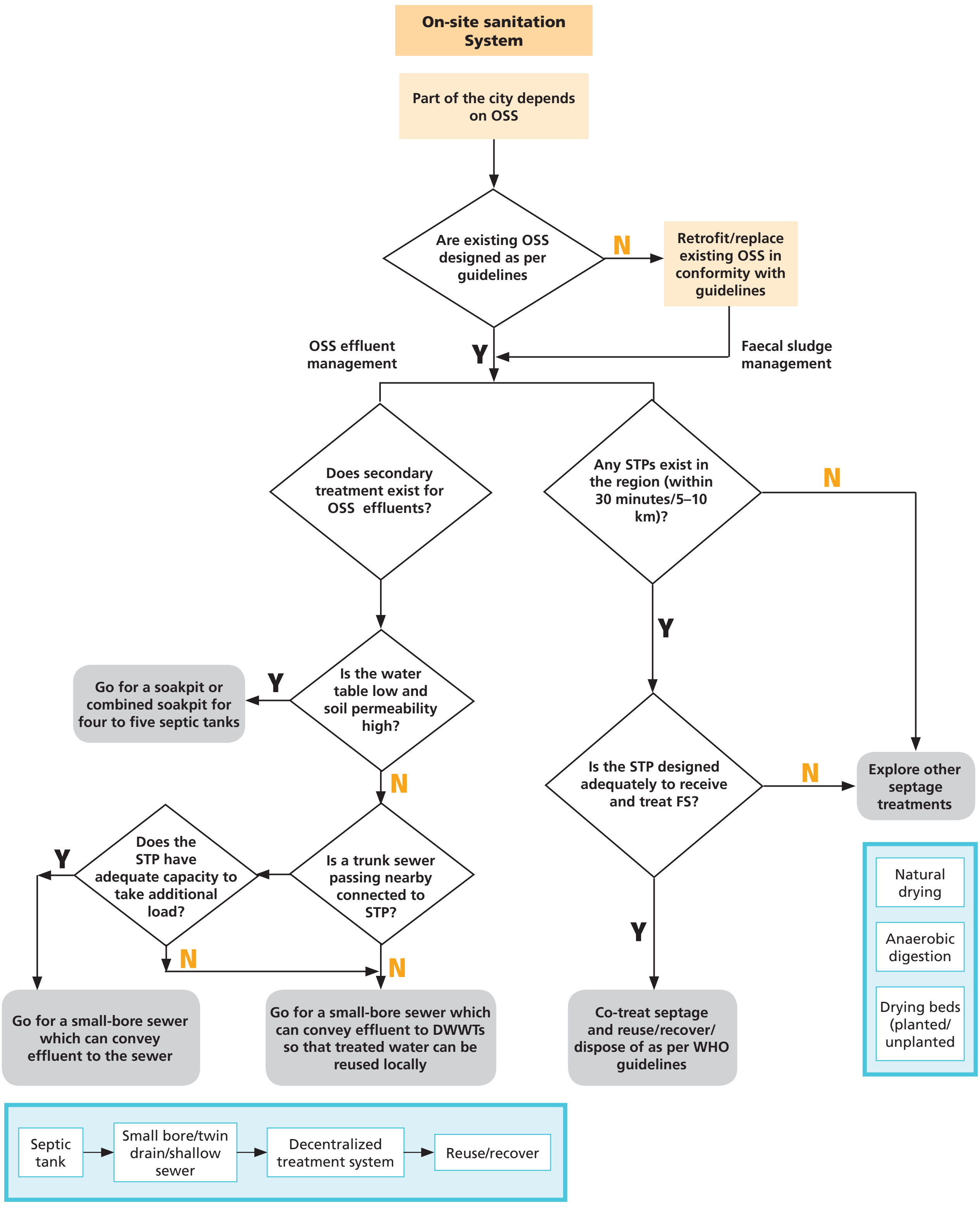
Annexure 5: List of stakeholders

Name	Designation	Organization	Phone No
Dr Francis	Director	CSIR-IIR	aboffour@hotmail.com
Solomon Noi	Chief engineer	Tema Municipal Assembly	solomonnoi@yahoo.co.uk
Dominic	Public health officer	Ga Central Municipal Assembly	stlithiym21@yahoo.com
Esther	Principal technologist	CSIR—IIR	eagyabengfofie@yahoo.com
Florence	General manager	Sewerage System Ghana Limited	fcobold@seweragesystems.com
Felix S. Danquah	Shit supervisor	Sewerage System Ghana Limited	fsdanquah@seweragesystems.com
Eric Nartey		IWMI	E.Nartey@cgiar.org
Mawgli Doali	Principal technical officer	CSIR—IIR	mawgli2002@gmail.com
Collins Tay	Acting director	CSIR—Environment Chemistry and Sanitation Engineering	7055519618
Esi Awuah	Professor	University of Energy And Natural Resources	esiawuahrt@gmail.com
Henreitta Osei-tu tu	Advisor	Ministry of Water Resources	henriettaot@gmail.com
Larbi Reuben	PhD Scholar	Lancaster University	r.larbi@lancaster.ac.uk

Source: Compiled by CSE, 2018.

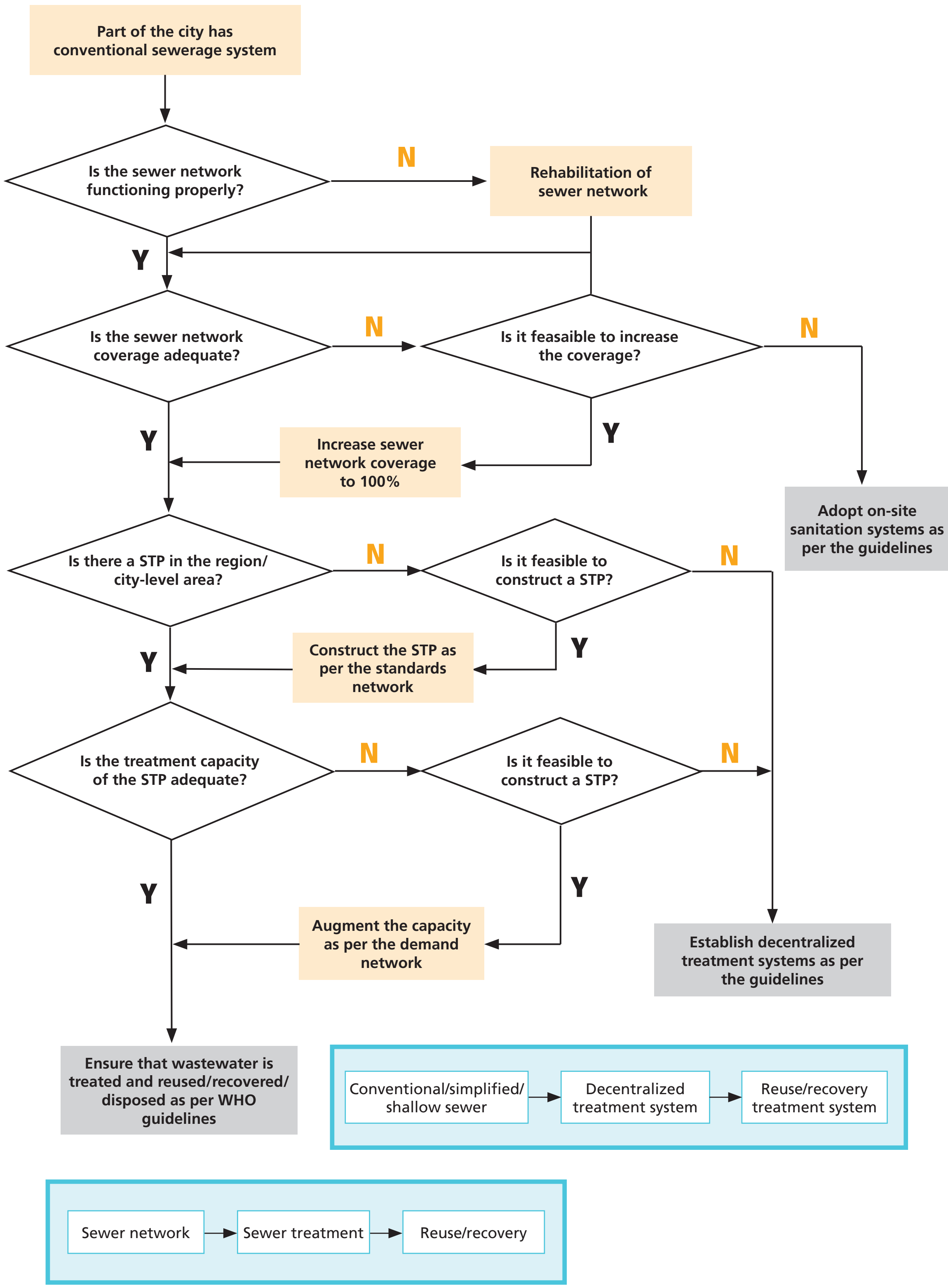
Annexure 6: Decision-making approach for sanitation systems

a. Approach for OSS



Source: Adapted from IWFM, 2018.

b. Approach for offsite sanitation system



Source: Adapted from IWFM, 2018

Annexure 7: Sample questionnaire for baseline data collection

Q. no	Question		Options
1	Form id		
2	Locality type	1	Slum
		2	Non-slum
3	What is the name of the locality?		Locality name
4	Ward no:	1	Number
5	Property number as per Council property tax records:	1	Number
6	Status of property during the survey	1	Open
		2	Locked
		3	Vacant
7	Type of property	1	Residential
		2	Institutional
		3	Commercial
		4	Mixed
8	Mark the house typology (only if 7 = Residential)	1	Bungalow
		2	Apartment
		3	Row house
		4	Wada
		5	Chawl
		6	Hut
		7	Others, specify
9	Select the type of Institution (only if 7 = Institutional)	1	Hospital
		2	Dispensary
		3	School/college
		4	Religious institutions
		5	Government office
		6	Others, specify
10	Select the type of commercial (only if 7 = Commercial)	1	Industry
		2	Shop
		3	Hotel/lodge
		4	Others, specify
11	Name of apartment/building:		
12	Number of blocks		Number
13	Name of the respondent/building secretary:	1	First name ________ Middle name ________ Last name ________
14	Contact no. of building secretary:	1	Number

15	How many flats are there in this apartment?	1	Number
		2	Don't know
16	How many toilets are there in this property?	1	Number
		2	Don't know
17	Number of flats that are occupied	1	
18	How many households are there on this property?		Number
19	Name of the respondent/Head of the Household	1	First name ______________________ Middle name ____________________ Last name _______________________
20	Pl provide a mobile Contact no. of head of the household	1	Number
21	What is the tenure status of this property?	1	Owner occupied
		2	Tenant occupied
22	Pl provide the name of the owner of this property:	1	Name
		2	Don't know
23	Pl provide a mobile contact no. of owner	1	Number
		2	Don't know
24	How many persons are there in this household (for commercial, approx. numbers of toilet users)?		Children (less than 6 years):_________, Other male: ____________ Other female: __________
25	Do you have your own toilet on your premises?	1	Yes
		2	No
26	Who constructed your toilet?	1	Self-finance
		2	Other (specify)
27	If no, where do you go?	1	Shared toilet
		2	Community toilet
		3	Public toilet
		4	Open defecation
		5	Other (specify)
28	What is the containment? (ST, P, T, NC, O)	1	Septic tank
		2	Pit latrine
		3	T-lined tank
		4	No containment
		5	Others

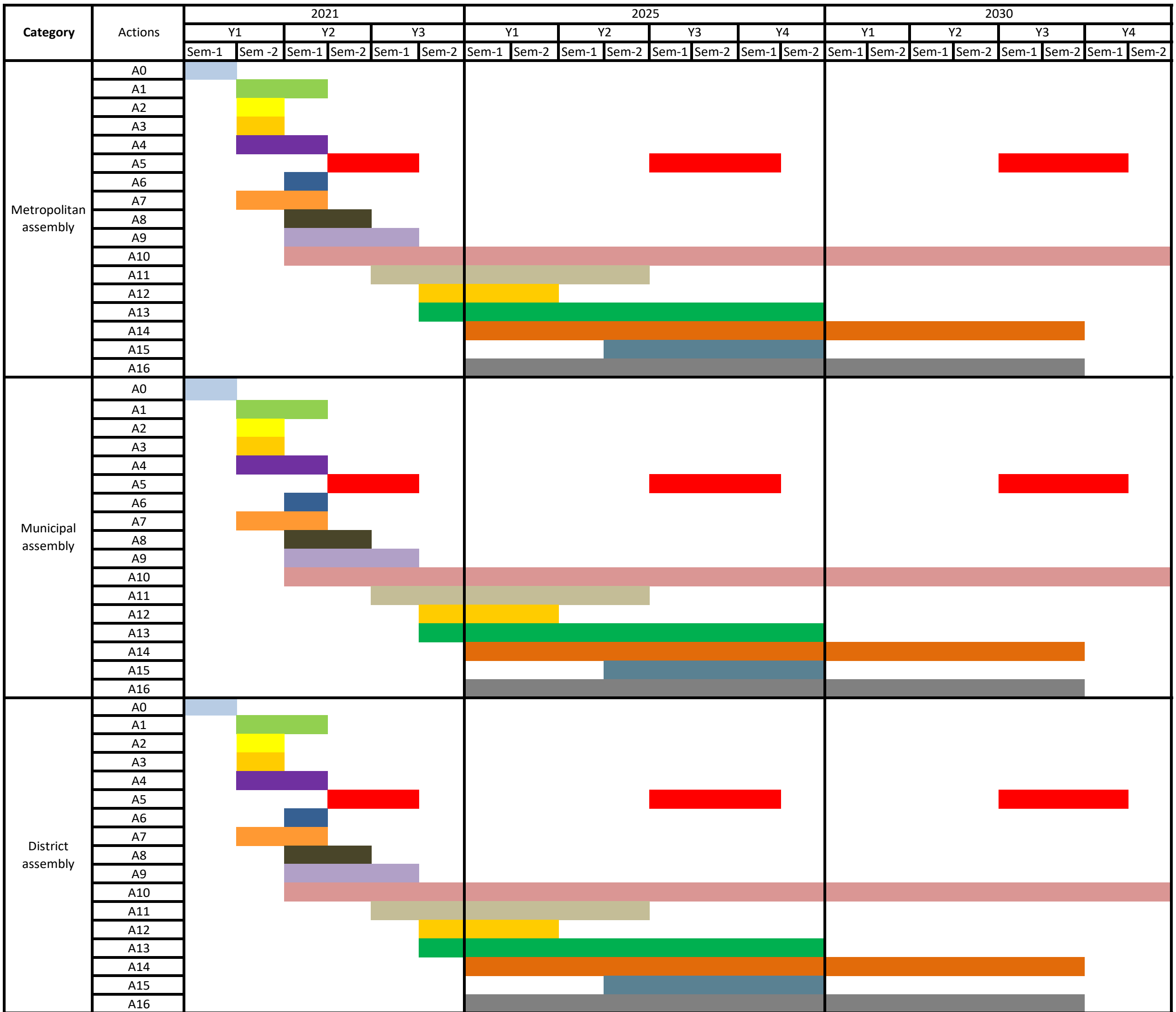
29	What is your own toilet connected to for disposal?	1	Sewer network
		2	Septic tank with soak pit
		3	Septic tank connected to open/closed drain
		4	Single pit
		5	Double pit
		6	Directly to open/closed drains
		7	Others, specify
30	If septic tank or pit, what are dimensions	1	No of chambers ___________
		2	Are four walls of tank plastered? (Y/N)
31	No. of septic tanks in the property	1	1
		2	2
		3	3
		4	Don't know
32	Type of septic tank	1	Individual
		2	Shared
33	This property shares septic tank with		
34	What is the shape of your septic tank	1	Rectangular
		2	Circular
		3	Don't Know
35	Provide dimensions (L relevant only if rectangular):	1	Don't know
		2	Length (ft.)
		3	Breadth/Diameter (ft.)
		4	Depth (ft.)
		5	Diameter, if applicable (ft.)
36	Are four walls of tank plastered?	1	Yes
		2	No
37	Is the bottom plastered?	1	Yes
		2	No
38	Septic tank outfall is connected to	1	Soak pit
		2	Open drain
		3	Covered drain
		4	Open land
		5	Others, specify
		6	Don't know
39	Where does the open drain terminate at?	1	Open ground
		2	Treatment plant
		3	Open field
		4	Others (specify)

40	When was the septic tank last emptied?	1	Last six months
		2	From 6 to 12 months
		3	12–24 months
		4	24–36 months
		5	More than 36 months
		6	Never emptied
		7	Don't know/remember
41	Why was the septic tank emptied?	1	Blocked toilet
		2	Overflow from access hole/manhole
		3	Smell
		4	Others, specify
		5	Don't know/remember
42	Emptying method of tank	1	Mechanically
		2	Manually
43	Were there any problems during emptying of septic tanks?	1	Access or distance for suction truck to house
		2	Break floor tiles to access septic tank
		3	Break concrete manhole to access septic tank
		4	Difficult to locate the septic tank
		5	Smell during emptying
		6	Made a mess
		7	No problem found
		8	Others, specify
		9	Don't know
44	Is the septic tank accessible from road for cleaning by using a suction emptier truck?	1	Yes
		2	No
45	Is there proper access with manholes/covers for any of the chamber of septic tank which can be easily opened?	1	Yes
		2	No
46	Charges of emptying		
47	Where is faecal sludge discharged after emptying?	1	Agricultural field
			Open ground
			Storm-water drain
			River
			Other (specify)
48	GPS Location ID		
49	Photlographs		

Source: Compiled by CSE, 2018

Annexure 8: Milestones and timeline to implement IWFM

Milestones and timeline



A0	Preparation of IWFM Guidelines
A1	Formation of Sanitation task force
A2	Baseline data collection and analysis
A3	Capacity building for service providers
A4	Permit and licensing to masons and emptiers
A5	Preparation of Integrated Wastewater and Faecal Sludge Management Plan into DESSAP
A6	Implementation of FSM charges included in the house tax
A7	Set up of call centre for OSS emptying service
A8	Identification of discharge sites for disposal of faecal sludge and prevent water supply source and network from being contaminated by wastewater, till the time proper treatment plant is in pl
A9	Adequate manpower and equipment for safe collection and transport of faecal sludge
A10	Capacity Building and IEC programmes for all the stakeholders
A11	Construction and operation of faecal sludge treatment facility with composting of dried sludge
A12	Preparation and Implementation of bye-laws identified during IWwFSM plan
A13	Operationalise DWWTs and reuse for the effluent generated from onsite sanitation systems at institutional level and commercial establishments
A14	Improvement of rudimentary OSS if existing any by subsidy for improved system
A15	Establishment of individual household or community level DWWTs
A16	All households with individual toilet in non sewered areas to have simplified sewer or small bore sewer system

Source: Compiled by CSE, 2018.

Annexure 9: Guidelines to constitute a sanitation task force (STF)

The Regional Collaborating Team as recommended in DESSAP can be reactivated as the sanitation task force or a new task force can be constituted with representatives from the following.

- Public bodies (as prescribed in the Handbook for preparation of DESSAP like Regional Environment Health Unit and District Planning Coordinating Unit)
- Private organizations (contractors, industries, hoteliers, etc.)
- Civil society organizations for in the fields of water and sanitation, urban development and slums, health and environment and gender
- Service providers (private emptiers, recycling agents, sanitary workers)
- Educational and cultural institutions (universities, schools, etc.)
- Community-based organizations (slum dwellers, Residential Welfare Associations, etc.)
- Media

The Mayor/Chairperson should be the head of the STF and the Chief or head of Waste Management Department the convener. At least one organization or expert working on women's issues needs to be included in STF to assure the inclusion of women's needs in the sanitation sector. The exact composition may vary from district to district according to size, existing institutions and focal areas.

The selection of stakeholders should be done according to following guiding questions:

- Who might benefit or be negatively affected (e.g. groups such as the poor, policy proponents such as environmental NGOs)?
- Who should be included because of their relevant formal position (e.g. government authority)?
- Who should be included because they have control over relevant resources (e.g. financial resources, technical expertise, and access to social groups)?

The task force should not comprise more than 15–20 members, in small and medium district assemblies the task force can function with a much smaller number of participants as well. Within the task force smaller working groups on focal areas can be formed to facilitate the task completion.

Source: ?????

Overall responsibilities for STF

- ✓ Providing overall guidance to the Sanitation Implementation Agency (SIA)
- ✓ Approving progress reports
- ✓ Approving of IWFM plans after consultation with citizens
- ✓ Supervise progress regularly
- ✓ Issue briefing about the progress to media & state government
- ✓ Launching the Sanitation Campaign
- ✓ Generating awareness amongst city's citizens and stakeholders
- ✓ Recommend MMDA to define roles and responsibilities for district-wide sanitation on a permanent basis

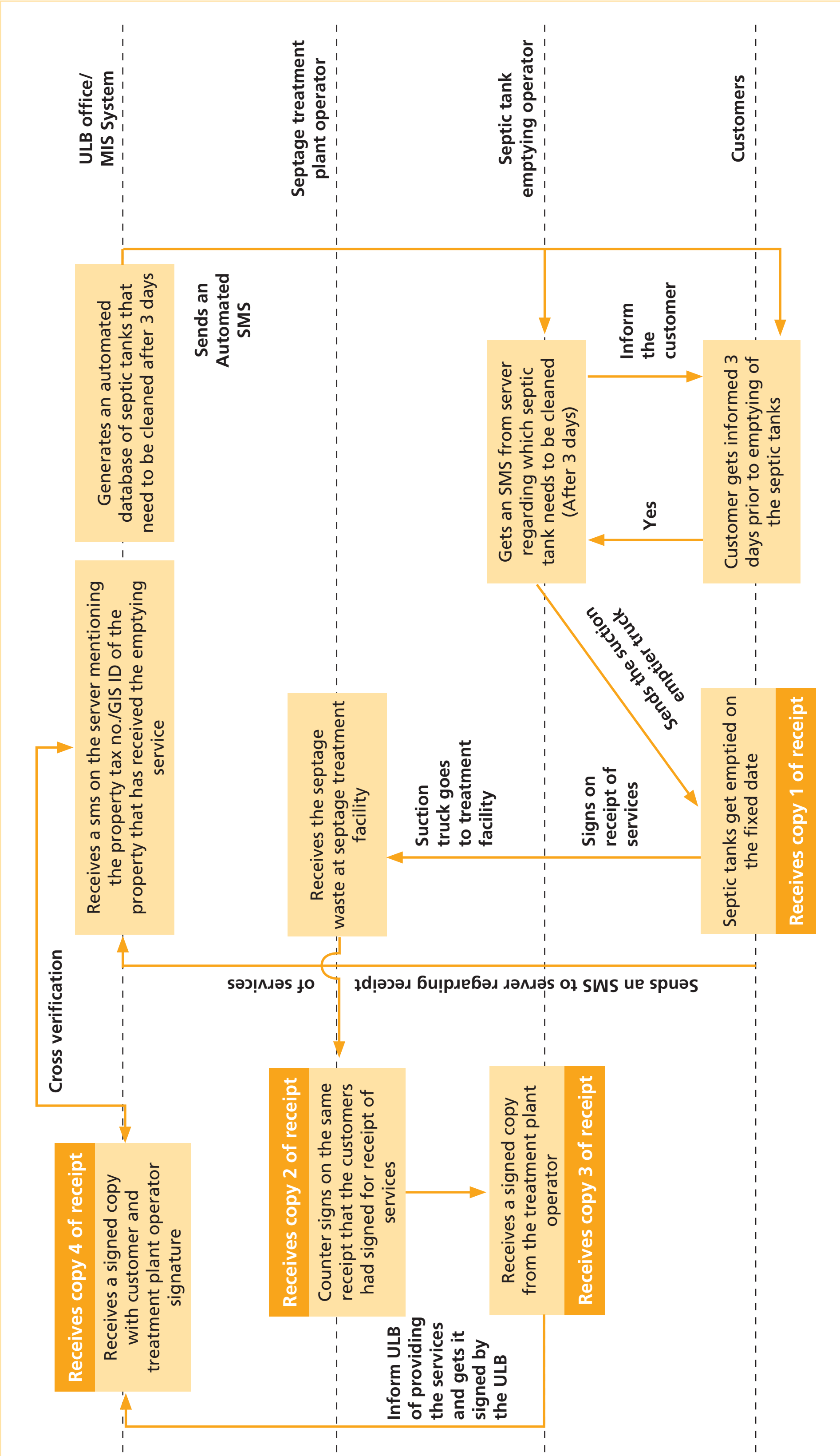
This Task Force may be given the responsibility of overseeing and guiding the execution of various components of country- and district-level sanitation missions and programmes as well as initiating projects that go beyond the mission's components and will make the assembly a forerunner in sanitation management.

Suggested Terms of Reference for the Task Force

- ➢ Review of action plan for declaring the city Open Defecation Free (ODF)
- ➢ Review of execution of ODF action plan—periodic
- ➢ Review progress of Individual HH Toilets and Community Toilets—periodic
- ➢ Review action plan and execution of wastewater management and faecal sludge management in the city.

Agenda for the meetings shall be decided unanimously, if a member of the STF raises any agenda on sanitation supported by 50per cent of the members- The Convener and Co-convener of the force shall call for the STF meeting within 30 days of the agenda submitted to Force. It is advised that Convenor of the STF gathers such agendas and conduct least meetings over a span. The proceedings of the STF meetings shall formally be recorded as minutes of the meeting (MoM).

Annexure 10: Monitoring framework for FSM activities



Source: Adapted from IWFM, 2018

Annexure 11: Methods, procedures and precautions for emptying OSS

❖ *Emptying frequency*

Regular emptying of OSS through a systematic extraction and collection procedure is essential to check environmental pollution. The frequency of emptying is determined by the local conditions including loading rate and performance of septic tanks. However, it is ideal to clean the septic tanks once in one or two years based on its design criteria. But in no case the cleaning frequency shall exceed two years.

❖ *Guidance for selection of sewer/OSS cleaning employees*

Persons considered for employment in confined spaces shall be physically fit and capable of understanding training given. Those with the undernoted disabilities shall not be recruited for this type of work and those who contract these should cease to be employed in this capacity:

- A history of fits, blackouts or fainting attacks;
- A history of heart disease or disorder;
- High blood pressure;
- Asthma, bronchitis or a shortness of breath on exertion;
- Deafness;
- Meniere's disease or disease involving giddiness or loss of balance;
- Claustrophobia or nervous or mental disorder;
- Back pain or joint trouble that would limit mobility in confined spaces;

❖ Recommended procedures to be followed for emptying of OSS

- Inform the occupant of the pending service and note any concerns or issues;
- Inspect the site for possible hazards, such as clearing the area of people, or identifying high groundwater that could cause a tank to 'float', if emptied;
- Park the truck as close to the OSS as possible. The maximum distance is determined by the length of hose and elevation rise from the bottom of the pit or septic tank to the vacuum truck. This should typically be not more than 25 metres in linear distance and 4 metres in elevation gain. In case, the length and elevation is more than the specified, intermediate pumping may be required;
- Break the mortar seal of the OSS lid. Inspect the tank for cracks or damage before and after the emptying of tank;
- Lay out and connect the hoses from the truck to the tank or pit to be emptied and secure the truck using wheel chocks;
- It is essential to ensure that the hose is in sound condition, and that the hose connections are locked into place prior to using this method;
- Open the tank or pit by removing the access ports or covers over the storage system;
- Engage the vacuum equipment by using a power take-off from the truck's transmission;
- Increase the vacuum to the proper level with the valve closed by watching the vacuum gauge, then lowering the end of the hose into the tank/pit, and open the valve sufficiently such that the faecal sludge is drawn out of the tank or pit;
- Break up faecal sludge that has agglomerated into a solid mass, either by making use of a long handle shovel and adding water when necessary;
- Operators shall leave behind sludge not less than 25 mm in depth in the bottom of the septic tank as this will act as the seeding material.
- Identify any abnormal conditions, such as high concentration of non-

biodegradable materials, oils and grease before taking to the treatment plant for final disposal;
- If the cover of the tank/pit has been removed, it should be replaced and sealed with cement plaster. If desludging has been carried out through a desludging hatch, the cover of the hatch should be replaced and sealed with cement plaster;
- Clean up any spillage using proper sorbent materials. The top of the cover and the area around the tank/pit is sprayed with 1 per cent chlorine solution;
- Two sets of working clothes will be provided for each worker, which should be dedicated to be used only during the desludging process. Clothes worn during the desludging process should be removed before the workers return home;
- Prepare a written report indicating: how much waste was removed; the condition of the tank or pit; any recommendations for repairs or maintenance; any recommendations for proper use of the system;
- Inform the client that the work is complete, and give them the final report along with recommendations, if any;
- The final report shall also be entered in the computer in the ULB so as to provide a database and to also know about the next emptying date, etc.;
- Remove the wheel chocks and drive the truck to the next site or to the nearest approved disposal site; and
- Worker shall not be allowed to enter pit/tank if height of tank is more than chest height of the emptier.

❖ *Protective gears and safety devices*

All the protective gears and safety devices shall be checked once in every six months and repaired or replaced as necessary. Proper inventory of all the protective and safety gears is to be maintained. The following are the protective gears and safety devices.

List of personal protective equipment

S. no.	Protective gears and safety devices	S. no.	Protective gears and safety devices
1.	Air compressor for blower	2.	Airline breathing apparatus
3.	Airline respirator with manually operated air blower	4.	Air purifier gas mask/chin cortege
5.	Artificial respiration/reticulate	6.	Barrier caution tape and barrier cone
7.	3-metre-long pipe of steel/iron (attached with gear plate)	8.	Safety showers at discharge site
9.	Blower/exhaust fan	10.	Breath mask
11.	Breathing apparatus	12.	Caution board
13.	Chlorine mask	14.	Emergency medical oxygen resuscitator kit
15.	First-aid box	16.	Face mask
17.	Gas monitor (four gases)	18.	Safety tripod set
19.	Full body wader suit	20.	Fishing wader suit attached with boots
21.	Hand gloves	22.	Head lamps
23.	Helmet	24.	Helmet demolishing
25.	Lead acetate paper	26.	Life guard pad
27.	Safety torch	28.	Normal face mask
29.	Nylon rope ladder—5 m	30.	Nylon safety belt
31.	Pocket book	32.	Search light
33.	Raincoat	34.	Reflecting jacket
35.	Safety belt	36.	Safety body clothing
37.	Safety body harness	38.	Safety goggles
39.	Safety gumboots	40.	Safety helmets

Source: Compiled by CSE, 2019

Annexure 12: Comparison of systems with respect to various parameters

S. no	System name	Type of system	System Life time	Applicability of system	Land availability
1	Twin-pit system	On-site system	Twin-pit, 10 years	Household level	5 m^2 per household for pit + toilet
2	UDB + WSP + co-composting + chlorination	Decentralized system	Septic tank, 50 years; soak pit, three-five years, UDB or WSP, 50 years	Ward-, city-, or cluster-level	7 m^2 per household for storage + toilet; WSP, 6,000 m^2/MLD
3	AD + co-composting + chlorination	Decentralized system	ST, 50 years; soak pit, three–five years, AD, 50 years	Ward-, city-, or cluster-level	7 m^2 per household for storage + toilet; AD, 600 m^2/MLD
3	Centrifugation + ASP + vermicompostin g + ozonation	Decentralized system	Septic tank, 50 years; soak pit, three-five years, UDB or WSP, 50 years	Ward-, city-, or cluster-level	7 m^2 per household for storage + toilet; ASP, 900 m^2/MLD
4	Centrifugation + SBR + co-composting + chlorination	Decentralized system	ST, 50 years; soak pit, three-five years, SBR, 50 years	Ward-, city-, or cluster-level	7 m^2 per household for storage + toilet; SBR, 450 m^2/MLD
5	Centrifugation + MBR + co-composting + ozonation	Decentralized system	ST, 50 years; soak pit, three-five years, MBR, 50 years	Ward-, city-, or cluster-level	7 m^2 per household for storage + toilet; MBR, 450 m^2/MLD
6	MD + AF + CW + co-composting + chlorination	Decentralized system	Treatment plant life, 50 years	Ward-, city-, or cluster-level	7 m^2 per household for storage + toilet
7	MD + WSP + co-composting + chlorination	Decentralized system	Treatment plant life, 50 years	Ward-, city-, or cluster-level	7 m^2 per household for storage + toilet
System 4	ASP + reed bed + sludge drying bed + co-composting	Networked system	Sewer and treatment plant life, 50 year	Ward-, city-, or cluster-level	ASP, 900 m^2/MLD
5	IT + CW + sludge drying bed + co-composting + chlorination	Decentralized system	ST, 50 years; IT, 50 years	Ward-, city-, or cluster-level	7 m^2 per household for storage + toilet; IT, 900 m^2/MLD
6	ABR+ sludge drying bed + co-composting	Networked system	Treatment plant life, 50 years	Ward-, city-, or cluster-level	ABR, 1,000 m^2/MLD
7	AF+ sludge drying bed + co-composting	Networked system	Treatment plant life, 50 years	Ward-, city-, or cluster-level	-
8	Belt filter press + CW + lime stabilization + chlorination	Decentralized system	ST, 50 years	Ward-, city-, or cluster-level	7 m^2 per household for storage + toilet
9	UASB + sludge drying bed + co-composting	Networked system	> 50 years	Ward-, city-, or cluster-level	UASB, 1,000 m^2/MLD
10	MD + WSP + solar drying + chlorination	Decentralized system	ST, 50 years; WSP, 50 years	Ward-, city-, or cluster-level	7 m^2 per household for storage + toilet; WSP, 6,000 m^2/MLD
11	PDB + CW + shallow trenches + chlorination	Decentralized system	ST, 50 years; trenching site, five–10 years	Ward-, city-, or cluster-level	7 m^2 per household for storage + toilet
12	Geo-bags + WSP+ chlorination	Decentralized system	ST, 50 years; geo-bag, six–12 months	Ward-, city-, or cluster-level	7 m^2 per household for storage + toilet; WSP: 6,000 m^2/MLD
13	ABR + CW + sludge drying bed + co-composting + chlorination	Decentralized system	> 50 years	Ward-, city-, or cluster-level	ABR, 1,000 m^2/MLD

Source: Technology Options for the Sanitation Value Chain, CSTEP, 2016.

Performance of the system	Energy requirement	CAPEX	OPEX
-	Not required	330 GH₵ per household for pit	30 GH₵ per household per year
BOD, 75–85 per cent; COD, 74–78 per cent; TSS, 75–80 per cent; TN, 70–90 per cent; TP, 30–45 per cent; coliform, 60– 99.9 per cent	WSP, 5.7 kWh/d/MLD	IST, 5600 GH₵ per household; WSP: GH₵ 171737/MLD; UDB: 2240054/MLD	IST, 110 GH₵ per household year; UDB, GH₵ 3732520/ MLD /MLD/year; WSP, GH₵ 15,000/MLD/year
BOD, 60–90 per cent; COD, 60–80 per cent; TSS, 60–85 per cent	AD, 60 kWh/d/MLD	IST, 5600 GH₵ /HH; AD, GH₵ 3732520/ MLD	IST, 110 GH₵/HH/year; AD, GH₵ 223951/MLD/year
BOD, 85–92 per cent; COD, 93–94 per cent; TSS, 75–80 per cent; TN, > 90 per cent; TP, > 90 per cent; coliform, 60– 90 per cent	ASP, 185.7 kWh/d/MLD; Centrifugation: 20–300 kWh per metric tonne of solid	IST, GH₵ 5600/HH; ASP, GH₵ 507745/ MLD	IST, GH₵ 110/HH/year; ASP, GH₵ 52250 /MLD/year
BOD, 95%; COD, 90%; TSS, 95%; TN, 70–80%	SBR, 153.7 kWh/d/ MLD; Centrifugation: 20–300 kWh per metric tonne of solid	IST, GH₵ 5598/HH; SBR, GH₵ 559826/ MLD	IST, GH₵ 110/HH/year; SBR, GH₵ 44786/MLD/year
BOD, 95%; COD, >90%; TSS, >90%; TN, >90%; TP, >90%	MBR, 302.5 kWh/d/ MLD; Centrifugation: 20–300 kWh per metric tonne of solid	IST, GH₵ 5598/HH; MBR, GH₵ 2239304 /MLD	IST, GH₵ 110/HH/year; MBR, GH₵ 67179 /MLD/ year
BOD, 50–90%; TSS, 50–80%	AF, 34 kWh/d/MLD	BD, GH₵ 4478/HH	BD, GH₵ 110/HH/year
BOD, 75–85%; COD, 74–78%; TSS, 75–80%; TN, 70–90%; TP, 30–45%; coliform, 60– 99.9%	WSP, 5.7 kWh/d/MLD	IST, GH₵ 5598/HH; WSP, GH₵ 171680/ MLD	IST, GH₵ 110/HH/year; WSP, GH₵ 14928/MLD/year
BOD, 90–95%; COD, 85–90%; TSS, >90%; TN, >60%; coliform, 90–99.9%	ASP: 185.7 kWh/d/MLD	ASP, GH₵ 507482/MLD	ASP, INR 52240/MLD/year
BOD, 30–50%; TSS, 50–70%.	IT, 45 kWh/d/MLD	IST, GH₵ 5597/HH; IT, INR 5,00,00,000/ MLD	IST, GH₵ 110/HH/year; IT, INR 30,00,000/MLD/year
BOD, 70–95%; TSS, 80–90%; coliform, 20– 30%	ABR, 34 kWh/d/MLD	ABR, GH₵ 3731485/MLD	ABR, GH₵ 22388/MLD/year
BOD, 50–90%; TSS, 50–80%	AF, 34 kWh/d/MLD	AF, US$350 to US$500 per cu.m for a treatment capacity of 10 cu.m, if the AF is used in combination with other treatment modules (e.g., in DWWTs)	-
-	22 kWh/d/MLD	-	-
BOD, 75–85%; COD, 60–80%; TSS, 75–80%; TN, 10–20%.	UASB, 34 kWh/d/MLD	UASB, GH₵ 507482 /MLD;	UASB, GH₵ 44777/MLD/ year
BOD, 75–85%; COD, 74–78%; TSS, 75–80%; TN, 70–90%; TP, 30–45%; coliform, 60– 99.9%	WSP, 5.7 kWh/d/MLD	IST, GH₵ 5597/HH; WSP, GH₵ 171648 MLD	IST, GH₵ 110/HH/year; WSP, GH₵ 5591/MLD/year
-	-	IST, GH₵ 5597/HH	IST, GH₵ 110/HH/year
BOD, 75–85%; COD, 74–78%; TSS, 75–80%; TN, 70–90%; TP, 30–45%; coliform, 60– 99.9%	WSP, 5.7 kWh/d/MLD	IST, GH₵ 5597/HH; WSP, GH₵ 171648/ MLD	IST, INR 1,500/HH/year; WSP, GH₵ 14925/MLD/year
BOD, 70–95%; TSS, 80–90%; coliform, 20– 30%	ABR, 34 kWh/d/MLD	IST, GH₵ 5597/HH; ABR, INR 5,00,00,000 /MLD;	IST, GH₵ 110/HH/year; ABR, INR 223889/MLD/year

Annexure 13: O&M for decentralized wastewater treatment systems

Being a nature-based technology designed to treat wastewater without use of any energy, the key features for O&M of the DWWTs are as given below:

- Minimal but consistent maintenance is required for optimal performance.
- The O&M activities can be carried by unskilled personnel who can be easily guided for the same.
- The frequency of monitoring need to be adjusted as per the site-specific need.

Settler and anaerobic baffled reactor

Important notes for its operations and maintenance:

- Do not allow solid waste/ napkins/vegetable peels or any other solid waste that can be disposed of in the dustbins to enter the settler. Introduce preliminary treatment modules like bar screens, O&G trap etc. at sites where it is necessary.
- Do not use acids/high dosage of inorganic chemicals for cleaning of the toilets that might enter the settler and hamper the performance of the system. It is recommended that organic and naturally biodegradable cleaning agents are used.
- Desludging should be done as prescribed by the design after every two to three years.

Planted gravel filter (PGF) bed

Important notes for its operations and maintenance:

- Before filling of the filter material, the basin should be checked for uniform flow and water tightness.
- Plantation of wetland plants in PGF should be done at some distance from the inlet and outlet points. At the same time, plantation needs to be done at equal distance within PGF for easy growth of roots.
- Check if water level is above the bed level. If so, the swivel pipe/ valves need to be adjusted accordingly.
- Canna, typha and scirpus are recommended wetland plant species. Local plant nursery can be contacted to supply these plants.

Polishing pond

Important notes for its operations and maintenance:

- Polishing pond should be prevented from developing an algal bloom.
- Visually the quality of treated wastewater should be monitored.
- It should be seen that the entire area of polishing pond should be exposed to the sun rays and no area should come under shade.
- The pond must be emptied and the sludge must be removed in defined intervals, before treatment quality goes down.

a) Dos and don'ts during O&M for decentralized wastewater treatment system

This section highlights the dos and don'ts to be followed. There is a need to install information boards and increase awareness about the DWWTs and treated water being used within the premises. There should also be an information board indicating cautions and precautions in the form of dos and don'ts displayed at the site. This should be converted in the most understandable language. This will also make staff and visitors improve awareness and less wary of the assumed risks. In addition, the maintenance staff should be trained/instructed formally on the maintenance activities and should be introduced to a monitoring log for ease of monitoring.

	Dos	**Don'ts**
During commission-ing	• Do frequent quality analysis of inlet and outlet wastewater frequently. Once the system stabilizes, analysis can be done once in three to six months.	• Don't let the wastewater enter the system without performing leakage test, level confirmation test, alignment test and flow test of the constructed system.
During O&M and monitoring (For information board)	• Use personal protective measures when reusing the treated water—wash hands post direct contact • Only domestic waste should enter the system. Chemicals, emulsions, paints and dyes etc. should be avoided	• Do not throw litter on or around the system • Nobody should be allowed to enter the settler and ABR • Do not drink the treated wastewater through sprinklers or taps around the green areas. • Non-biodegradable substances such as plastics, glass, metals, polythene, chemi-cals and large wood debris should not be allowed to enter inside the systems. These may choke pipes, pump or hinder the treatment process. • No flammable objects or activities should not be carried out near the vents.
During O&M and monitoring (for maintenance staff)	• The quality of treated wastewater should be moni-tored visually at least once in a week. A record/note of observation should be made. • Water quality testing should be done regularly. • Desludging of the settler and first two chambers of anaerobic baffled reactor should be done mechani-cally. • If degradation of the quality of treated wastewater at the final outlet occurs, ensure the filter material of the planted filter bed is removed, cleaned and put back • Regularly harvest and trim the green plants of the planted filter bed. • Cleanliness in the surrounding area should be main-tained. • Use the treated water to maintain the green land-scape inside the premises. • Maintain log for maintenance activities.	• Don't de-sludge completely else re- acti-vation of the sludge would be required. • Don't carry out maintenance activities without using personal protective equip-ment and measures: • Rubber hand gloves, facial mask, protec-tive aprons and hand sanitizer

Source: Compiled by CSE, 2018.

b) Monitoring

Monitoring of the O&M activities will ensure regularity. The following table provides for a sample format for monitoring:

SAMPLE FORMAT

ACTIVITY—EVERYDAY
Physical examination of inlet chamber Physical examination Planted filter bed
Physical examination collection chamber for treated water

Date/ Day	Remarks ACTIVITY 1	Remarks ACTIVITY 2	Remarks ACTIVITY 3	Responsible person	Supervised by (Admin)
MONDAY	ACTIVITY 1 and ACTIVITY 3—Done. No variations reported. ACTIVITY 2—Flowering of yellow canna flowers observed.			ABC	XYZ
WEDNESDAY					
FRIDAY					

Annexure 14: Indicative strategic framework to raise sanitation awareness in urban areas

While the proposed methodology for preparing the national communications strategy for sanitation awareness in urban areas would lead to the development of a comprehensive, evidence-based communications strategy, the strategy per se would need to fit into a framework that is easy for policymakers and those involved in the implementation of the strategy to follow. This section of the document presents such a prescriptive framework.

The framework highlights the issues and communication needs of 'target audiences' or 'consumers' of the communication activities and indicates a set of possible communication activities to address the communication needs of the target audiences.

It must be noted that the identification of communication needs and efforts and possible communication activities are not exhaustive but are purely indicative and presented to give a flavour of the range of communication efforts and activities required to address the needs (see *Annexure 14: Indicative strategic framework to raise sanitation awareness in urban areas*).

Issue/communication needs	Target audiences	Communication thrust/objective	Po ssible set of communication activities/ efforts
Improving urban sanitation is not top priority for state and city level institutions and officials Perspectives and awareness on strategies such as need for universal coverage, city wide approaches, mainstreaming the poor, need for developing localized need-based solutions, need for proper O&M of sanitation facilities, etc. differ among policymakers and city managers	• Officials of state level institutions involved in urban development • Officials of MMDAs and parastatal agencies • Elected representatives	• Strengthen programmatic awareness on urban sanitation and related policies/ programmes/ schemes, etc. in order to ensure uptake and effective implementation • Strategic communications/advocacy to push sanitation higher-up on the agenda of these institutions and to build support for strategies such as city-wide approaches, mainstreaming the poor, local needs-based technological options, proper operations and maintenance of sanitary installations etc. The communication inputs should be aimed at honing perspectives of officials and staff on the above-mentioned themes/strategies. • Strengthening communication mechanisms between institutions at the national, state and local level in order to ensure regular and effective flow of information/knowledge on urban sanitation between institutions involved in sanitation service delivery at different levels • Bring 'sanitation' to the forefront of the political debate at the national and district level for ensuring that districts prioritize urban sanitation.	• Attractive multimedia presentations on urban sanitation • Specially designed information materials including briefing kits (fact sheets, talking points and Q&A on urban sanitation) and multimedia presentations with details of policies and programmes. • Personalized communication by the Minister of Water Resources and Sanitation • Special advocacy events— national round tables, regional workshops and consultations on the following themes: mainstreaming the poor, city wide approaches, understanding sanitation, financing sanitation need for localized need based solutions, financing sanitation etc. • Creation of a dedicated web- site and virtual information hub on urban sanitation • Briefing meetings with executive committees, ministers responsible for portfolios linked to sanitation (health, education and environment)
Low priority accorded to sanitation Limited awareness of programmes and schemes as well as rights and duties as citizens vis-à-vis sanitation	Urban households	Provide information and raise awareness on the following issues: • What is sanitation—its holistic definition; • Importance of sanitation; • Linkages of sanitation with health, economic well-being and the environment; • Information on schemes and programmes aimed at ensuring sanitation facilities; and • Whom to approach for further information	• Branded multi-media and multi-channel communications campaign including, but not restricted to: o Radio campaign—spots and jingles o TV spots/programmes o Information materials o Theme-based media campaign • Strategic placement of sanitation awareness messages in popular TV serials and radio shows
Issue/communication needs	**Target audiences**	**Communication thrust/objective**	**Possible set of communication activities/ efforts**

Limited and disinterested media coverage of sanitation issues	Media—print, audio, audiovisual and internet-based media	Create a buy-in for sanitation and sanitation related issues	• Specially designed information materials including briefing kits (fact sheets, talking points and Q&As on urban sanitation) and multimedia presentations with details of policies and programmes • One-on-one briefing meetings with editors, journalists and beat reporters • National/district level workshops or round-tables with editors and journalists • Media exposure tours for journalists and beat reporters • Special sanitation scholarship/ fellowship scheme for journalists and beat reporters
Lack of interest/ sporadic interest and involvement of industry bodies, citizens associations and bodies on sanitation related issues	• Industry and tradesperson associations • Voluntary associations like the Rotary Clubs, Lions Clubs, Young Men/Women' Christian Associations, etc.	Create avenues / opportunities for active engagement of these stakeholders on sanitation related issues	• Research to identify best fit corporate/ industry associations/ voluntary associations to partner with national/ district level institutions for raising sanitation awareness • Organization of meetings/special events with identified corporate bodies/industry associations/ voluntary associations to raise sanitation awareness • Co-branding of special events, programmes

Source: Adapted from Integrated Faecal Sludge Management Guidelines, GIZ 2018.

Annexure 15: Regulations for FSM

The MMDAs shall develop an institutional framework defining roles and responsibilities of stakeholders and enforcement and monitoring of strategies for successful implementation of FSM systems.

Improving design and construction of septic tanks: Adoption of improved designs of septic tanks for households. Also, the use of advanced septic tanks (three chamber septic tank with better settling capacity and retention time) and Decentralized Waste Water Treatment (DWWT) systems by institutional and bulk consumers such as hotels, colleges and apartments etc. This shall be achieved by adopting regulations on septic tank designs and construction methods as part of building plan regulations.[51]

Conversion of insanitary latrines into sanitary latrines: Detailed baseline study to identify improperly constructed on-site systems. The information to be used for educating and giving notices to the households with insanitary toilets to retrofit them as per the approved designs. In addition to safe containment, the process would contribute to periodic desludging and therefore safe management of faecal sludge. Providing subsidy to household in order to promote the exercise.

Emptying of faecal sludge: All MMDAs shall adopt a formal process of licensing private desludging operators. The process involves issuance of notification and calling for applications from operators to apply for license to operate. The license will be valid for 5 years and needs to be renewed every year. The households should be informed to engage the licensed operators for collection and transportation of faecal sludge. The list and contact details of licensed operators should be displayed on the respective websites and to be advertised through digital media. A letter shall also be issued to traffic police stating to seize desludging operator's vehicles who are operating without a license, issued by the competent authority. Multiple rounds of training and demonstrations should be organized to explain the approved standards and procedures for pumping and desludging and about the use of Personal Protective Equipment (PPE). A feedback form must be signed and collected from the beneficiary. Based on the feedback, an emptier can be rewarded with more desludging opportunities or vice versa.

Faecal sludge transportation: The empaneled desludging operators must have trucks that meet the approved standards for desludging and transportation. There shall be trained workers equipped with uniforms, safety gear, tools and vacuum trucks. As per the requirements, the vehicles should be fitted with a Global Position System (GPS) by the MMDAs. The data should be tracked by the district assemblies for vehicular monitoring. Going forward the GPS tracking can also be used for assignment of desludging requests to the nearest located vehicle.

Regulations for issuance of permit to collect and transport faecal sludge
Criteria for issue of license

- The applicant should own leak-proof, odour-proof and spill-proof transporting vehicle (s) with a proper vacuum/suction and discharging arrangement
- The vehicle shall have a valid permit of the Transport Department to operate
- The applicant shall have workers adequately trained for this purpose
- The workers shall be equipped with safety gears and other protective

equipment required to safely collect, transport and dispose of the faecal sludge at the designated sites
- Applicant must have a valid registered vehicle
- All required equipment and technical devices to be installed as prescribed under Assembly regulation

Application for license
A copy of license shall be prominently displayed on the vehicle used for transportation of faecal sludge. The vehicle/container/tanker shall be painted with yellow colour and duly marked with (the precaution) in red colour 'SEPTIC TANK WASTE' (in English and in the local language)

FAECAL SLUDGE TRANSPORTER PERMIT FOR ....Assembly
(to be filled by the private contractors)

In accordance with all the terms and conditions of the current .... Assembly's Rates, Rules and Regulation, the Special permit conditions

Accompanying this permit, and all applicable rules, laws and regulations of Government of Ghana. Permission is hereby granted to:

NAME OF PERMITTEE: ____

ADDRESS: ____

For the disposal of faecal sludge from domestic septic tank commercial holding tank at the ______________________ STP.

This permit is based on information provided in the faecal sludge transporter permit application

which Constitutes the faecal sludge management permit.

This Permit is effective for the period set forth below, may be suspended or revoked for condition of non-compliance and is not transferable. The original permit shall be carried in every registered vehicle used by the permittee.

EFFECTIVE DATE: ____________________

EXPIRATION DATE: ____________________

Permit is liable to be cancelled in case of violations of any Acts, Rules and Regulations relating to the operation of faecal sludge systems or in cases of safety protocols not being adhered to or in case of non-permitted disposals.

COLLECTION AND CONVEYANCE RECORDS

(Including schedules for septic tank emptying service)
(to be filled by operator/ transporter of faecal sludge)

I. Identification of waste :

a) Volume:
b) Type: (1) Septic tank (2) Others
c) Source: (1) Residential (2) Commercial (3) Restaurant (4) Public or Compound Toilet (5) Others

II. Details of waste generator

a) Name: ____
b) Phone number: ____
c) Address: ____
____
d) PIN: ______________________

The undersigned being duly authorized does hereby certify to the accuracy of the source and type of wastewater collected and transported.

Date ______________________ Signature: ______________________

III. Details of transporter/operator filled by discharge site operator

a) Company name: ____
b) Permit no: ____
c) Vehicle registration number: ____
d) Driver's name: ____
e) Pump out data: ____

The above described wastewater/faecal sludge was picked up and hauled by me the disposal facility name below and was discharged. I certify that the foregoing is true and correct:

IV. Signature of authorized agent and title:

The above transporter delivered the described wastewater to this disposal facility and it was accepted.

Disposal date: ______________________
Amount collected from transporter: ______________________
Signature of authorized signatory and title: ______________________ Assembly.

Vacuum truck drivers should follow all the rules of the road

- Take the most expedient route to the disposal site considering traffic flows
- Plan the trip to arrive at the disposal site within the specified disposal site operating hours
- In the event an accident or moving violation (citation), cooperate with local authorities.
- Be prepared to show driver's license, vehicle registration, and insurance if requested.
- A complete report will be required and all incidents should be investigated.

APPLICATION FOR EMPTYING OF ON-SITE SYSTEM
ABC Assembly

Name of the applicant: ………………………………………………………………………………...

Contact number ………………………………………………………...……………………..……

House tax no. ……………………………………………………………………………………………

Address of emptying site: ……………………………………………………………………..……

Landmark: ………………………………..…………………………………………………….…………

Access road width: ………………………… Type of tank: Septic tank pit
other

Size of tank: ……………………………..… When was OSS emptied last time ……...........
Month………………… Year…………………

Signature of the applicant……………………………………….…...

Signature of officer…………………………………………………

Date: ………………

Important information

- Cost of first emptying shall be borne by Assembly, once in a year for the households and once in three months in case of public toilets
- There shall be a rebate of 50 per cent off on second emptying request within a year for the households and within three months in case of public toilets
- Submission of house tax receipt is mandatory

Annexure 16: Strategies to fill the gap between investments and quality of services

Strategy	Description
Service specific escrow accounts	Escrow accounts are ring-fenced accounts with defined usage. The grants for wastewater and FS management, from various sources shall be pooled in these escrow accounts, which will bring financial stability between the parties. Further, the fund disbursal from these escrow accounts should be linked to the institutional reforms, financial sustainability of various deployment options and necessary output such as Key Performance Indicators to keep a check on the fund usage.
Private funding	PPP fill the financing gap by bringing its own source of funding as debt/equity as mentioned above
Scale in fund usage	Fund usage indirectly follows the economics of scale provided in large projects and hence rather than following a piecemeal input driven approach in fund usage, a holistic output driven approach shall be followed

Annexure 17: Capacity building and IEC/BCC strategies

<table>
<tr><th>Sector</th><th>Designation</th><th>Training need</th><th>Training timeline</th><th>Topics for IEC/BCC campaign (for all)</th></tr>
<tr><td rowspan="4">Access to sanitary toilets</td><td>Maintenance engineer</td><td>By-laws (design consideration of toilets), Water and energy efficient fixtures</td><td>Once a year (compulsory) Remaining trainings as and when required (such as induction of new staff, invitation from MoSWR</td><td rowspan="2">• Campaigns for school faculties on the importance of sanitary education
• For students (different age-groups) on how they can contribute in making the region clean and healthy
• Menstrual hygiene education campaign
• Use and maintenance of CTs by the locals and how it can prevent OD and OU
• Campaign on why OD is not an acceptable practice, by children or adults</td></tr>
<tr><td>Sanitary inspector</td><td>Estimation of floating population, homeless, disabled, method to identify OU OD hotspots, by-laws, assessment of functional status of PTs/ CTs</td><td>One training in first year then refresher training every year</td></tr>
<tr><td>Field officer</td><td>Qualitative and quantitative research</td><td rowspan="2">Once a year (compulsory) Remaining trainings as and when required (such as induction of new staff, invitation from MoSWR</td><td rowspan="2">• Campaign highlighting the acceptance of OU and why it is harmful for citizens
• Campaign for greater civic involvement in maintaining</td></tr>
<tr><td>Field assistant</td><td>Data collection, data entry, public interaction</td></tr>
</table>

Sector	Designation	Training need	Training timeline	Topics for IEC/BCC campaign (for all)
Faecal sludge management and wastewater (FSM and WW)	Assistant engineer	• Planning and designing of sustainable and decentralized solutions for FSS and WW • Policies, programmes and guidelines for sewage, FSSM • Use of mapping/spatial data and IT in O&M and for data analysis • Data generation for FSS & WW management for BA • Innovative approaches to implement scheduled desludging and regulated emptying in BA Setting up a call centre and MIS for better management and implementation of scheduled desludging	Once a year (compulsory) Remaining trainings as and when required (such as induction of new staff, invitation from MoSWR	Public participation and awareness on: Scheduled desludging Ill-effects of an unclean city—Impact on public health and environment Ill-effects of using untreated FS and WW in agriculture. It can be a resource if used wisely Stencil signs on road (No dumping of FS/WW) for waterbodies and drains • Slogans and interactive programmes/events on beautiful landscape/ water bodies and clean environment • Brochures and workshops on how to do DWWTs for buildings with area more than 100 sq. m
	Junior engineer		Once a year (compulsory Remaining trainings as and when required (such as induction of new staff, invitation from MoSWR	
	Truck operators	• Use of PPE	Once a year (compulsory) Remaining trainings as and when required (such as induction of new staff, invitation from MoSWR	
	Faecal sludge treatment plant operators	• Role of field staff in effective FSM Use of cleaning agents • Public interaction • Data management • Maintenance of their vehicles • Awareness of labour laws, social welfare schemes • Reporting process—complaints, innovations, issues pertaining to human resource management	Once a year (compulsory Remaining trainings as and when required (such as induction of new staff, invitation from MoSWR	• Brochures on use of native plants and landscaping on smaller/individual scale (Native plant kits on sale). • Biodiversity: Noticeboard near green areas and water bodies stating details of existing flora and fauna Workshop at schools and colleges with dummy models to be prepared by students on above topics (RWH, landscaping, save waterbodies, species surrounding us)

Annexure 18: Sector-specific effluent quality guidance for discharge into natural waterbodies (maximum permissible levels)

	PARAMETER	SECTORS						
		Textile	Food and beverages	Paints and chemicals	Pharma-ceuticals	Paper and pulp	Hotels and resorts	Wood and wood processing
1.	pH	6–9	6–9	6–9	6–9	6–9	6 - 9	6–9
2.	Oil and grease (mg/l)	5	5	10	5	10	5	5
3.	Temperature increase	< 3°C above ambient	< 3°C above ambient	< 3°C above ambient	< 3°C above ambient	< 3°C above ambient	< 3°C above ambient	< 3°C above ambient
4.	Color (TCU)	400	200	300	150	200	150	250
5.	COD (mg/l)	250	250	250	250	250	250	250
6.	BOD_5 (mg/l)	50	50	50	50	50	50	50
7.	Total dissolved solids (mg/l)	1000	1000	1000	1000	1000	1000	1000
8.	Chromium (+6) mg/l	0.1				0.1	0.1	0.1
9.	Sulphide (mg/l)	1.5	1.5	1.5	1.5	1.5	1.5	1.5
10.	Phenol (mg/l)	2	2	2	2	2	2	2
11.	Total Coliforms (MPN/100 ml)	400	400	400		400	400	400
12	E. coli (MPN/100 ml)	10	10	10	10	10	10	10
13.	Turbidity (NTU)	75	75	75	75	75	75	75
14.	Total suspended solids (mg/l)	50	50	50	50	50	50	50
15.	Lead (mg/l)	0.1	0.1	0.1	0.1	0.1	0.1	0.1
16.	Nitrate (mg/l)	50	50	50	50	50	50	50
17.	Total phosphorous (mg/l)	2	2	2	2	2	2	2
18.	Conductivity (µS/cm)	1500	1500	1500	1500	1500	1500	1500
19.	Mercury (mg/l)	0.005	0.005	0.005	0.005	0.005	0.005	0.005
20.	Ammonia as N (mg/l)		1.0				1.0	1.0
21.	Total pesticides (mg/l)		0.5				0.5	0.5
22.	Total arsenic (mg/l)	1.0	1.0	1.0	1.0	1.0	1.0	1.0
23.	Soluble arsenic (mg/l)	0.1	0.1	0.1	0.1	0.1	0.1	
24.	Alkalinity as $CaC0_3$ (mg/l)	150	150	150		150		
25.	Fluoride (mg/l)		10					
26.	Chloride (mg/l)	250	250	250	250	250	250	250

Sector-specific effluent quality guidelines for discharge into natural waterbodies (maximum permissible levels)

	PARAMETER	SECTORS						
		Cement, ceramics and tiles industry	Thermal power plant	Glass iIndustry	Hospitals and clinics	Oil and gas exploration, production and refining	Mining and minerals processing	Metals industry
1.	pH	6–9	6–9	6–9	6–9	6–9	6–9	6–9
2.	BOD_5 (mg/l)	50	50	50	50	50	50	50
3.	Oil and grease (mg/l)	5	5	5	5	10	10	5
4.	Total dissolved solids (mg/l)	1000			1000	1000	1000	1000
5.	Total suspended solids (mg/l)	50	50	50	50	50	50	50
6.	Cadmium (mg/l)	0.1				0.1	0.1	0.1
7.	Total phosphorus (mg/l)	2.0	2.0	2.0	2.0	2.0	2.0	2.0
8.	Temperature increase	< 3ºC above ambient	< 3ºC above ambient	< 3ºC above ambient	< 3ºC above ambient	< 3ºC above ambient	< 3ºC above ambient	< 3ºC above ambient
9.	Colour (TCU)	200	200	150	150	200	150	200
10.	COD (mg/l)	250	250	250	250	250	250	250
11.	Chromium (+6) mg/l	0.1		0.1	0.1	0.1	0.1	0.1
12.	Sulphide (mg/l)	1.5	1.5	1.5	1.5	1.5	1.5	1.5
13.	Phenol (mg/l)				2	2	2	2
14.	Total coliforms (MPN/100 ml)			400	400	400	400	400
15.	E. coli (MPN/100 ml)			10	10	10	10	10
16.	Turbidity (NTU)	75	75	75	75	75	75	75
17.	Lead (mg/l)	0.1	0.1	0.1	0.1	0.1	0.1	0.1
18.	Nitrate (mg/l)	50	50	50	50	50	50	50
19.	Conductivity (μS /cm)	1500			1500	1500	1500	1500
20.	Mercury (mg/l)				0.005	0.005	0.005	0.005
21.	Zinc (mg/l)					10	10	10
22.	Tin (mg/l)							5
23.	Total chromium (mg/l)					0.5	0.5	
24.	Total iron (mg/l)					10	10	10
25.	Free cyanide (mg/l)						0.2	
26.	Cyanide as weak acid dissociable (mg/l)						0.6	
27.	Total cyanide (mg/l)						1.0	
28.	Aluminium (mg/l)							5.0
29.	Total antimony (mg/l)						1.5	1.5
30.	Fluoride (mg/l)							10
31.	Chloride (mg/l)							250
32.	Alkalinity as $CaC0_3$ (mg/l)							150
33.	Copper (mg/l)					5	5	5
34.	Total arsenic (mg/l)	1.0		2			1.0	1.0
35.	Soluble arsenic (mg/l)	0.1					0.1	0.1

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This guidelines aims to help decision makers working in the water and sanitation sector to plan wastewater and faecal sludge management.

Bridging action plans proposed in planning documents and implementation of projects on the ground, this document provides direction to practitioners to plan, design and implement low-cost, nature-based, equitable and sustainable-for-all projects in the specific context of Ghana.

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