Assessment of Faecal Sludge Management

Strategic Guidance for future investments in Small Towns
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Acknowledgements

Faecal Sludge Management is a growing problems for cities, emerging and small towns in Nepal. It has been a privilege for us to take up this assignment as it has further strengthened our capacity and knowledge to understand and tackle urban sanitation problems in Nepal.

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Executive Summary

Following the development of the National Hygiene and Sanitation Master Plan (2011) many settlements have been declared open defecation free (ODF) through construction of thousands of on-site sanitation systems. However, there is not much guidance on best practice for collection, treatment, disposal or re-use of human excreta stored in these on-site systems. This stored excreta is also referred to as faecal sludge (FS). Problem of FS management is especially challenging in dense urban settlements, small and emerging towns where space is a limitation to build proper toilets with pre-treatment facilities such as septic tanks. Without proper containment and management systems, FS constitutes a health hazard. Realizing the need to study the status of and need for FSM in rural and small town on-site sanitation, this study was conducted. This study was based on a reviews, rapid assessments and interviews conducted in 9 small towns located mostly in the Hills and in the Terai.

The key findings of this study shows that urbanization is rapid in these small towns where FSM is coming up as a burning problem. Most of the towns are non sewered and rely predominantly on onsite sanitation systems such as single pits and septic tanks. Private entrepreneurs are providing FS emptying services but in the absence of disposal and treatment facilities, all FS is dumped into water bodies and in the community forests. In some towns like Bardaghat and Khairenitar, private operators dispose raw FS in agriculture fields when demanded by farmers. Thus, there is an informal demand for such products at the users level. Absence of national level policies and bylaws on FSM, lack of resources and knowledge among stakeholders to address FS were some of the key gaps identified. Several operational challenges also exists at the local level. There is a need to demonstrate a proper FSM system at the town level where business plans, management modalities, treatment technologies are carefully engineered and developed. These demonstration units can be instrumental to influence local and national stakeholders. Some of the towns such as Gorkha, Bardaghat, Khairenitar have potential need to improve FSM systems and also exhibit enabling conditions for future investments.

FSM technological options are being piloted in different parts of the world but there is no one single solution ideal for towns in Nepal. However, this study recommends to explore some of the technologies such as digestor combined with Sludge Drying Beds, to help in stabilizing the sludge and to reuse it as a soil conditioner in agriculture. For a sustainable FSM system, a sound business plan is a prerequisite. As part of developing the FSM plan, this study recommends to approach it from a City Wide Sanitation perspective where FSM is positioned as one of the integral components of the plan.

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Glossary

Biosolids: The solid fraction of faecal sludge (or sewage sludge) after the solids-liquid separation. If biosolids are hygienically safe, it can be used in agriculture.

Constructed wetland: It consists of gravel and sand filters planted with plants like reeds, bulrushes or cattails. These are constructed by mimicking the natural wetlands. Such man made “wetland” has been used for treating wastewater. But it can also be used to dewater and dry faecal sludge and is termed as “drying beds”.

Eutrophication: It is the ecosystem response to the addition of nutrients through detergents, fertilizers, or sewage, to an aquatic system. One example is the "algal bloom" or great increase of phytoplankton in a water body as a response to increased levels of nutrients. Negative environmental effects include hypoxia, the depletion of oxygen in the water, which may cause death to aquatic animals.

Faecal sludge: Sludge removed from different on-site sanitation systems (e.g. septic tanks, bucket latrines, pit latrines, etc.).

Faecal sludge management: Faecal sludge management means collection, treatment, recycling or disposal of faecal sludge using environmentally sound methods with no adverse impact on health.

Pit latrines: Pit latrine refers to a simple pit dug on the ground (sub structure) for storage of products (urine and faeces) with a temporary or permanent superstructure.

Private operators: Private companies/individuals associated with faecal sludge collection

Septage: Contents of septic tanks (usually comprising settled and floating solids as well as liquid fraction).

Septic tank: A septic tank is a watertight chamber made of concrete, fibreglass, PVC or plastic, through which black water and grey water flows for primary treatment. Settling and anaerobic processes reduce solids and organics, but the treatment is only moderate. A septic tank should typically have at least two chambers. However, in the assessment towns, septic tanks are generally large holding tanks.

Sewage: Sewage is a water-carried waste and consists mostly of grey water (from sinks, tubs, showers, dishwashers, and clothes washers), black water (the water used to flush toilets, combined with the human waste that it flushes away); soaps and detergents; and toilet paper (where used). Whether it also contains surface runoff depends on the design of its route back to the environment.

Wastewater: Wastewater is any water that has been adversely affected in quality by anthropogenic influence. Wastewater can originate from a combination of domestic, industrial, commercial or agricultural activities, surface runoff or storm water, and from sewer inflow or infiltration.

Abbreviations and Acronyms

ADB	Asian Development Bank
BMGF	Bill and Melinda Gates Foundation
CDD	Consortium for Dewats Dissemination
DWSS	Department of Water Supply and Sewerage
DWSO	District Water and Sanitation Office
Eawag	Swiss Federal Institute of Aquatic Sciences and Technology
ENPHO	Environment and Public Health Organisation
FS	Faecal Sludge
FSM	Faecal Sludge Management
FSTP	Faecal Sludge Treatment Plant
GoN	Government of Nepal
KMC	Kathmandu Metropolitan City
M-WASH-CC	Municipal WASH Coordination Committee
NHSMP	National Hygiene and Sanitation Master Plan
NGO	Non-Governmental Organisation
ODF	Open Defecation Free
PSMC	Pokhara Sub-Metropolitan City
SDP	Sector Development Plan
STWSSSP	Small Town Water Supply and Sanitation Sector Project
WASH	Water, Sanitation and Hygiene
WUSC	Water Users and Sanitation Committee
WUSO	Water Users and Sanitation Office

1. INTRODUCTION

1.1 Background

Global efforts to achieve the MDG target on water and sanitation by 2015 have led to substantial increase in installation of number of traditional on-site sanitation systems as pit latrine, cesspit or septic tank. These increments have consequently generated additional need and demand for proper fecal sludge management (FSM) services in many developing countries of the world. Unfortunately, current practices on FSM only consider emptying of on-site systems and disposing-off collected fecal sludge (FS) into the environment without any or with minimal treatment.

In order to have positive outcomes in the quality of water resources and the land environment, development practitioners must address issues of FS. Whenever possible, development initiatives should prioritize minimizing/ avoiding pollution of groundwater and surface waters to safeguard the viability of aquatic life and the attractiveness of Nepal's natural heritage to tourism, a major contributor to the gross domestic product of Nepal. Development projects must also safeguard public health through proper sanitation controls so that water bodies do not become polluted. Further, any use of fecal matter for the enrichment of soils and enhancement of agricultural production must follow safe treatment guidelines.

Most of the essential guidelines for sanitation advancement in Nepal have been developed and adopted within the current National Hygiene and Sanitation Master Plan and the Nepal WASH Plan. Thousands of on-site septic pits have been constructed and hundreds of thousands more are planned, however without clear guidance on best practice for collection, treatment, disposal or re-use of the FS, or national guidelines on FS management (FSM). Without proper containment and management systems, FS constitute a major health hazard, even leading to epidemics. There is an urgent need to study the status of and need for FSM in rural and small town areas

In this context, as a part of its long term Sanitation Programming sustainability, USAID entrusted Environment and Public Health Organization (ENPHO) and its associates to conduct this study on "Feacal Sludge Management in Small Towns". This report provides the findings of the field level investigations and recommends strategic measures to guide future investments in FSM in Nepal.

1.2 Objectives

The specific objective is to provide recommendations to USAID Nepal on potential areas of work on FS and its management in selected small towns of Nepal.

The assessment aims to:

(i) understand the current situation and practices on FSM in the selected small towns,

(ii) understand major stakeholders involved,
(iii) understand policy and regulations on FSM and
(iv) identify key gaps and challenges to address FSM in the country.

Key questions:

The assessment was conducted based on the following key questions:

i) What are the current practices of FSM in the selected small towns and how do they impact on the public and environmental health?
ii) Who are the major stakeholders in FSM management in the assessed small towns?
iii) Is FSM adequately addressed in the National policy and regulations?
iv) What are the best practices for FSM in the region that can be replicated/adapted in the assessed small towns?

1.3 Scope of work

The purpose of this study is to identify the best practices for effective FSM in rural and small town on-site sanitation. Initially, this assessment intended to cover rural areas and small towns of the Terai, Hills and Mountains at the national level. However, with USAID direction, the focus was limited within the Western Development Region.

1.4 Study limitations

There are a few limitations to this study which are described below:

i) Status of FSM in the rural areas has not been captured in this study. Although the scope of the assessment was initially proposed for both rural and urban towns, this study presently only focusses on emerging/small towns' in the Hills and Terai region. This was decided on the basis of our understanding that the need of FSM is more pronounced in urban areas, given their high population density, settlement size and severity of multiple problems related to proper sanitation and hygiene.

ii) Situation of FSM in the mountain region was also not assessed in this study; the assumption being less severe FSM problems in this area due to sparse settlements as compared to dense inhabitation in Mid-Hills and Terai. . Nevertheless, there is still a pressing need for assessment of FSM situation, especially in the District headquarters, as some of these headquarters in the mountain region have recently attained an urban status, with the declaration of new municipalities by the Government of Nepal.

iii) A detailed assessment of the towns is necessary to recommend or propose potential combinations of treatment technologies and the operation modality for FSM. However, such an assessment was not conducted during the study period although key

stakeholders were consulted to collect their inputs with regards to the status and future direction for FSM at the town level.

1.5 Study area

The assessment was conducted in nine small and emerging urban towns of the Western Development Region of Nepal. The region was prioritized based on USAID's recommendation to the study team. Within the development region, towns located in the Mid-Hills and Terai were selected for the study in consultation with the Small Town Water Supply and Sanitation Sector Project (STWSSSP) Office at Department of Water Supply and Sewerage (DWSS). A total of 10 urban towns located in six districts were visited during the study (Table 1). Figure 1 shows the map of study area and the specific towns that were visited as part of this study.

Table 1: Study area, towns and districts

Districts	**Small Towns**	**Population**	
		Municipality	Service area*
Mid Hill			
Gorkha	Gorkha Bazaar	39,262	7,500
Kaski	Lekhnath	68,622	43,000
Lamjung	Bhote Odaar***	20,475** Sundarbazar	7,560
	Besi Shahar***	26,640**	13,150
Myagdi	Beni	28,51**	
Tanahun	Bandipur	15,591**	3,400
	Khairenitar	38,307** Shuklagandaki	14,500
Terai			
Nawalparasi	Bardaghat	34,717**	20,000
	Kawasoti	56,788**	28,000

Source[1]: Municipality population: http://www.muannepal.org.np/;
Bhote Odaar Population: http://cbs.gov.np/wp-content/uploads/2012/11/VDC_Municipality.pdf
Note: * service area of the STWSSSP; ** Municipalities declared in 2071 BS; *** not under STWSSSP

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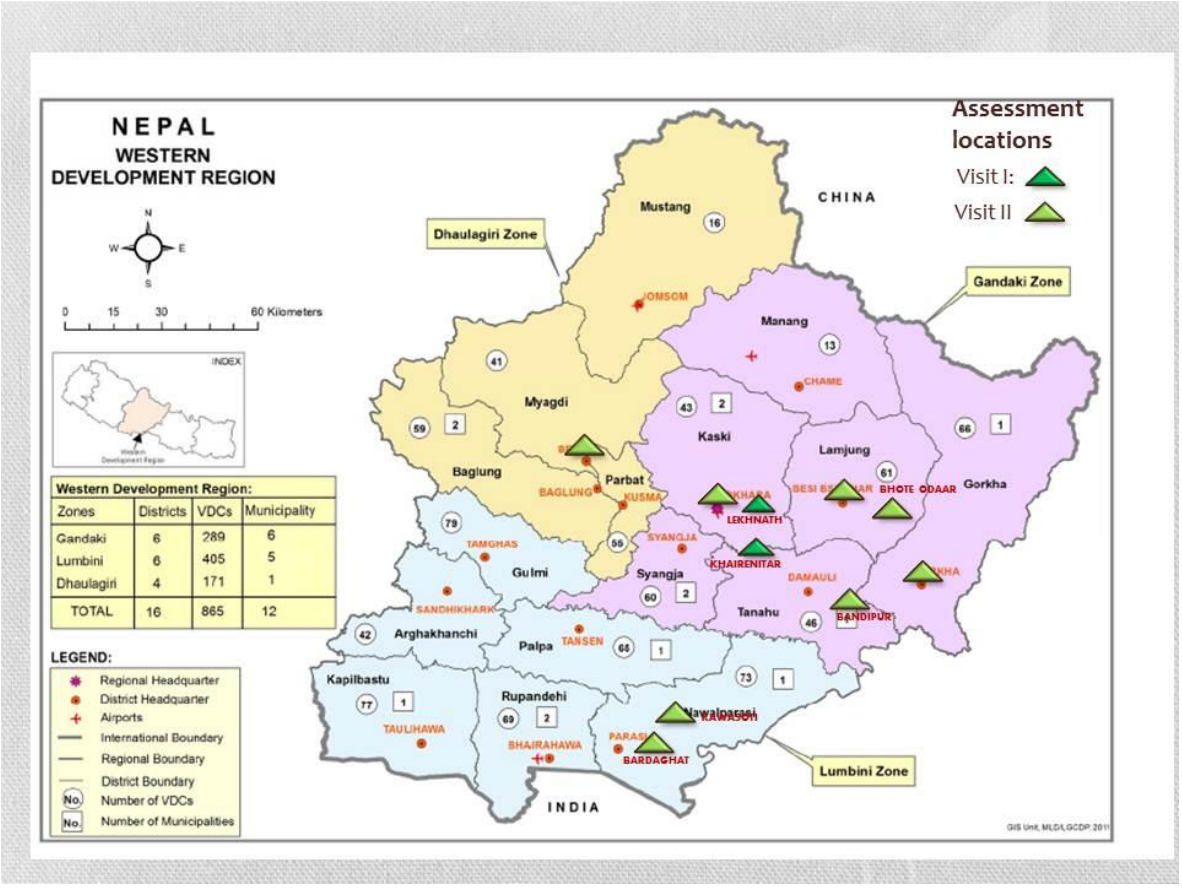


Figure 1: Towns visited in the Western Development Region

1.6 Methodology

This section provides an overview of the methodology adopted for this study in a step wise manner.

1.6.1 Desk review

A number of relevant literatures on FSM and urban sanitation were reviewed to collect background knowledge on the topic. Extracts from the review have been incorporated throughout several sections of this report.

1.6.2 Town selection

Towns and emerging settlements falling into the criteria of Small Towns, as defined by the Government of Nepal (GoN), was the fundamental basis of the selection. The updated 15-Year Development Plan for Small Towns Water Supply and Sanitation and Sanitation Sector (2009) has defined following identifiers for small town as:

(i) have a population size of 5,000 to 40,000 (Hills and Terai);
(ii) be located on a road linked to the strategic road network;
(iii) have at least one lower secondary school and a health post, in addition to grid electricity, basic telecom, banking etc.

The Plan has identified 233 small towns in addition to the 29 towns covered under STWSSSP-I and 3 towns covered under JICA project, with a total of 265 possible small towns as against 209 towns identified in the previous 15-year Plan.

The final selection of towns in the Western Development Region was based on the recommendations from the Small Town Water Supply and Sanitation Sector Project (STWSSSP) office[2]. These towns were tallied with the areas/districts falling under the *Hariyo Ban*[3] programme. Towns which were part of the STWSSSP and the *Hariyo Ban* program were prioritized for the assessment. However, additional towns which did not fall into the later criteria, were also selected for the assessment.

1.6.3 Consultation with local Stakeholders

Following the selection of study locations, meetings and interactions were held with local level stakeholders to understand the local sanitation situation with focus on FSM, community understanding and interests on the issues and importance of FSM. The following local stakeholders were consulted:

1. The Small Town Water Users' and Sanitation Committees
2. Divisional Chief of the Divisional District Water Supply and Sanitation Office at Tanahu, Nawalparasi and Gorkha
3. Sub-divisional Officer of the Divisional District Water Supply and Sanitation Office in Myagdi
4. Chief Executive Officers at Gorkha, Shukla Gandaki and Bardaghat Municipalities
5. Two FS entrepreneurs from Bardaghat and Pokhara

[2] STWSSSP is an integrated water and sanitation project funded by the Government of Nepal and ADB. Users invest 50% of the total cost for the water supply component, a unique model implemented in Nepal. The project is now in its third phase and will be implemented in 26 small towns. Late Mr. Binay Shah, who headed the Project Management Office (PMO) of the STWSSSP Phase II was very helpful in coordinating and recommending suitable towns for this study.

[3] *Hariyo Ban* is USAID funded program on forest conservation and is being implemented in selected district of the Western and Far Western Development Region.

2. SANITATION CONTEXT

This chapter provides first, a theoretical perspective to the sanitation systems concepts. Second, it provides an overview to the concepts to sanitation with an existing sanitation situation in Nepal especially with reference to sanitation in urban areas, status of policies and plans, institutional setting, faecal sludge management scenario, and existing challenges and gaps in the urban sanitation sector.

2.1 Sanitation Systems

Sanitation system refers to the entire sanitation chain from the point of generation to the point of treatment and end use or in other words from cradle to grave (Tilley *et al.*, 2008). According to Tilley et al, 2008, it "is a context-specific series of technologies and services for the management of these wastes (or resources), i.e., for their collection, containment, transport, transformation, utilization or disposal. Sanitation system also includes the management, operation and maintenance (O&M) required to ensure that the system functions safely and sustainably".

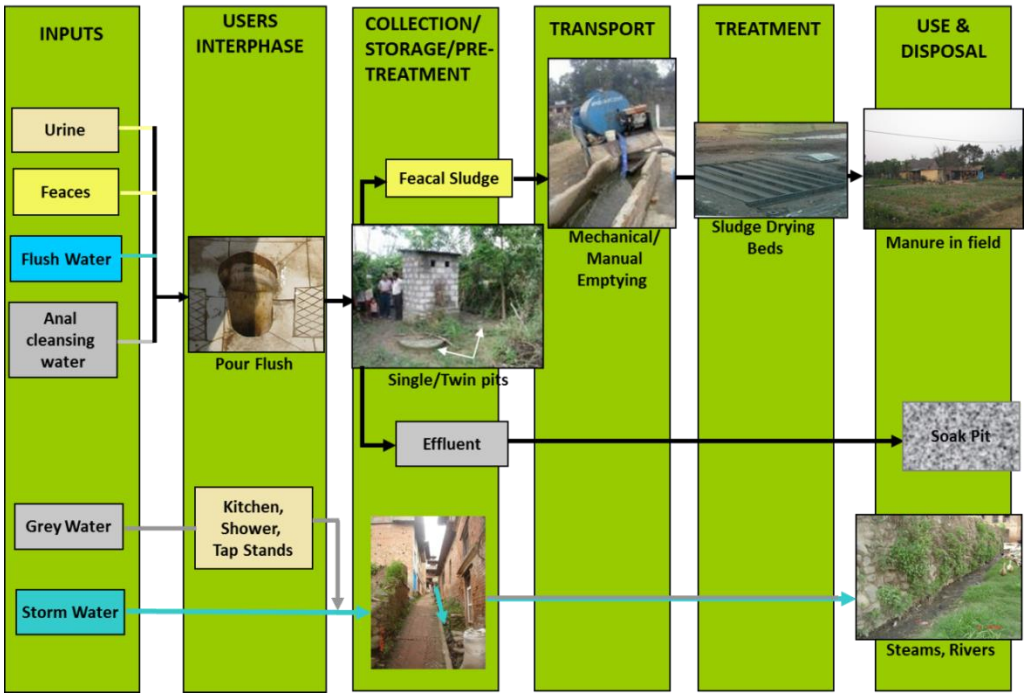


Figure 2: Pour Flush Satiation System
Source: M. Sherpa (2011)

Sanitation system is a combination of various technologies required to manage the waste generated from origin to disposal and can have a maximum of five functional groups: (i) user

interface; (ii) collection and storage/treatment; (iii) conveyance; (iv) (semi-)centralized treatment; and (v) use and/or disposal.

A sanitation system template[4] as shown in Figure 2 depicts a pour flush type sanitation system. In the figure, the system inputs are shown on the left hand side (urine, faeces, anal cleansing water, flush water) passing through different functional groups while passing from left to right. Likewise, other system inputs include grey and storm water.

2.1.1 Improved and Unimproved Sanitation

JMP has categorized different sanitation technologies prevalently promoted and used as improved and unimproved. An improved sanitation facility hygienically separates human excreta from human contact so that it does not pose risk to human health (UNICEF and WHO 2012). Technologies under the improved category include cistern/pour flush toilet connected to piped sewer system (including conveyance, treatment and disposal), septic tanks or pits, ventilated improved pit latrine, pit latrine with slab and composting toilet, Similarly, the unimproved category lists cistern/pour flush toilet where the excreta is flushed to the street, yard/plot, open sewer, a ditch, a drainage way or other location, open pit latrine, bucket toilet and hanging latrine. Shared or public sanitation facilities are not considered improved under the JMP definition as these are not reliable in terms of hygiene and accessibility (UNICEF and WHO 2012).

2.1.2 On-site vs. Off-site Sanitation System

An on-site sanitation system combines collection, treatment and disposal of excreta at the point of generation. This form of sanitation system is predominantly promoted in rural and peri-urban areas of developing countries as a campaign to increase access to improved sanitation. Depending on use of water, on-site sanitation systems can be further categorized as wet or dry (WASH Help desk). While single pit system can function both as wet and dry system, waterless system with alternating pits and with urine diversion are examples of dry systems. Likewise, pour flush system with twin pits and black water treatment system with infiltration are wet systems.

According to the definition in WASH Help desk, in an off-site system, human wastewater stored on-site is transported away from the point of generation for treatment and use and/or disposal and can further be categorized as centralized and decentralized. Number of households connected to a community level treatment facility forms a decentralized system. Black water treatment system with infiltration can also be established as a decentralized system. Systems using constructed wetlands are also successfully demonstrated decentralized systems. When more than one community is connected to a treatment facility, it is taken as a centralized

[4] A system template defines a suite of compatible technology combinations from which a system can be designed. Each system template is distinct in terms of the characteristics and the number of products (wastes or resources such as urine, feaces, etc.) generated and processed (Tilley, Elizabeth et al., 2008)

system. The most prevalent system is conjugated with the conventional wastewater treatment facility. Decentralized systems are gaining popularity especially in the urban settlements of developing countries with its multiple benefits in terms of affordable investment with a sustainable community ownership and management.

2.2 Urban Sanitation

With an annual urbanization rate of 2.7%, Nepal is among the most rapidly urbanizing countries in South Asia. Small and emerging towns are expanding at an alarming rate in the country, with around 265 small towns already identified by the Government of Nepal (GoN)[5]. More importantly, lack of a clear, long-term urban development plan, and inability to address long-term urbanization problems are giving rise to a haphazard urban sprawl, as has been observed in many small towns and settlements of the country. With the increase of municipalities from 58 to 191 in 2014, many of these towns have been converted into new municipalities. Such urban growth has significantly increased the national urban population from 17% (2011) to 38% (2014). However, majority of these municipalities have weak institutional capacities and inadequate resources to address urbanization problems. The unchecked pattern of urban development will seriously pose numerous challenges in the long run and will require increased investments in re-designing and rebuilding urban infrastructure like sewers, storm water drainage, wastewater treatment facilities within a built city environment.

Coordinated efforts towards meeting the MDG target on sanitation has resulted in a massive increase in the construction of toilets - mostly pit latrines, septic tanks - particularly in the developing countries including Nepal. The National Open Defecation Free (ODF) campaign backed by the National Hygiene and Sanitation Master Plan (NHSMP) further gave impetus to the nationwide toilet coverage and momentous declaration of ODF areas over the past years. As a result, the urban sanitation coverage in Nepal has increased from 80% to 91% and rural sanitation from 25% to 55% from 2000 to 2011 (CBS, 2011).

However, taking into account the massive toilet and ODF campaigns, the actual practices in urban sanitation has ceased to change or innovate over the last decade. Urban FSM and sustainable sanitation is still a big problem development practitioners face today and remains almost stagnant, mainly due to rapid population increment in the municipal and other urban areas and poor address of the sanitation needs of informal settlements such as slums and squatter areas[6].

Compared to rural sanitation, urban sanitation has its own complexities and therefore poses major challenges to be adequately addressed, thereby ensuring minimal risks and damages to the environment and public health considering sanitation from a systems perspective, even though access to sanitation is better in urban areas, treatment and safe reuse/disposal mechanism are completely lacking.

[5]15 year Development Plan for Small Town Water Supply and Sanitation
[6]MAF Report

2.2.1 Sanitation Facilities in Urban areas

Sanitation facilities in most urban areas are predominantly on-site (Figure 3). As per census 2011, 30% of population has toilets connected to sewer system while 48% have septic tanks. This indicates that on-site sanitation system is still the predominant form of urban sanitation system in the country.

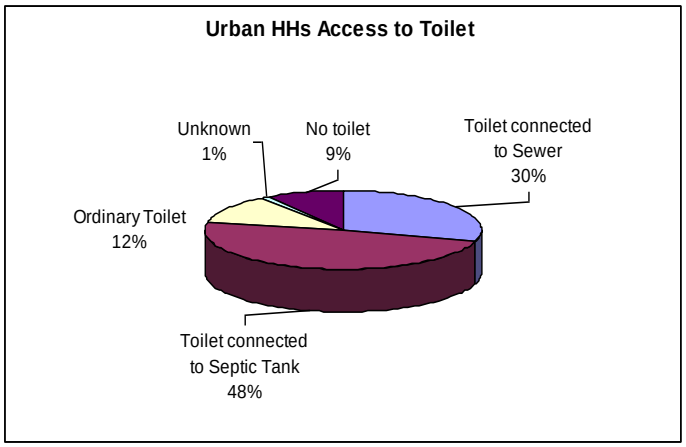


Figure 3: Toilet access in Urban Areas
Source: CBS (2012)

Limited sewer connection exists only in few major city areas like Kathmandu. A study in Kathmandu Valley conducted to characterize the onsite sanitation systems shows that 50% of the septic tanks are single chambered and 45% are double chambered. Likewise, a case study from Panauti Municipality shows that 78% of the septic tanks were single chambered (ENPHO, 2015). In the absence of septic tank design guidelines in Nepal, what households construct as a septic tank is predominantly nothing more than simple holding tanks.

2.2.2 FSM in Urban Areas

Emptying, collection, transportation, and treatment of FS in urban areas are largely unregulated. Study results from Kathmandu Valley and Panauti (ENPHO, 2015) shows that a high percent of septic tanks and pits are never emptied. Those emptied are usually done due to overflow indicating that a regular emptying practice has not been followed at the household level. Households predominantly utilize services of private mechanical emptier and small percent of household either contact manual emptier or go for self-emptying. In the absence of FSM systems, sludge from the septic tanks or pits and wastewater are either dumped into nearby rivers or on marginal land without any treatment. Manually emptied sludge is either collected in a pit dug nearby or discharged into sewers in the urban areas. Kathmandu Valley, which hosts five large municipalities and many newly formed small municipalities, does not yet have a FSM system in place. Also, less than 5% of the wastewater generated in the Valley is treated while remaining is directly discharged into the rivers.

2.3 Rural Sanitation

As per the government definition, settlements with a population size below 1000 inhabitants are considered as rural areas. In principle, settlements that are not classified as urban belong to the rural category. Rural sanitation has

2.3.1 Sanitation Facilities in Rural areas

A list of on-site sanitation options promoted by the Department of Water Supply and Sewerage (DWSS) and other sector stakeholders is provided in Table 2. Among these options, the most common is the single or double pit systems. The pits are generally made of concrete rings or stone masonry walls while superstructures can vary based on costs and availability of materials. Ecosan or urine diversion toilets have been promoted but implementation is still only at a smaller scale by various agencies.

Table 2: Sanitation options promoted in Nepal[7]

	Types of onsite sanitation system	Descriptions
1	Pit Systems	The technology is based on use of a single or double pit technology to collect and store excreta. The system can be used with or without flush water depending on the water availability and local habits. When the pit is full, it can be filled with soil and plants can be grown on it. Alternatively, FS generated has to be removed and transported for further treatment.
1.1	Water seal, offset type, single pit latrine	Similar to single pit system but the location of pit is offset type
1.2	Water seal, direct type, pit latrine	Similar to single pit system, location of pit underneath the pan
1.3	Ventilated Pit Latrine	Similar to single pit system, ventilation pipe installed to get rid of the smell
2	Latrine Option for Differently Able People	Similar to pit system with modification in the toilet super structure. Provision of access ramp, removable chair with arm rest
3	Latrine with Septic Tank and Soak Pit	Toilet connected to a Septic Tank with Soak Pit (no designs are available)
4	Ecosan Latrine (Dry Type)	Urine diversion toilet where feaces is kept dry and composed using additives such as ash. Urine is used as a fertilizer after dilution with water at 1:3. Anal cleansing water is treated separately in a small wetland.
5	Ecosan Latrine (Wet type)	Urine is diverted and used for agriculture. Feaces is mixed with flush and anal cleansing water and stored in pits.

[7] DWSS chart on different types of household toilets

6	Latrine attached to biogas	Latrine is attached to an airtight biogas reactor where the sludge from the latrine and other biodegradable waste is degraded producing (a) biogas which can be used for cooking or lighting and (b) digested slurry, which is not completely pathogen free, but can be used as fertilizer.

2.3.2 FSM in Rural Areas

In the rural context, human excreta is mostly managed at the point of generation. Most of the sanitation systems prevalent in the rural areas are on-site systems that are ideally designed not only for collection of human excreta but also for its on-site treatment.

Single pit latrines made of stone masonry walls or simple pits are the prevalent type of sub-structures used for excreta management. The superstructure varies as per households and locations. Likewise, densely settled emerging towns in rural areas also rely on similar type of systems. In the district headquarters, in the recent years storm water drainage have been built but these drainage systems are often misused for discharge of black water.

The section below provides an understanding of how FS is managed in some of the prevalent onsite sanitation systems in rural areas:

Single Pit Latrine

When a pit gets filled it is covered with soil and left to decompose naturally and an alternate pit is dug. Depending upon the size of the pit and the design (eg. permeable or impermeable walls and base), it can be used for many years without emptying.

Twin Pit Latrine

Similarly, in case of twin pits, when one pit is filled it is allowed to rest and undergo drying and desiccation while the second is in use. Once the second pit is also filled, it is covered and the first pit is emptied and put to use. Due to the long resting time of at least 6 months from covering, the pit content is usually sanitized and humus-like. This material is suitable for application in agriculture land directly or after co-composting with solid waste. This cycle can continue indefinitely if the structure is sturdy and well maintained. However, one of the major drawbacks with pit system is its quick filling in areas with high groundwater table and the subsequent pollution of groundwater.

Ecological Sanitation

In the case of dry Ecosan toilet, the basic principle is to utilize separated urine in agriculture as fertilizer and the dried and hygienised excreta as soil conditioner to improve the agricultural productivity. Each chamber of an Ecosan is designed to rest for at least 6 months to ensure

sanitization of the stored faeces. Water is not used in dry Ecosan and dry material like saw dust and ash is used as additive materials, creating an ideal environment for desiccation and pathogen removal from the stored faeces. With wet Ecosan, urine is separated and faeces is collected in single or double pits.

2.4 Legal Framework

There are many water and sanitation related policies and strategies in place, the most important and the recent being the NSHMP, 2011-2017. Legislation on water & sanitation service provision has evolved quickly over the past decades, with inconsistencies in different laws due to different ministries leading the development of sectoral legislation. The major inconsistencies include overlapping mandates given to different ministries, lack of implementing regulations and supporting standards and the issue of poor enforcement of regulation. Furthermore, there is less coverage of sanitation and urban sanitation related issues in existing legal documents (SNV, 2014).

Furthermore, none of the policies and plans relevant to urban WASH has specifically addressed the issue of FS and its management. In the National Urban Water Supply and Sanitation Policy (final draft, 2009), one of the key objectives is to ensure the availability of basic, safe, accessible and adequate water supply and sanitation services to all urban populations for improved quality of life. However, among several strategies outlined, the most relevant ones with reference to FSM indicates needs to develop and implement appropriate on and off-site sanitation systems but does not provide direction for management of FS generated from these on-site systems. The NSHMP also fails to adequately address the issue of FSM. In the absence of guiding policies and operational plans on FSM, unsafe handling and illegal disposal practices of FS and formalization of the sector has so far remained unaddressed.

Recently, GoN is in the process of preparing WASH Act, WASH Policy and National WASH Sector Development Plan (SDP) which is envisioned to address WASH in a holistic manner and to shape the post-ODF strategy for the nation. The SDP highlights environmental sanitation as one of the challenges that needs to be addressed in urban towns and municipalities. It defines the scope of environmental sanitation to include management of on-site sanitation, solid waste and wastewater, as well as surface drainage. As an action step, the SDP recommends establishing decentralized systems to address FSM in towns.

2.5 Institutional set up

The Ministry of Urban Development is the lead ministry in the WASH sector. Table 3 below give the list of institutions engaged in the sector and their responsibilities.

Table 3: Institution in WASH, their roles and responsibilities[8]

Ministries/agencies	**Roles and responsibilities**
Ministry of Urban Development (MoUD)	Lead -WASH
Department of Water Supply and Sewerage (DWSS) Water Supply and Sanitation Division Offices (WSSDOs) Water Supply and Sanitation Sub-Division Offices (WSSSDOs)	Department under MoUD; lead execution and facilitation in all the 75 districts
Regional Monitoring Supervision Offices (RMSOs)	Agency under DWSS; monitoring and supervision of WASH interventions in the region concerned
Rural Water Supply and Sanitation Fund Development Board (RWSSFDB)	Programme under MoUD; facilitation of implementation of the rural WASH programme through non-government organizations in selected districts and communities
The Ministry of Federal Affairs and Local Development (MoFALD)	Facilitation of implementation of small water supply and sanitation projects Guidance and support to DDCs, Municipalities and VDCs for implementing WASH programme at local level
Department of Local Infrastructure and Development of Agriculture Roads (DoLIDAR) District Technical Offices (DTO)	Department under MoFALD; facilitation of implementation of small water supply and sanitation projects
Ministry of Education (MoE) Departments District Offices	Coordination and implementation of school WASH programmes across the country
Ministry of Health and Population (MoHP) National Health Education, Information, Communication Centre (NHEICC) Department of Health Services (DoHS) District Offices Grassroots Network	Promotion of health, hygiene and sanitation initiatives with specific attention on hand-washing with soap and improved hygiene behavior through a nationwide campaign
Coordination Committees	**Roles and responsibilities**
National Level National Sanitation and Hygiene Steering Committee (NSHSC) Constitutes of representatives from the National Planning Commission (NPC), key sectoral ministries viz. MoUD, MoFALD, Ministry of Finance (MoF), MoHP, MoE and Ministry of Women, Children and Social Welfare (MoWCSW) and sector stakeholders actively engaged in the sector	Responsible for bringing all stakeholders concerned—governmental and non-governmental—to one platform to review progress, document lessons learnt and recommend the NSHSC and sectoral ministries for appropriate actions
Regional Level R-WASH-CC	Operational in the five development regions for providing overall guidance, dissemination of policy documents, capacity building, knowledge-

[8] JSR Report, 2013

	sharing and regular monitoring of sanitation and hygiene campaigns in the region
District Level District Development Committee D-WASH-CC M-WASH-CC V-WASH-CC	 Lead coordinating local body Chair of D-WASH-CC Responsible for overall planning, coordinating, monitoring and providing strategic guidance for sanitation and hygiene promotion throughout the district with a common approach and result framework. Responsible for planning and facilitating operation of sanitation and hygiene programmes at the Municipal level Responsible for planning and facilitating operation of sanitation and hygiene programmes at the VDC level

2.6 Past and Current Initiatives on FSM

Over the past decade, a number of studies and researches have been done on different aspects of FS and its management. These studies have been helpful in understanding the status of FSM and stakeholders active in the FSM business. A strategy document was also prepared which provided guidance on managing FS of Kathmandu Valley. Table 4 provides an overview of the different studies undertaken till date. Table 5 provides an overview on established FSM systems and their current status.

Table 4: Past Studies on FSM in Nepal

Year	Topic	Who	Remarks
2005	MSc. Thesis study on FSM in Kathmandu Valley	Sherpa, M.G.	Analysis of Kathmandu Valley's FSM status and recommendations
2011	Study Report on: Status & Strategy of FSM in Kathmandu Valley	HPCIBID UN-HABITAT	Analysis of Kathmandu Valley's FSM status, treatment design for BASP and business model
2014	Study on Private Sector Engagement in FSM in Kathmandu Valley	BMGF/DFID ENPHO	Identified challenges for private sector involvement in FSM
2014	Landscaping of FSM in Birendranagar Municipality	SNV ENPHO	Situational analysis of FSM in Birendranagar
2015	FSM assessment of FSM in Small Towns	USAID ENPHO 500B Solutions Pvt. Ltd.	Situation assessment of FSM in selected small towns - ongoing

In addition to the above research works, SNV Nepal has recently conducted a research study on farm use of FS in Birendranagar Municipality, Nepal through a multi-barrier approach. The research focusses on four barriers, viz. treatment process (fermenter pool technology), occupational safety (use of protective gears), application method (fertigation) and withholding period (stop application one month prior to harvesting)[9]. The study is still at its preliminary stage and concrete results are yet to be known on the safety of the treated FS and health of the harvested crop including the nutritional benefit to the crops.

Likewise, a researcher collaborating with the International Water Management Institute (IWMI) office in Nepal had also conducted some interview with private FS entrepreneurs in Kathmandu Valley. However, there were no significant outcomes from the study which was documented.

Table 5: Overview of FSM systems established in Nepal

Year	Description	Budget (USD)	Remarks
1998	The first FS treatment system was established in the Teku Transfer Station as part of a PhD research project. The system was designed by Environment and Public Health Organization (ENPHO) and established with funding from Kathmandu Metropolitan City. The operation and management of the system was also undertaken by KMC. In addition to KMC suction vehicles, private vehicles also brought sludge for disposal in the system. However, as a result of operation and management problems, the system was shut down and is not in an operational condition anymore. As of now, KMC has no plans for its revival and to provide FS treatment service in the Valley.	28,000	Constructed, operated and already demolished
2000	A treatment system was established in Pokhara within the landfill site area to treat FS and leachate from the landfill (Figure 4). The system was designed jointly by East Consultant Pvt. Ltd. and ENPHO and the system was established with the support from ADB. However, the system was closed after 6 months of operation due to public opposition. Since then, no steps have been taken to bring it back to operation by the concerned authorities.		Non-functional at present
2011	A decentralized wastewater treatment system was established in a peri-urban community of Nala in Kavre District to treat black water for a population of 2300. The system was the outcome of a Community Led Urban Environmental Sanitation (CLUES) process in the community through collaboration of the community, EAWAG, UN-HABITAT, ENPHO and WaterAid. The system consisted of a	165,000	Fully operational. Contact person Mr. Shyam Shrestha, Chairperson of Users Group (9841608775, 9851095158)

[9]National FSM Workshop presentation: On-Farm Use of Faecal Sludge- Example from Birendranagar Municipality, N. Khawaja, WASH Sector Leader, SNV Nepal

	simplified sewerage network for black water collection and conveyance, combined with a wastewater treatment facility[10].		
2014/15	Under the ADB support, the STWSSSP- Phase II is in the process of establishing demonstration projects on FSM in 6 small towns viz. Vyas, Mukundapur (Figure 5), Rampur, Dhankuta, Letang and Darakh-Sukhad. The treatment facility in all the 6 towns will comprise of sludge drying beds in addition to evaporation pond and composting in Vyas. Similarly, in the STWSSSP, Phase III FSM is proposed for 14 towns out of which 4 towns are under study for design under the BMGF/ADB funding[11].		Under construction. Some of the infrastructures have been built during submission of this report. Contact Small Towns Project Office for details
2014/15	With financial support from WaterAid Nepal, ENPHO is in the process of improving an existing FS treatment facility in Panauti Municipality through action research, effective planning and collaboration with local stakeholders. This project will also demonstrate pragmatic PPP model on FSM for sector learning. Overall purpose of the project is to safeguard the environment including water bodies of Panauti Municipality.	55,700	Assessment study completed, infrastructure improvement works in progress
2015	ENPHO in partnership with Practical Action and Gulariya Municipality are planning to establish a central level FS treatment facility in Gulariya Municipality. The facility will consist of equalization tank, sludge drying bed, anaerobic baffled reactor, horizontal constructed wetland and polishing pond[12]. The project will also develop a business plan for effective O&M of the system.	20,000 from project; land contribution from municipality	Design completed, infrastructure work not started yet

[10] Manandhar Sherpa *et. al*, 2013. CLUES: Local Solutions for Sanitation Planning (http://www.eawag.ch/forschung/sandec/publikationen/sesp/dl/nala_flyer.pdf)
[11] Presentation: M. Bhattarai, Nepal
[12] M.G. Sherpa and B. Dangol, Nepal

Figure 4: FSTP showing Sludge Drying Beds and Constructed Wetlands, Pokhara

Figure 5: Sludge Drying Beds (under construction), Mukundapur, Nawalparasi
Photo source: M. Bhattarai (2015)

2.7 Key gaps and challenges

Past studies on FSM have identified a number of gaps and challenges. For example, ENPHO under the financial support of BMGF conducted a study to assess the status of FSM in the Kathmandu Valley in 2014. During interactions with private FS entrepreneurs, a number of gaps and challenges in FSM were identified and prioritized:

- In the absence of FS treatment facility, the private entrepreneurs are compelled to dispose the collected FS into an open environment

- Due to the lack of policy on FSM, role of the private sector is informal and unrecognized creating numerous operational challenges on a daily basis:
  - Social stigma where FS service providers are looked down upon
  - FS pumping devices that are assembled locally are not effective in pumping out all the contents from the septic tanks/pits;
  - As routine cleaning is not practiced at households, old aged septic tanks are difficult to empty due to high solids content.

- Due to foul smell, private operators face social and public opposition especially during FS haulage and disposal

- Due to the competitive behavior among the handful of private FS entrepreneurs, they are not being able to capitalize on the potential benefits of working together

In addition, the recently held National FSM workshop[13] also identified a number of key gaps and challenges on FSM at the policy level:

1. In the absence of guiding policies and operational plans on FSM several issues remain unaddressed, such as:
   - there are no checks to control unsafe handling and illegal disposal of FS,
   - role of private sector, mainly their involvement in the collection and emptying of FS, remains informal,
   - even when the national building code mandates construction of septic tanks for households not connected to sewer network, there is no guideline available with design specifications for septic tank construction[14],
   - due to an unregulated sector, private FS entrepreneurs have a monopoly over emptying fees.

[13]The first National FSM Workshop was held in Kathmandu from March 16-17, 2015. It was organized by Government of Nepal and ADB

[14] If required international septic tank construction guideline could be referred to while developing the same for Nepal.

2. There is lack of clear mandates among different institutions involved in urban sanitation. Overlapping roles and responsibilities and lack of coordinated efforts among the different institutions have led to piece meal approaches to addressing sanitation problems in urban areas.
3. The weak institutional capacities, coordination and planning, lack of trained and dedicated human resources and an inconsistent support mechanism are the major factors behind the poor implementation of the existing policies.
4. There is also lack of knowledge and awareness among the sector stakeholders including lack of human and institutional capacity on FSM at different levels. FSM has not been a priority agenda till date both at the national and local levels. National movement on sanitation has focused on increasing basic sanitation coverage through the national ODF campaign but there are no clear strategies and actions beyond ODF.
5. There are no sustainable financing strategies or mechanism to support establishment of FSM systems and the investments made so far has been project specific.

Furthermore, some of the *operational challenges* that were discussed during the national workshop were[15]:

1. In dense urban settlements, pits are not always accessible due to narrow lanes and roads
2. As routine cleaning is not practiced at households, old and aged septic tanks are difficult to empty due to high solids content.
3. In the absence of disposal and treatment facilities, people are forced to dispose FS into open areas such as forests and water bodies and face public opposition.
4. Septage management projects often over-focus on infrastructure (procurement of equipment/sludge drying bed) and forget to address the software aspects.
5. As with sewage treatment projects, O&M costs and roles are undervalued.
6. One of the major bottlenecks in establishing public sanitation facilities and waste and wastewater management facilities is unavailability of land in urban areas. In many instances, where land is available, bad experience of existing facilities leads to public opposition in establishing new ones.

[15] FSM National Workshop, March 16-17, 2015, Output Report (Draft)

3. TREATMENT OPTIONS AND MANAGEMENT ASPECTS

This section provides an overview of the FSM treatment options and management aspects including design considerations for proper FSM planning, health concerns with a few examples of FS treatment cases around the world.

3.1 FS Treatment Overview

FS treatment consists of primary and secondary treatment processes. Primary treatment basically involves stabilization of the FS and solids- liquid separation from the FS collected from on-site sanitation facilities. Stabilization of FS decreases odor, the levels of pathogens and further decay of septage. The quality of the solids and liquids after primary treatment depends upon the process adopted.

For a complete treatment, primary treatment process has to be combined or complemented with secondary or polishing treatment processes for further treatment of both the solids fraction (biosolids) and liquid fraction derived from the primary treatment process. A number of FS treatment technologies are available some of which are well established, some are being transferred while a number of technologies are in the research and development phase. Technologies have different fields of application where some can be used for treating fresh sludge (eg. from public toilets) while some are better suited to treat digested FS (eg. from septic tanks) or pretreated FS. Figure 6 gives an overview of potential modest-cost options for FS treatment.

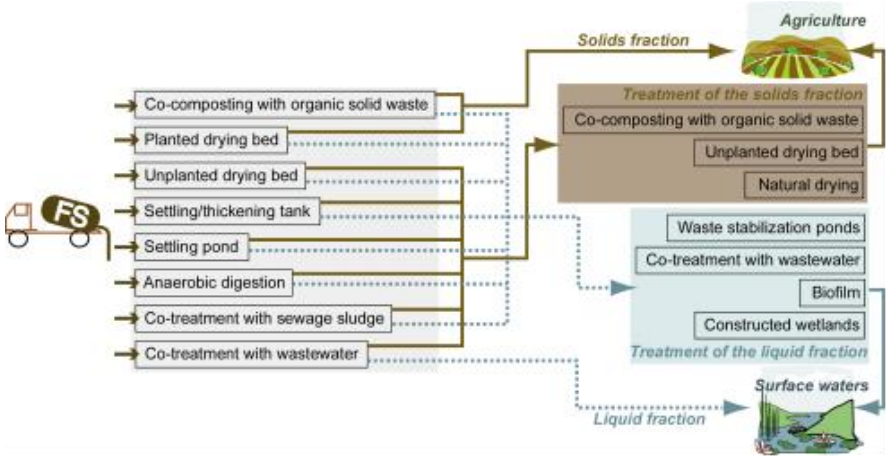


Figure 6: Overview of treatment options[16]

3.1.1 FS Treatment Technologies

FS can either be co-treated with wastewater or with sludge generated from the wastewater treatment plants. However, where this is not a feasible option due to distance to the treatment facility or the capacity of the facility, separate treatment system for FS is a better option. Such

[16] *Strauss & Montengero, 2002*

dedicated treatment facilities have separate processes for treating solids and liquid fractions of FS. Treatment using natural processes, including waste stabilization ponds, unplanted sludge drying beds, constructed wetlands, and composting are considered as cost-effective solutions. Anaerobic digestion (with biogas generation), lime treatment and mechanized systems, such as activated sludge process, are also widely used technologies in treating septage.

Table 6 gives a list of technologies options used for primary and secondary treatment of FS along with the advantages and disadvantages of each technology . In developing countries like Nepal, to prevent haphazard disposal and pollution of water bodies as well as to minimize total management cost, decentralized or semi-centralized FS treatment units are more appropriate. As per experience, using small to medium size FS treatment systems can help to minimize FS haulage volumes and thus reduce the treatment cost borne by the operators of FS emptying facilities

Table 6: List of technologies to treat FS

	Treatment Options	Description	When to use	Advantage	Disadvantage
1	Co-treatment of raw fecal sludge (FS) with sewage or sewage sludge	Treatment of FS together with sewage where FS is mixed with sewage before treatment or with sewage sludge before sludge treatment	Presence of sewage treatment plant which should have enough capacity to receive the additional FS	Economic; do not require sludge stabilization and post treatment	Reuse of FS as resource is not possible
Primary treatment of fecal sludge					
2	Anaerobic digestion and biogas production	Fresh FS that contains biodegradable organic matter is digested anaerobically either alone or mixed with animal dung or vegetable waste. Methane gas will be produced and utilized for cooking or lightening	Potential for use of biogas; fresh FS such as that collected from public toilets is necessary; animal dung or vegetable waste is necessary for mixing	Energy can be generated; fresh FS can be stabilized; less area is required	Higher cost of installation; additional treatment is required; difficulties in removing settled and thickened solids in the reactor
3	Settling and digestion (Imhoff tank)	It is developed for pre-treatment of wastewater in small treatment systems. Solids will accumulate on the bottom, be stabilized by digestion and thickening	When conditions are not favorable for biogas digesters and when no space for stabilization ponds is available	Settling and digestion in a single step; less land is required.	Expensive structure Risk of blocking of sludge draw-off pipe Frequent removal of sludge
4	Settling/thickening tanks	Solid part of sludge will be accumulated at the bottom. The clarified supernatant effluents need to be further treated. The accumulated sludge needs to be removed periodically.	Partly stabilized sludge such as that from septic tanks	Simple and reliable process Less area required	Not suitable for fresh sludge
5	Sedimentation/stabilization ponds	Similar with settling tanks. However, the ponds are larger, and the sediment removal interval is longer	Sufficient land is available Used for fresh sludge	Simple in operation, Cost of construction, is less Sedimentation and stabilization capacity is better than the settling tanks	Large area is required
6	Drying beds	Consist of a gravel-sand filter, and have a drainage system. Water is removed by percolation	i) Used for dewatering of partially digested raw or pre-settled FS. ii) can be used as second stage of dewatering of settled sludge of options 3, 4 and 5	Low moisture content in dried sludge Technology is reliable	Dried sludge will not be completely free of pathogens. It has to be further treated if it is to be reused Not suitable for fresh sludge unless diluted
7	Constructed wetlands	Consist with a drained gravel and sand filter and marsh plants. The sludge loaded in bed will be dewatered by percolation in the filter and evapotranspiration by	If sludge is planned to reuse	Complete system -the process of dewatering, stabilization and hygienization will be achieved	Need to care for plant growth

		plants. The long solids retention period favors further mineralization and pathogen die-off, and allows direct reuse of solids in agriculture		Sludge will be free of pathogen and ready to be reused	
Secondary treatment of liquid fraction					
The liquid and solid obtained after the primary treatment of sludge will not be completely free of pathogens thus requiring further treatment for their safe disposal/reuse. Therefore, secondary treatments are required. The options for secondary treatments of the solid and liquids fractions are tabulated below					
Post treatment of liquid fraction					
1	Co-treatment with sewage	Effluents from primary FS treatment will be mixed and treated together with sewage	Presence of STP STP should have enough capacity to receive the additional FS	The solids fraction is separated during the primary treatment and can be reused in agriculture	
2	Stabilization ponds	The pond can be anaerobic depending upon the organic load in effluents. The remained part of the sludge in the effluents will be accumulated on its bottom which needs to be removed periodically	Sufficient land is available	It is simple, well known and reliable	Require large area The release of NH3/ NH4 in presence of fresh FS may hinder well-functioning of ponds
Post treatment of solid fraction					
1	Drying beds	Consist of a gravel-sand filter, and have a drainage system. Water is removed by percolation (Note: it can be used as primary treatment of sludge or as post treatment of solid waste)	Used as second stage of dewatering of settled sludge of options 3, 4 and 5 (primary treatment)	Low moisture content in dried sludge Technology is reliable	
2	Co-composting with solid waste	Pre-treated FS is composted together with organic solid waste	When compost is desired and is to be utilized Sufficient amount of qualitative solid wastes are available	Offer soil conditioner Utilizes of both sludge and solid waste	Contaminants of solid waste deteriorate quality of compost
3	Storage and natural drying	Storage over at least 6 months allows natural pathogen die-off in dewatered sludge from settling facilities or drying beds. Further drying of sludge contributes to pathogen die-off and increases the safety of the method	When fecal sludge is to be reused in agriculture but the methods of co-composting or constructed wetlands are not favored	Method is cheap and simple	Large area is necessary

3.2 Innovative on-site sanitation technologies

Over the recent years several innovative sanitation on-site technologies have been introduced in the market. While some are still in its experimental phase, some have advanced and are now being trialed in several places. Based on the regional experience of team members of this study, some technologies have been provided in this section for reference. Under the support of the Bill and Melinda Gates Foundation (BMGF), the Dutch organization ICCO together with IDE and DSK (partners of a consortium), have been testing and validating four innovative on-site systems are being in Bangladesh since 2014 under the SanMark City Project[17]. The four technologies are the: Tiger Toilet, Enbiolet, Biofill and SunMar toilets. Out of the four, based on the preliminary validation of these technologies, two systems have shown promising results in the context of urban slums in Bangladesh. These systems have shown potentials for replication in Nepal and in other similar settings. A brief introduction of these systems have been provided below:

ENBIOLET

The Enbiolet® technology, developed by Stone India Ltd., India, decomposes solids by continual bacterial digestion in a multi-chambered digester tank, the design and footprint of which depends on the number of users and the available space (Figure 7). Collection happens in the first chamber and treatment begins as the bacteria breaks-down the accumulated solids through aerobic decomposition. The system specifications indicate that as the waste flows from one chamber to another, the multi-strain bacteria processes waste converting them into water. Chlorine is added to the last chamber to disinfect wastewater prior to environmental discharge.

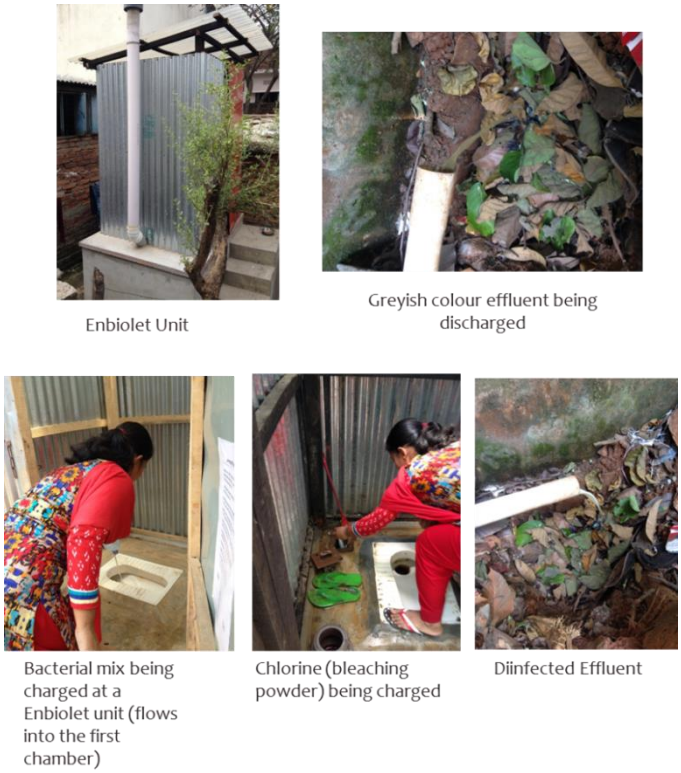


Figure 7: Enbiolet toilet under validation in Bangladesh

[17] Information provided by one of the study team members, who is was part of the SanMark City Project.

BIOFILL

The Biofil® Toilet System developed by BIOFILCOM, Ghana, uses aerobic digestion to decompose fecal matter on-site (Figure 8) . The technology combines the principles of a pour-flush latrine and a composting latrine incorporating simplicity that is desired for local adaptation and ease of use. With a specialized porous concrete drainage filter and by means of rapid separation of solids from liquids, the technology decomposes the retained solids while ensuring free draining of wastewater through bio-filtration. Depending on the local context, the treatment layer is a mix of medium of soil and macro-microorganisms, a handful of earthworms with coconut fiber and hay were used for fecal decomposition in SanMark CITY Project. As indicated by the technology provider, a minimum of three months is necessary for the Biofil Toilet System to reach a state of equilibrium to self-regulate the inflow of waste and wastewater, treatment of waste and outflow of wastewater that is further infiltrated into ground through a soakage pit. Effective drainage is fundamental to the uninterrupted working of Biofil technology.

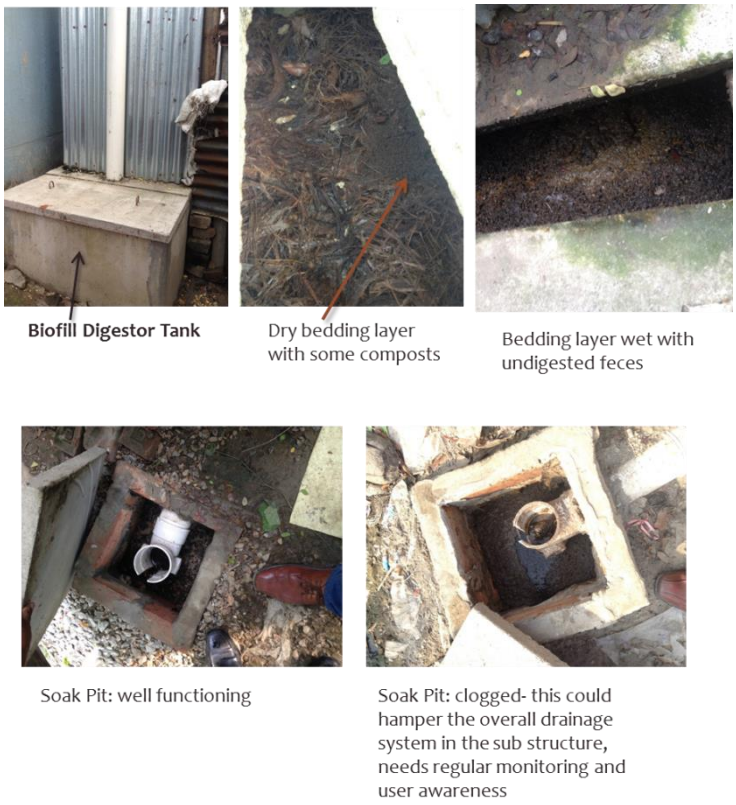


Figure 8: Biofill system under operation in Bangladesh

3.3 FS Management Aspects

The need for proper management of FS arises mainly due to health concerns of FSM. The main objective of FSM is the protection of public and environmental health. This section provides first, an overview on the health concerns of FS and inputs for sustainable FSM design and implementation.

3.3.1 Health Concerns

The high concentrations of nutrients in untreated FS can result in environmental contamination like eutrophication and algal blooms in surface water and drinking water contamination eg. nitrate contamination causing disease *methemoglobinemia*, commonly called the blue baby syndrome. Furthermore, discharge of untreated FS into water bodies can deplete oxygen level affecting the water ecosystem[18]. This can be achieved through pathogen reduction, stabilization

[18] FSM Book, IWA Publishing

of organic matter and nutrients and the safe end-use or disposal of end-products. The major health concerns related to FS are pathogens and heavy metals[19].

Heavy metals

Heavy metals in FS can have toxic effects and have long-term negative impacts on soil. However, risk with heavy metal should be evaluated on a case-by-case basis and it is a major concern only if FS is mixed with industrial effluents or if solid wastes like batteries, solvents, paints, etc. are disposed into the collection tanks. In the context of Nepal, heavy metals contamination might not be a major concern.

Micro-organisms

Microorganisms in FS are potentially pathogenic and exposure to untreated FS anywhere along the service chain constitutes a significant health risk, either through direct contact or through indirect exposure.Understanding exposure pathways and avoiding risky practices is therefore of paramount importance along the entire service chain. Pathogens in FS are organisms or other agents that cause disease like bacteria, viruses, protozoa, helminths, etc. Mode of transmission of these to humans is through infection cycle with different stages and hosts. Among all the pathogens of concern, helminth eggs are highly resistant to inactivation and may remain viable for several years. WHO (2006) guidelines recommends < 1 viable helminth egg / g TS and <1000 E.coli / g TS for use in agriculture. The parameters that play major role in getting rid of pathogens are:

- Time
- Desiccation
- Filtration – physical exclusion
- Partitioning
- Heat
- Irradiation
- Chemical oxidation and
- Predation and competition

Reduction of pathogens can be achieved through stabilization of organic matter and nutrients and the safe end-use or disposal of end-products. But whether or not there are health risks depends on the practices and many factors/parameters along the entire FSM chain.

3.3.2 FSM System design

FS management in settlement and towns should take into account of the entire service chain (Figure 9). The chain consists of containment, emptying, collection/transportation, treatment and safe use and/or disposal of the treated solid and liquid end-products.

[19]National FSM presentation: Safe Use of Faecal Sludge: Overview of Options and Health Considerations, L. Ulrich, Eawag, Switzerland

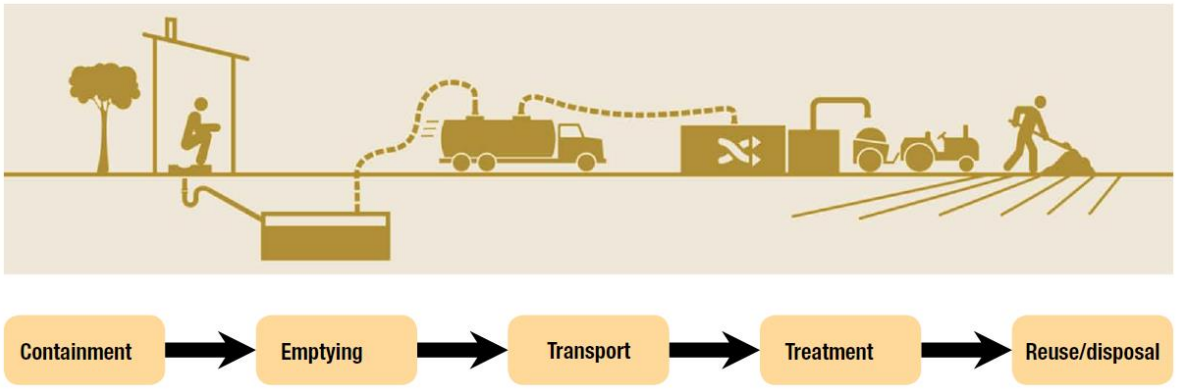


Figure 9: FSM service chain

FSM systems should be designed to meet the end-use goal to avoid both over-design (waste of resources) and under-design (inadequate to protect human and environmental health). While designing an FSM system, all the important design variables should be considered to arrive at an appropriate system. For example, affordability of costs and of skills required for O&M of the facility established should be a consideration as compared to capital intensive and highly mechanized infrastructure. In the long run, it can entail high O&M costs leading to overburdening to the responsible entity, malfunctioning of the system or disuse and ultimate abandonment.

The design variables worth considering are:

a. FS characteristics and quantities
b. Existing FS infrastructure and services
c. Skills and capacities
d. Legal requirements, regulations, norms
e. Social acceptance
f. Operation and management
g. Financial viability

Figure 10 gives an overview of the essential components requiring detailed investigation and analysis to design a FSM system and produce an implementation strategy.

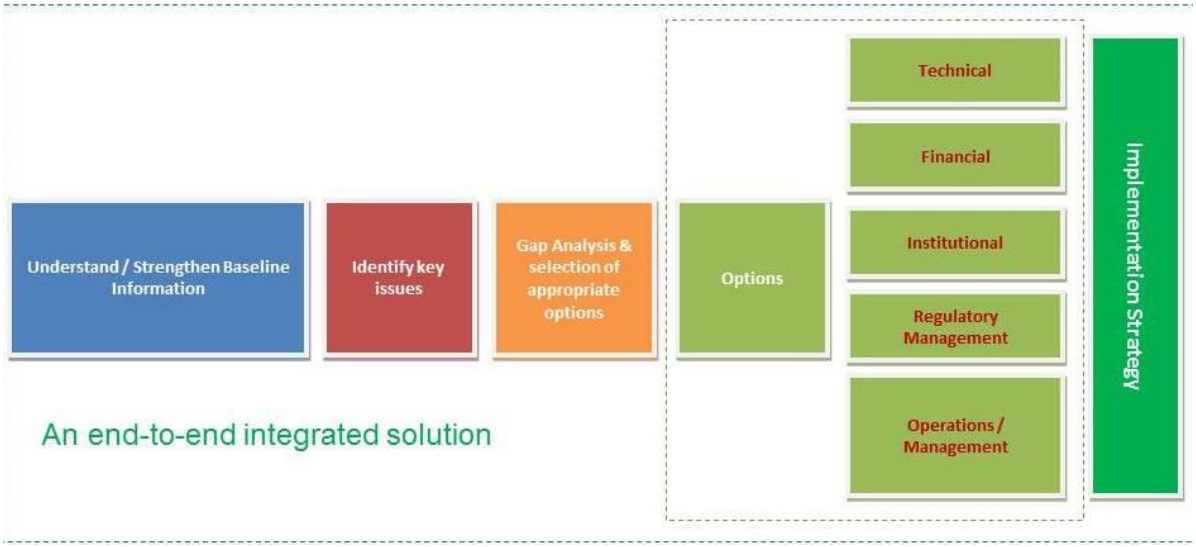


Figure 10: Components for an end-to-end solution on FSM

3.3.3 End Use Options

Design and selection of FSM system can also be done backwards through the end use options. For a sustainable production and use of the end-product some factors like demand of the end-product, market size and its growth potential and social acceptance should be taken into account. Some of the available options for end-use and resource recovery are:

a. Land application as soil conditioner (dried sludge, compost, pellets, etc.) and fertilizer (NPK added) is the most common and widespread form of resource recovery. Benefits of application include increased water holding capacity, improved soil structure, reduced erosion, and source of slow releasing nutrients.
b. Water reclamation for irrigation and other uses which can be effluent of FS treatment processes or septic tank effluent. Quality standards in terms of concentration of nutrients, pathogens, heavy metals, etc. should be of consideration.
c. Production of fodder crops and ornamental plants
d. Production of fish and aquatic plants. Concern with aquaculture is that fish can carry pathogens and can transfer it to clean water ponds for several weeks. Fish can also act as an intermediate host to helminths, which is a concern with FS.
e. Incorporation in building materials eg. in manufacturing of cement and bricks, clay-based products and in manufacturing of ceramics.
f. Production of biofuels, heat and electricity
g. Production of proteins with black soldier fly larvae is under research and development

3.3.4 Multi-barrier approach for pathogen reduction

Multi-barrier approach can be one of design options to achieve pathogen reduction in FS. Reduction of helminth eggs to WHO guideline level is not always required. For example, sludge used as fuel for combustion or for growing animal forage, does not require the same degree of pathogen reduction as sludge that has the potential to come into contact with crops for human consumption. In its 2006 guidelines on excreta use in agriculture, WHO puts less emphasis on safety limits for treatment, but more on health-based targets and a multi-barrier approach. So, according to the guidelines, risk management includes an assessment of who is exposed, and the implementation of corresponding health protection measures at different stages in the system. Such health protection measures, or barriers, can include:

- Treatment
- Application technique
- Crop restrictions
- Withholding period
- Protection of workers
- Handwashing
- Health and hygiene promotion
- Food handling and cooking

3.3.5 Case Studies of FS treatment options

As FS and its management is still a new area for Nepal, we need to learn from the experiences of other countries within and outside the region. Few case studies showcasing good practices on FSM based on experiences of cities in developing countries are described in this section[20]:

Case 1: Anaerobic Digestion (Thailand)
Nonthaburi Municipality, Thailand has established a faecal sludge treatment facility using an anaerobic treatment process and caters to about half the total population of the Municipality of 270,000. Annually, the Municipality collects and treats around 9,000 m3 of faecal sludge from around 3,300 septic tanks. The treatment facility consists of anaerobic digestion tanks, sludge drying beds and an oxidation pond to produce fertilizer from the treated sludge. The liquid effluent drained from the sludge drying beds filters through the sand beds into the oxidizing pond before being applied as liquid fertilizer in the city's public parks green areas. The fertilizer produced was also tested to be safe for agricultural use21.

Case 2: Co-composting of FS (Ghana)
Composting is a biological process where microorganisms decompose organic matter under controlled and predominantly aerobic conditions. The resulting end-product is stabilized organic matter that can be used as soil conditioner or an organic fertilizer. In a well operated composting heap, temperature can reach as high as 60-70oC during which pathogen die-off is at its highest. A research pilot plant was established in Kumasi, Ghana in 2002 where FS from public toilets and household septic tanks were

[20] UN-HABITAT, 2011
[21] http://issuu.com/lindashi/docs/thailand-country-assessment_0/1

collected, dried in unplanted drying bed and subsequently co-composted with organic municipal solid waste. The organic solid waste and dried FS were mixed in a ratio of 3:1 and composted using an open windrow system. The compost tested on the germination capacity of selected vegetables produced acceptable results and farmers interviewed also showed a willingness to use excreta-based compost22.

Case 3: Sedimentation/thickening tanks

Sludge hauled from un-sewered public toilets and septic tanks in the city of Accra, Ghana is treated in two parallel, batch-operated settling/thickening tanks. The first treatment step consists of a solid-liquid separation in these tanks. The sludge is settled in the tank and the supernatant flow into the parallel pond for further treatment. The accumulated sludge is then allowed to dewater to attain stability.

Case 4: Deep-row Entrenchment (South Africa)

This technology is both a treatment and an end-use option. The eThekweni municipality in Durban has been utilizing deep-row entrenchment for disposal and treatment In this, deep trenches are dug which are then filled with FS and covered with soil. Trees are planted on top which benefit from the organic matter and nutrients that are slowly released from the FS. It is a simple low-cost technology requiring minimum O&M issues and does not pose problems related to sight and smell and can be best suited in rural areas. The limiting factor in this system is the availability of adequate land with groundwater table low enough to avoid contamination23.

Case 5: Waste stabilization ponds (Argentina)

In Alcorta, Argentina, 65% of its population of 4,000 used septic tanks and cesspits while the remaining of the population was connected to the sewer system. Sludge is treated along with the wastewater in a series of two stabilization ponds. The two ponds are operated alternatively to provide adequate dewatering and drying time in one pond while the other was being fed. The effluent from the sedimentation ponds is co-treated with wastewater in waste stabilization ponds.

Case 6: Planted Drying Beds or Constructed Wetlands (Thailand)

Constructed wetland consists of gravel and sand filters planed with plants like reeds, bulrushes or cattails. Three constructed wetlands were pilot tested at the Asian Institute of Technology (AIT) in Bangkok to study the potential of constructed wetland for faecal sludge treatment. The system has proved to be a promising option for the sludge treatment as demonstrated by successful treatment of septage during the study period between 1997-2004.

Unplanted Drying Beds

Properly designed sludge drying beds produces a solid by-product which can be used either as soil conditioner or fertilizer in agriculture, or deposited in designated areas without causing adverse impact to the environment. Drying bed treatment is normally not classified as a solids-liquid separation process. It nevertheless effectively separates solids from liquids through gravity percolation and evaporation. Drying bed percolate tends to exhibit considerably lower levels of contaminants than settling tank supernatant.

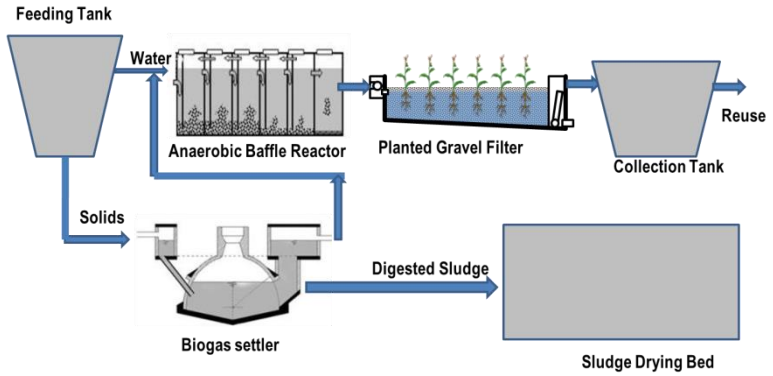
[22] IWA FSM book

[23] IWA FSM book

Case 7: CDD, India

Description: A pilot scale FS treatment unit was set up by Consortium for DEWATS Dissemination Society (CDD) within its office premises with the objective of understanding the characteristics of septage and faecal sludge; assessing the treatment performance of treatment modules for treating FS/septage and producing hygienically safe by-products for reuse.

Treatment module: The treatment process consisted of sedimentation, anaerobic digestion and aerobic decomposition. FS was fed into the biogas settler from the feeding tank. Digested sludge from the biogas settler was allowed to dry in the sludge drying bed and the effluent was channeled to anaerobic baffled reactor (ABR). Effluent from the ABR was further treated in the constructed wetlands. Final treated biosolids from the sludge drying bed was used as compost and the liquid effluent from the constructed wetlands was reused in the CDD office premises for irrigating the green areas.



Preliminary results: As the system was recently started (commissioned from Sept 2014), more time is required to observe its performance. However, preliminary results shows promising reduction in organic contents (see table below).

Sample Points	BOD, mg/l	COD, mg/l	TS mg/l	VS, mg/l	NH4-N mg/l	PO_4- P mg/l
FT Inlet	43750	92234	67848	40969	555	190
FT supernatant	1700	2519	2980	1225	470	126
BGS Outlet	1050	1722	1929	752	622.5	66
PGF Inlet	47	131	964	200	144	11.9
PGF Outlet	5	<25	510	125	14	32

4. FIELD ASSESSMENT FINDINGS

This section provides an overview of the findings from the field assessment.

4.1 Urbanization of small towns

The urbanization trend in the towns visited was found to be rapid characterized by haphazard settlements. The main reason for this rapid urban growth attributed to a number of factors[24] such as: i) migration from rural areas to avail better services such as education, health and economic opportunities, ii) increased disposable income among rural population due to flow of remittance, iii) increased social trend to have a property in the town center which is seen as a sign of prestige and well-being in the society.

In the absence of proper urban planning and lack of foresight of the local authorities, small traditional towns such as Beni, Besi Shahar, Gorkha have been rapidly transformed into cramped urban towns losing its traditional face value. Failure to timely upgrade infrastructure and services have resulted into severe urban environmental problems such as haphazard solid waste disposal along river banks, illegal disposal of untreated FS into drainage and water bodies, etc.

In addition to the degrading urban environment and the living conditions, urbanization also has a direct impact on agricultural practices in these small towns. In some of the towns visited such as Bhote Odar, Besi Shahar, Beni, the transformation of agricultural land into build-up areas was seen to be quite rapid, pushing farm land further to the peripheral areas. This has brought a reduction in utilization of FS from on-site facilities creating a problem of FS handling by households who were once managing FS within the farmland with the added benefit of enhanced farm productivity. However, peri-urban agriculture practice is still common and a potential market for FS compost.

4.2 FSM Stakeholders

A list of key local level stakeholders is tabulated under Table 7, with their mandates, roles and responsibilities on urban sanitation improvement.

From the consultations with local authorities, responsible water and sanitation agency and Water Users and Sanitation Committees (WUSCs) in the small towns, it was felt that there was a lack of institutional clarity at the local level on WASH. All the small towns visited were recently brought within the jurisdiction of Municipality which has created uncertainty in the roles and responsibilities on water and sanitation among institutions. The Water Users and Sanitation Committee (WUSCs) established under the Water Resource Act have played a vital role in

[24]Based on consultation with number of water and sanitation users groups, individuals and household in the study area.

developing and operating water supply schemes in all the small towns under the ADB/GoN funded STWSSSP and independent projects of the GoN and users. WUSCs also have the responsibility of addressing sanitation issues within their service area. However, municipalities under the Local Self Governance Act (1999) have the mandate for overall physical and infrastructure development including water and sanitation. Water Users and Sanitation Organization (WSUO) behaves more or less like a utility company and do not have such a mandate for infrastructure development, financing capital costs for sanitation (eg. solid waste management) interventions from the government. Therefore, existing dubious roles among institutions poses a serious challenge to address environmental sanitation problems at the town level.

Table 7: Stakeholder identified at the small town level, their roles and responsibilities

Stakeholders	Roles and responsibilities	Observations/Inferences
Drinking Water and Sanitation District Divisional/Sub Divisional Office (DWSO), Ministry of Urban Development	▪ Lead government agency for Water and Sanitation at the District level ▪ Has a mandate to provide technical support, monitoring and guidance on issues of water supply sanitation ▪ Providing impetus in sanitation coverage through the National open defecation free (ODF) campaign ▪ Lead role to implement and technically supervise the Small Town Water Supply and Sanitation Project in towns (under Phase I and II project)	▪ Successfully leading the ODF campaign focused on toilet coverage but a clear strategy is missing on sustainable sanitation planning beyond ODF ▪ No concrete plans and policy to address FSM in a country in a post-ODF scenario ▪ Piloting FS treatment systems under STWSSSP, Phase II in two towns: Byas Municipality, Tanahu District and Mukundapur, Nawalparasi District
Local Municipalities	▪ As per the Local Self Governance Act, they have the mandate to address all environment related problems within their boundaries including solid waste and liquid management	▪ In the absence of a locally elected representative, the municipality office is currently headed by an Executive Officer ▪ FSM is not a priority issue of concern and in some cases, they are not even aware about the topic ▪ Many responsibilities have not being taken up including their mandate on sanitation issues ▪ New municipalities just developed in many towns with minimal institutional capacity ▪ The coordination framework on sanitation such as the M-WASH-CC at the municipality level is weak in terms of implementation
Private FS service	▪ Provide FS collection service at the	▪ Face challenges of narrow roads,

providers	household level for a certain fee ▪ Several private entrepreneurs provide collection services either individually or through associations in towns ▪ FS emptying is being taken up as a successful business	inaccessible areas while performing the service ▪ In the absence of a designated location and a treatment facility, they are compelled to dispose collected untreated sludge in open spaces, agricultural fields and water bodies ▪ Private service providers earn a good income and do not pay penalties for illegal disposal due to weak enforcement mechanisms
Small Town WUSCs	▪ The users committee is a legally registered body under the Water Resource Act at the District level, elections are held regularly to elect representatives among the users for a certain period ▪ In small towns, where water supply systems have been developed, such users committee oversee the operation of the systems ▪ The committee has a mandate to provide water supply and sanitation facilities in their designated service areas in small towns	▪ Even though they have the mandate to provide sanitation services within their service area, the Users Committees are focused more on the water supply component ▪ Have been a strong partner for the ODF campaign in the small towns ▪ Many user's committee are unaware about the need for faecal sludge management at the town level ▪ Feels that FSM should be taken care by the respective Municipality and not them
Households	▪ Most household have on-site sanitation systems in all the towns and require regular pit emptying services when they are full	▪ Are not aware on the proper design of sanitation system such as septic tanks ▪ Usually do not have a clear understanding of FS management system

4.3 Situational Analysis - Sanitation System Perspective

The situation of FSM in the selected towns has been explained in this section from a sanitation systems perspective. The field level findings on the sanitation situation have been presented using a Systems approach. Each of these sub section presents the functional group of the system.

4.3.1 User Interface

User interface describes the type of toilet, pedestal pan or urinal that the users come in contact with. It is the way users access the sanitation system. In most towns, pedestal pan was the common type observed at the household level. However, commode with flush systems was also observed in private homes. Public toilets located in the market areas had pedestal pan and urinals and separate cubicles for women and men.

4.3.2 Storage/Pre-Treatment

The **storage/pre-treatment** component refers to the methods and the type of technologies in use for collection, storage and sometimes treatment of products that are generated at the user interface level. The treatment provided by these technologies at this stage are a result of containment/storage and is usually passive,. Thus products generated from these technologies often require further processing and treatment.

Most common types of collection and storage technologies noted were pit latrines and septic tanks (single or multiple chambered). Variation in the pit latrines were observed in towns ranging from simple pits to single pits made with concrete rings (5-6 rings stacked vertically)[25]. Septic tank was found to be the dominant form of collection and storage system in the towns. However, the perception and construction of septic tanks[26][27] differed widely across towns. In the absence of design guideline and specifications, they were known to be constructed in an ad-hoc manner, based on own knowledge or neighbor's experience with the intention for prolonged retention to avoid frequent emptying. Size of tanks varied depending upon the household needs and space availability. Septic tanks could be:

- Single or double chambered tank with sealed or unsealed base
- Single conical tank made of dry stone walls with unsealed base, common for hilly region

Based on consultations, it seemed that majority of newly constructed houses in the small towns had sealed septic tanks constructed within their premises or under the building if land was unavailable. However, details on types and number of septic tanks were not available and a detailed survey would be required for such data. Furthermore, filling up of septic tanks were not yet seen as a major concern for most households. Geological conditions in mid hills-small towns allowed infiltration of leachate from pits thereby delaying the emptying interval. Households that had newly constructed sealed septic tanks, of relatively high volume, were yet to know the frequency of emptying.

[25] This type of technology was promoted as part of the National ODF campaign where very poor households also received subsidies to build toilets. Pan, pipe and rings were distributed.
[26] A well-designed septic tank is generally three chambered with baffle walls separating each chambers. The effluent passes successively through the first to the last chamber while solids are retained and undergo degradation in the first chamber and soak pits after the to absorb and treat the effluent generated from the tanks
[27] After the initiation of the ODF campaign, many districts like Nawalparasi made it mandatory to construct permanent septic tanks with a sealed base.

4.3.3 Conveyance

Once the on-site collection and storage systems are full, faecal sludge generated from these units need to be regularly emptied and transported for safe disposal and treatment. Frequency of emptying varied depends on number of factors such as:

- soil/geological conditions
- type of collection and storage facility built
- size of the facility
- number of people using the facility

As a detailed survey could not be conducted at the town level, emptying frequency could not be determined. However, based on consultations with households and stakeholders, it was found that emptying frequency could be as early as 6 months to beyond 15 years.

Figure 11: Mechanical emptying trucks from Pokhara and Bardaghat

When the septic tank needed emptying, households contacted either mechanical or manual emptying service providers (Figure 11).Two types of mechanical collection services were found to be operating:

i) truck or tractor mounted with a pumping device, storage tank and pipes (either Municipal or private owned)
ii) pump, pipe and a generator (private owned and operated in areas inaccessible to large suction vehicle)

Households could be self-emptying or hiring manual emptiers either to avoid higher service of hiring a suction vehicle, due to inaccessibility or due to availability of disposal site nearby. It was also noted that manual emptying was typical for households with adequate space to dig a pit for temporary storage of sludge or with agricultural land nearby. The service charge for mechanical emptying varied, ranging between minimum of NPR 2,000 to maximum of more than NPR 10,000, based on distance travelled, volume emptied and proximity to suitable

disposal area. Manual emptying rates were also found to vary. Normally, manual pit emptiers' negotiated on a package basis to clean up the pit depending on the volume of the tank.

4.3.4 Treatment

Any form of treatment facility was completely lacking in all the small towns. Even though need for FS treatment facility was felt by the local stakeholders, it was also understood that finding suitable land to construct appropriate FS treatment systems would be a major challenge in most towns as available public land is either in the forest areas or close to river banks. In core settlement areas, land is expensive and scarce. In case facilities are built close to settlements, public opposition is highly likely.. Due to these reasons, there was strong preference shown from the WUSC's to develop integrated solutions for solid waste and FS management in future.

4.3.5 Use and/or Disposal

We did not find many examples from field investigations on use of FS as it was found to be predominantly disposed untreated in various locations. Upon request by farmers/households, raw FS was found to be discharged into agricultural fields (Table 8). Apart from minimal use of the raw sludge, in the absence of any treatment facilities, almost all the collected septage was dumped untreated in the environment eg. forest areas, river banks, open land.

Table 9 shows the emptying and disposal practices in the small towns.

Table 8: Example of use of FS

Place	Use
Khairenitar	Sludge from the public toilet, located at the bus stop, was known to be disposed in the vegetable garden within the premises of the Nepal Army Barrack.
Pokhara	Farmers from a village near Pokhara were using the sludge from the disposal site of the local entrepreneur. Similarly, he frequently disposed sludge in agricultural lands upon request.

Table 9: FS emptying and disposal practices in Small Towns

District & Small Towns	Emptying and Conveyance	Disposal practices
Gorkha District		
Gorkha Bazaar	▪ Gorkha municipality owns a FS collection vehicle ▪ There is also a group of manual pit emptiers in operation	▪ Municipality owned vehicle dispose the collected sludge at the landfill site which is located in the forest area ▪ Private collectors dispose the sludge in open areas and in the household premises
Kaski District		
Lekhnath	▪ Due to geological conditions, FS emptying is not yet a major concern ▪ Self or manual emptying predominant ▪ Few households have started to take up mechanical emptying services provided by private service provider from Pokhara	▪ Disposal site is not known ▪ Mechanically collected FS by private entrepreneurs from Pokhara is disposed into the *Bijayapur Khola*
Lamjung District		
Bhote Odaar	▪ Manual emptying ▪ Mechanical emptying provided by private service provider from Pokhara	▪ Collected FS disposed in forest areas, along the banks of River Marshyangdi or other areas not specified during consultation
Besi Shahar	▪ Emptying so far is not a problem ▪ Mechanical emptying provided by private service provider from Pokhara	▪ Collected FS disposed in the forest areas, along the banks of River Kali Gandaki or other areas not specified during consultation
Myagdi District		
Beni	▪ Emptying so far is not a problem ▪ Mechanical emptying provided by private service provider from Baglung	▪ Collected FS disposed along the banks of Kali Gandaki River or other areas not specified during consultation
Nawalparasi District		
Bardaghat	▪ Four mechanical private service providers are operating in Bardaghat	▪ All collected FS is dumped in the forest areas
Kawasoti	▪ Mechanical and manual emptying practices ▪ Service providers could not be determined	▪ Disposal practices at the town level could not be determined
Tanahun District		
Bandipur	▪ Filling up of collection/storage facility not a problem due to geological conditions which allows infiltration of leachate ▪ Manual emptying by the household ▪ Mechanical emptying provided by Byas Municipality and private service provider from Pokhara	▪ Stored in pit dug in the household premises ▪ Disposal site is not known

Khairenitar	▪ Households opt for manual and mechanical emptying ▪ Mechanical emptying provided by Byas Municipality and private service provider from Pokhara	▪ Disposed in the banks of River Seti and forest areas ▪ Sludge from public toilet often disposed in kitchen gardens inside the Army Barrack, located in Khairenitar

4.4 Interest and need for FSM in towns

This section provides an analysis of the level of stakeholders' interest and FSM needs at the town level. The following criteria have been used as a basis to assess the needs:

i. Level of interest shown by the local stakeholders
ii. Level of need felt at the towns
iii. Disposal practices of FS (high priority placed on FS disposed into water bodies)
iv. Land availability for development of treatment system

In the above criteria, the level of interests and needs were assessed based on interaction meetings with the key stakeholders mainly the WUSC, DWSO, local Municipality and random discussions held with households on the need for frequent emptying.

Disposal of FS into water bodies has been considered as one of the important aspects because of its significance for future USAID's project on Integrated Water Resources Management (IWRM). Stopping illegal disposal of FS into water bodies through the establishment of FSM system will be an important input to IWRM. Likewise, availability of land has been considered as additional criteria because of the challenges around finding suitable land for establishment of public sanitation facilities. Readily available public space speeds up the project planning and implementation process allowing the project to be completed on time. Table 10 provides the scoring guidelines for each of the proposed criteria.

The actual scoring results and its analysis are presented under Table 11. It is to be noted that these findings provide a preliminary screening output for USAID to select appropriate towns for future investments in FSM. However, following the earthquake in April/May 2015, local situation and interests might have changed slightly (especially Gorkha)[28]. Thus, we recommend that quick feasibility studies be conducted before investments are decided.

[28] Gorkha district was the epicenter for the first earthquake that struck Nepal on 25 April 2015. There were lot of damages in the district.

Table 10: Scoring Guidelines

Criteria	Scoring level		
	3 (High)	2 (Medium)	1 (Low)
Level of Interest of WUSC	▪ High interest to have a FSM system in place	▪ User feel that it would be good to have a FSM system in place	▪ Not keen in having a FSM system
Level of need for FSM	▪ Need for frequent emptying of pits in the area ▪ Illegal disposal of FS into drains and water bodies	▪ Few household have demanded pit emptying services in the towns ▪ Disposal of FS is not a problem	▪ Households do not require pit emptying services at the moment ▪ Space available for digging up alternate pits to manage contents
FS disposal into water bodies	▪ Mechanically collected FS is directly disposed into rivers	▪ Mechanically collected FS is disposed into forests and sometime into open drains	▪ Mechanically collected FS is disposed into forest and fields only
Land Availability	▪ Public land available for establishment of treatment systems	▪ Public land can be made available through local consultation and assessment	▪ Public land can be made available after consultation with authorities at the national level

Table 11: Analysis of needs and interest of the towns

District	Town	Level of Interest of WUSC	Level of need for FSM	FS disposal into water bodies*	Land Availability	Total score (out of 12)	Ranking
Gorkha	Gorkha Bazaar	High (3)	High (3)	Medium (2)	High (3)	11	I
Kaski	Lekhnath	Medium (2)	Low (1)	Low (1)	Low (1)	5	V
Lamjung	Bhote Odaar	Medium (2)	Medium (2)	High (3)	Medium (2)	9	III
	Besi Shahar	Medium (2)	Medium (2)	High (3)	Low (1)	8	IV
Myagdi	Beni	Medium (2)	Medium (2)	High (3)	Low (1)	8	IV
Nawalparasi	Bardaghat	Medium (2)	High (3)	Low (1)	High (3)	9	III
	Kawasoti	Low (1)	Medium (2)	Low (1)	Low (1)	5	V
Tanahun	Bandipur	Medium (2)	Low (1)	Low (1)	Low (1)	5	V
	Khairenitar	High (3)	High (3)	Medium (2)	High (2)	10	II

Note: * Please refer to Table 9 for emptying and disposal practices

Based on the preliminary analysis of the need and level of interests shown by local stakeholders and existing disposal practices, **Gorkha Bazaar** shows the highest promising opportunity to develop a potential project on FSM. Some of the key reasons for such potential are

- the strong interest shown by the stakeholders to address the illegal disposal of FS in the market area,
- existence of both private (semi mechanized emptying services) and public FS collection services (from the municipality),

- existence of potential locations to build treatment facilities (designated solid waste dumping site where space is available to build treatment system).
- all collected and illegally disposed FS was found to be directly discharged into water bodies causing water pollution[29].

The second feasible town for future investment in FSM is **Khairenitar**. Some of the key reasons for recommending this town are:

i) presence of a strong water users and sanitation committee (WUSC). The Khairenitar project was established under the ADB funded STWSSSP, Phase I. The town was ranked first in terms its performance to sustainable operate the water supply system. Likewise, the users have successfully cleared all loans borrowed from ADB to construct the system,

ii) there is a strong level of community interest,

iii) iii) town has developed a wastewater management plan few years back and have designated areas allocated to build decentralized treatment facilities. Compared to Gorkha it was ranked slightly low because collected FS is disposed into the forest area and the problem of FS did not look as severe as in Gorkha.

In the third ranks for investment are **Bardaghat** and **Bhote Odar**. In these towns, there is a high level of interest to establish FSM systems. Disposal of FS is not yet severe. Compared to Gorkha and Khairenitar, these towns do not have designated areas to build FS treatment systems. In Bhote Odar such treatment facilities needs to be identified through involvement of DDC or the new municipality.

In Bardaghat, there is a potential to locate treatment sites in the community forest area. Currently, private operators use the forest area to illegally dispose-off FS. One of the strong causes for investment in Bardaghat is the presence of active private sector in the FS business. There are currently four entrepreneurs providing such services. Among them there is an inspiring FS entrepreneur[30] who has designed and inbuilt FS suction pump (better compared to other locally assembled pumps) in his FS collection vehicle. . This entrepreneur is willing to invest to establish and operate a treatment system provided that some external support is provided. This case makes Bardaghat a strong case for successful investment.

4.5 Other specific issues on FSM

This sub section further details out the issues and concerns with respect to FSM in small Towns. The issues have been described below:

[29] USAID has a particular interest to stop pollution of water bodies as part of its potential IWRM project

[30] Mr. Chandra Narayan Shrestha (9847256095) is an experience FS entrepreneur in Bardaghat. While in Gulf countries, he worked for several years in a wastewater treatment facility. He returned back to Nepal to start off his own FS collection and plumbing business.

4.5.1 Lack of local representatives

In the absence of local elected representatives, local institutional leadership and public accountability is missing in the development sector. Local offices such as municipalities are run by government employees and they do not feel as accountable as local representatives. Therefore, there is a political vacuum in these fronts to drive the development process at the local level. This has been seriously affecting a number of projects over the past decade.

4.5.2 Management and Operation of Public Toilets

A limited number of hygienic public toilets were observed in the small towns visited. Most of these facilities were constructed through funds received from the STWSSSP, Phase I or through funds from DDC and local municipality.

In public areas like bus stands, these facilities cater services to a large number of users. However, most toilets visited were un-hygienic (not clean, soap not available, limited water available) and not properly maintained (no taps, broken urinals and wash basins). One of the reasons for low maintenance was a lack of continuous operation and management system. Box 1 presents a case from Khairenitar highlighting the operational modality. It was observed that a detail investigation on the status and options for significant improvement would be required in the management modality to deliver quality services to the public and

Box 1: Operation of public toilet in Khairenitar (based on interview conducted on 14 January 2015)

In Khairenitar, out of two existing public toilets, one was completely abandoned many years back due to frequent filling of the holding tank which created blockages. This facility was built under the support of the local VDC.

The second public toilet was built in 2004 under the STWSSSP, Phase I. This toilet is located in the market area, close to the public bus stand and during the time of the visit, it was found to be operational. However, many operational challenges have been observed in the facility. The Khairenitar WUSC has provided a private water supply tap connection for the toilet and has assigned Mr. Buddhi Bahadur Nyaupane as the caretaker responsible for the overall management and operation of the facility. According to Buddhi, he charges Rs 5 for the usage of urinal and Rs. 8 for defecation. He earns between Rs 800-900 on a daily basis and the facility needs to be emptied twice every year. Buddhi takes FS emptying service from Pokhara which is around 30 kms from Khairenitar and post negotiation, he pays around Rs 15,000 as a lump sum for emptying the entire holding tank with a capacity of 32 m3 (8 trips is required to empty holding tank with a truck volume of 4m3). Since there are no FS treatment facility, Buddhi has to arrange the final FS disposal site. In the case that private FS entrepreneur has to arrange the disposal site, additional charges have to be borne. During the last two years, FS collected from the public toilet has been disposed in the fields inside the army barrack, although this often might not be the case. On an average, Buddhi earns a net amount of 15,000 rupees per month, but this is a part of his and family's salary as well. There is no capital to finance the repair and maintenance costs and Buddhi has no motivation to do anything more or innovative than he is already doing leading to the existing poor condition of the facility.

4.5.3 Sensitization, awareness and capacity for FSM

There is a lack of knowledge and understanding on FSM at the local level as it is often confused with wastewater management. While the newly established municipalities are struggling to establish itself as an institute of authority and responsibility, they lack capacity and resources to address the issue of FS and its management.

Town authorities and relevant stakeholders need to be sensitized on the issues and available options for FSM. As observed from the interactions, there are no clear strategic directions on how to move forward with urban sanitation following ODF declarations. Although post ODF strategies have been designed in some of the districts, these strategies are limited to providing access to sanitation services and does not provide guidance on how to address the entire sanitation value chain. There is a need to devise a way forward for urban sanitation.

4.5.4 Addressing integrated sanitation components

The environmental sanitation situation of the towns shows that there are multiple sanitation needs. FSM is one the components that needs to be addressed but there are demands to address other sanitation components such as solid waste management, storm water, and grey water management. The need for a citywide sanitation planning approach was felt in order to minimize duplication of work and to address multiple sanitation problems in a coordinated manner.

4.5.5 Implementation of model FSM system

There are no functional FSM systems which can serve as a demonstration for small towns in Nepal. Past treatment facilities that were built earlier in Kathmandu and Pokhara operated only for a short duration and stopped functioning due to poor operation and management. Field investigations showed that, even the two FS treatment systems being constructed in Byas and Mukundapur did not have any business and operational plans in pipeline. Therefore, a need is felt to demonstrate sustainable FS management models and technologies at the local level.

4.5.6 Development of design guideline on FSM

Even when the national building code mandates construction of septic tanks for households not connected to sewer network, there is no guideline available with design specifications for septic tank construction. Monitoring mechanism both during construction and after operation (eg. to check illegal connection to surface drains) is weak / absent.

4.5.7 Research and Development

FS and its management is a new area of work in the sanitation sector not only for Nepal but for other developing countries too. Therefore, a lot of issues related to FSM still require research

and development for establishing and improving the service provision in terms of technology choice, system establishment, operation modality, safe reuse of end products, etc.

5. STRATEGIC RECOMMENDATIONS

This is an ideal time that USAID has taken up the issue of FS and its management as an agenda within the programme of Integrated Water Resource Management. The Department of Water Supply and Sewerage (DWSS) has recently conducted a national level workshop on FSM to increase awareness on the challenges and emerging developments in policy and practices on FSM and to come up with strategy recommendations to effectively address the FSM in the revised National Hygiene and Sanitation Master Plan[31]/National WASH SDP[32]. In this context and based on the findings from the field assessment, the following strategic actions have been recommended for USAID.

5.1 Policy Advocacy

While national level policies on FSM will be drafted by the Sector Efficiency Improvement Unit (SEIU)/MoUD or by the ADB/GoN funded STWSSSP (phase III), it is recommended that USAID supports the national initiatives by conducting evidence based advocacy on different areas such as: health, technology, financing, identification of resource gaps, operational and management aspects, etc.

Likewise, as awareness level of the FSM is very low among sector stakeholders, USAID could facilitate a series of knowledge sharing events at the national and regional level for stakeholder sensitization and building capacity for the same.

5.2 Establishment of FSM demonstration models

To demonstrate a sustainable FSM model, the towns prioritized by this study can be taken as the basis for implementation. These demonstration projects should be carefully engineered to showcase viable business models, alternative FSM technologies and self-sustaining operation and maintenance scheme. The key approaches indicated below should be considered while formulating the project:

5.2.1 City-wide Sanitation Planning (CSP)

The planning process provides a basis to identify needs and prioritize actions at a city wide level addressing the sanitation value chain. Guidelines such as IWA published *Sanitation 21*, CLUES approach by Eawag-Sandec could be useful frameworks to follow for the planning process. FSM should be positioned as part of the city wide sanitation plan and further integrated into the Urban Development Plan of the city, municipality. This planning exercise itself is a new approach to addressing FSM through a structured process, which could be a contribution for the WASH sector.

[31] Revision to the National Sanitation and Hygiene Master Plan (2011) is being planned by NWASH CC
[32] Being formulated by SEIU/MoUD

5.2.2 International and national partnerships

Both international and national level partnerships will be valuable to implement the project. International partners such as Eawag-Sandec, Switzerland[33] which have vast research experience on the subject matter, could bring additional value to the project. Their role could be in the form technical backstopping the planning process as well as conducting specific research within the project.

At the national level, partnerships need to be established with professional organizations that specialize in FSM planning, design and implementation. Strategic partnership with the ADB/GoN funded Small Town Water Supply and Sanitation Sector Project (STWSSSP)[34] will be beneficial. STWSSSP is developing FSM systems, including treatment technologies, in several small towns of Nepal. During the study it was observed that investments were earmarked for setting up the hardware components (treatment infrastructures) for FSM but there were no concrete software components such as the business plans and operational models in these projects. We believe these are important elements to de addressed for sustainable operation of the FSM systems. Through collaborations, USAID could take up few of these towns and technically support in operationalizing these systems. Likewise, under the STWSSSP (Phase III), development of FSM policies and guidelines are in the pipeline. These could be strategic areas of interests where USAID could provide technical inputs.

Partnerships can also be established with the National Urban Sanitation Knowledge Hub[35] located at the Institute of Engineering (IoE) at Pulchowk. As per the ongoing ADB supported project, they are responsible for building capacity on FSM in Nepal.

5.2.3 Partnerships at local level

While developing investments on FSM, strategic as well as financial partnership should be sought with local authorities such as the municipalities, DDC and VDCs. Likewise, cost sharing mechanism should be developed with households/users themselves as well.

Local municipalities are open to public private partnerships models and are willing to invest around 30% of the total project costs. Therefore early consultation and partnerships with local authorities is recommended while conducting feasibility studies in specific towns. Strategic partnership will local authorities is vital to identify appropriate land for establishment of treatment facilities. This will be one of the bottlenecks for devising FSM projects and hence such partnerships are essential.

33 Possibilities of potential collaborations were discussed with Eawag-Sandec in Hanoi, Vietnam and Kathmandu during the FSM conferences

34 Mr. Tiresh Khatri is the Project Director of STWSSSP and can be reached at 98511 262 45

35 The Urban Sanitation Knowledge Hub is based at the Department of Urban Planning, Institute of Engineering at Pulchowk. Contact person is Dr. Sudha Shrestha,

5.2.4 Demonstration of Business Models

Pokhara Sub-metropolitan City (PSMC) already has a fecal sludge treatment facility at the solid waste landfill site, comprising of a sludge drying bed (SDB) and a constructed wetland for treating effluent from the SDB and leachate from the landfill. Apart from small technical error in the wetland, the facility is in good shape for operation. USAID can play crucial role in two aspects to operationalize the facility. Firstly, it can facilitate the dialogue among the concerned stakeholders including District Administrator, PSMC and local community to solve the social dispute. Secondly, it can support PSMC in developing a business plan for a sustainable operation of the system once the dispute is resolved.

Business model can also be developed for the FSM systems established under the STWSSSP, Phase II to demonstrate a sustainable FSM system.

5.3 Technology demonstrations

A range of FS technological options can demonstrated in the prioritized towns. The following section provides strategic recommendations on type of technologies that could be considered for demonstration purpose.

Based on the analysis of the end use options as described under Section 3.1.3, several technological options can be demonstrated. However, in case of small towns, the study recommends further exploring on the following specific end use options:

5.3.1 Use of treated bio-solids in agriculture

There is a good potential to use treated FS or bio-solids in agriculture. The treated FS helps in enriching nutrient content and soil texture, thereby improving soil fertility. Analysis of local practices shows that there is a trend of disposing FS into agricultural fields to increase crop productivity. There is an informal demand for such products. Through selection of appropriate treatment systems (please see Section 3) FSM systems could be developed to facilitate end use of treated FS in agriculture.

Likewise, since emerging and small urban towns are facing multiple environmental problems of solid waste and FS management. The concept of co-composting FS with municipal organic waste could be a strategic solutions to tackle both problem. Some of the co-benefits is: i) the use the same location/site to establish the treatment facility which otherwise is very difficult to find, ii) Co-composting will increase the volume of compost produced. FS treatment alone does not produce significant amount.

5.3.2 Waste to Energy

The other recommended area to focus is to assess the potential for generating energy from FS with combination of other organic waste products. Users in many towns and rural areas are

quite familiar with the concept of generating biogas using animal manure. Likewise, many household in the Hills and Terai have toilet attached biogas. Capitalizing on this experience, FS could be used to generate energy at a decentralized level (at the neighborhood or settlement level). However, the viability of such option should be carefully explored. The CDD, Bangalore model (Case 7) could a good option to consider as it digest the FS to produce biogas[36]. It is recommended the pilot study in India and elsewhere is followed up to see potentials for replication. Likewise, there are couple of technologies from Finland which offers waste to energy options[37] which could be explored for FS management in small/emerging towns[38].

The digested FS and organic waste, could be further stabilized and again reused as soil conditioner in agriculture.

5.4 Towns for intervention

The section below recommends some of the priority towns for developing FSM projects based on the preliminary analysis. It provides guidelines on what could be done in the specific towns:

Gorkha Bazaar:

There is a strong need felt for FSM in Gorkha Bazaar, Gorkha. Land is available both for establishing treatment facility and for demonstration of reuse of end products in agricultural fields. Establishing a FSM system through improvement of the entire service chain including treatment and reuse would be a good option to demonstrate in Gorkha. Since Gorkha Bazaar is a hill town, establishing such a system would be one of its first kind for Nepal to demonstrate.

Alternatively, Gorkha could also be an ideal location for establishing a blackwater management system. A simplified sewerage network combined with a decentralized wastewater treatment facility (Dewats) could be one of the feasible option. Due to a natural gradient present in Gorkha the feasibility of laying out simplified sewerage network is quite high. A similar system is under operation in Nala, Kavre catering to a population of 2300 inhabitants[39] which could be replicated in Gorkha.

Khairenitar

Similar to Gorkha, Khairenitar has a strong demand and need for FSM. The WUSC have also developed a wastewater management plan and identified appropriate site for establishment of Dewats facilities. The study could be helpful to devise strategies and actions to establish

[36] ENPHO in collaboration with CDD India is putting up similar systems in Kathmandu Valley to treat FS. The experience from this installation could be a good case to learn.

[37] Kathmandu valley solid waste management will be privatized. The Detail Feasibility Report is being prepared. Technologies from Europe which produced energy from organic waste are being explored as part of the DPR.

[38] NOCART Finland is in the process of installing waste to energy systems in Nepal

[39] Manandhar Sherpa *et. al,* 2013. CLUES: Local Solutions for Sanitation Planning (http://www.eawag.ch/forschung/sandec/publikationen/sesp/dl/nala_flyer.pdf)

appropriate FS treatment systems. An active users group, good track record of operation of water supply system, demand for FSM services and land demarcated for establishment of Dewats facility makes this town unique among other towns for FSM interventions.
Khairenitar could also be a potential town to showcase operational business models to upgrade public toilet facilities.

Bardaghat

FSM has not yet been realized as an issue of immediate concern. However, a strong need has been shown from the private sector for FSM management and reuse of end products. Even though land is a limiting factor, Municipality and WUSC are in dialogue with the Ministry of Forest to avail land for solid waste management. If land is made available, FSM can be integrated with solid waste management with the benefit of potential co-composting, combined treatment of liquid effluents from FS treatment and leachate from the landfill and the operation and management of both the components under a single business model.

Bhote Odaar

Since Bhote Odaar is a fast growing town, it will soon be in need for a FSM system. There are possibilities of land availability for establishing a treatment facility, potentially along the river banks downstream of the settlement. By establishing a FSM system for Bhote Odar, Lamjung, it could also cater to adjoining towns like Besi Shahar and Bandipur. There are very low chances for establishing FS treatment facilities in both Besi Shahar and Bandipur due to unavailability of land.

5.5 Documentation and research on FSM

There are very limited research studies in Nepal with respect to FSM. USAID could take up a leading role to finance and execute some of the research topics as outlined below. The objective of the research should be geared towards gathering evidence based results for advocacy and sensitization of the wider audience.

- Research on the quality of sludge: in the local context, this area has not been looked into seriously. This could provide useful information on sludge quality and characterization which could be beneficial for designing FS treatment systems.

- Landscaping study of FSM status across different geographical regions in Nepal to find current practices, challenges and insights into design treatment consideration

- A money flux analysis of the entire sanitation value chain should be undertaken to determine the costs-benefits of establishing a FSM system. Such analysis will provide insights to assess the viability of FSM business as well as highlight the opportunities and modalities of private sector engagement in the sanitation value chain. FSM design guideline should be developed based on research from different geographical regions so

that the technologies selected and system established are best suited to the local conditions.

- Research in the area of hygiene condition of treated sludge and the effluent is necessary to ensure correct technology selection and to ensure that the effluent standards are met for end-use and safe disposal.

6. FSM Business Model Guideline

The following section provides guidance for developing FSM business model.

6.1 Planning Business Model

A FSM business model should aim to develop a financially viable, technologically sound and socially acceptable system to provide sustainable FSM service to population with on-site facilities. There are a number of components to be addressed while developing a FSM business model. This section gives a brief introduction to each component with an aim to guide in the development of an FSM business model.

6.1.1 FS Service Chain

The FSM business strategy should be developed with a focus on providing sludge emptying service to both households with on-site sanitation facilities, and public and private institutional building and public toilets without an on-site treatment facility and not connected to a sewer system. A FSM business model should be developed based on the sanitation and FSM service chain which includes[40]:

- **User Interface/ Collection storage/containment**: Responsibility lies upon households who invest in building the infrastructure masons who build the infrastructure and utilities who monitor and enforce guidelines
- **Emptying and transport**: Responsibility lies upon the manual or mechanical private emptier or state operated emptier
- **Treatment**: Major responsibility lies with the local government/utilities
- **Re-use/ disposal**: Depends upon the guideline and decision from local government and interest from local farmers, etc.

6.1.2 Situational Analysis and Market Investigation

A thorough analysis of the market is prerequisite for development of a viable business model. The key aspects outlined below are of importance for investigation:

1. **Market survey**: Market survey is crucial to understand the market size in terms of population and FS generation. Market calculation can be based on (i) number of households, average size of septic tanks and pit latrines, actual de-sludging interval or on (ii) theoretical sludge accumulation rate. However, an accurate estimation of actual and potential volume FS generation in the potential service area is essential. The survey should also explore market availability of potential end-use of products to determine the treatment technology choice.

[40] Parkinson *et. al*, 2013

2. **Collection vehicles**: Identifying need for number of FS collection vehicles and types of vehicles will depend on a number of parameters like road conditions, quality and quantity of sludge collection, distance to treatment facility and competition in the market
3. **Willingness to pay**: Willingness to pay for improved FSM system should be studied adequately for financial analysis. Willingness to pay for sanitation services including FS service has been less studied than for drinking water supply in developing countries.
4. **Financial analysis**: Financial analysis for FSM will be based on financial flow analysis on income and expenditures for the primary stakeholders viz. household, emptier and faecal sludge treatment operator. The financial analysis should come up with clear cost benefit analysis and cost recovery options, should recommend reasonable tariff for cost recovery. An operator's financial analysis is based on three major parameters:
    a. investment costs which could include truck and treatment and/or reuse plant,
    b. operating costs eg. personnel, fuel, maintenance, facilities and utilities and
    c. revenue eg. fee, selling of reuse products.

6.1.3 Private Sector Participation

Fostering partnership between the public and private sector is essential for sustainable management of FS. The PPP is based on the premise that both public and private sector have individual traits which can prove to be beneficial for providing the service in a most economical and efficient manner. The public sector can work with the private sector through various models such as (i) contracting, (ii) franchise, (iii) concession and (iv) open competition[41].

The FSM business model should essentially be able to:

- Attract and engage private sector in the FSM business (eg. through preparation of service level contract and agreement document for towns)
- Attract corporate financing
- Engage existing private operator to formalize their business
- Involve manual pit emptier (sweepers) and to incentivize disposal of FS collected by the manual emptiers in the treatment facility.

6.1.4 Management Modalities

The business model should explore potential operation and management (O&M) modalities for FSM and identify the best modality through consultations with relevant stakeholders. The O&M modality should clearly identify institutions and stakeholders in the business with clear definition of roles and responsibilities. In addition, the FS collection and transportation options and FS treatment and reuse options should be identified and the O&M clearly defined for each component. A few possible O&M modalities for the urban FSM could be:

Option-1: Municipality owned and operated system
Responsibility of FS collection and treatment is taken by the Municipality.

[41] Status and strategy for faecal sludge management, GoN/UNHABITAT

Option-2: Municipally Owned and Privately Operated System
Responsibility of FS collection and treatment is taken by the Municipality as part of the municipal services but operated by a private sector, eg. under lease and management contract.

Option-3: Privately Owned and Operated System
FS collection and treatment service is provided by private sector as a commercial activity. This type of service could be allowed under build, own, operate and maintain (BOO) system.

6.1.5 Business canvass

The figure below is a specimen of a business model for FSM value chain based on the business model canvas developed by Alexander Osterwalder. It outlines several prescriptions which form the building blocks for a FSM business model (Figure 12).

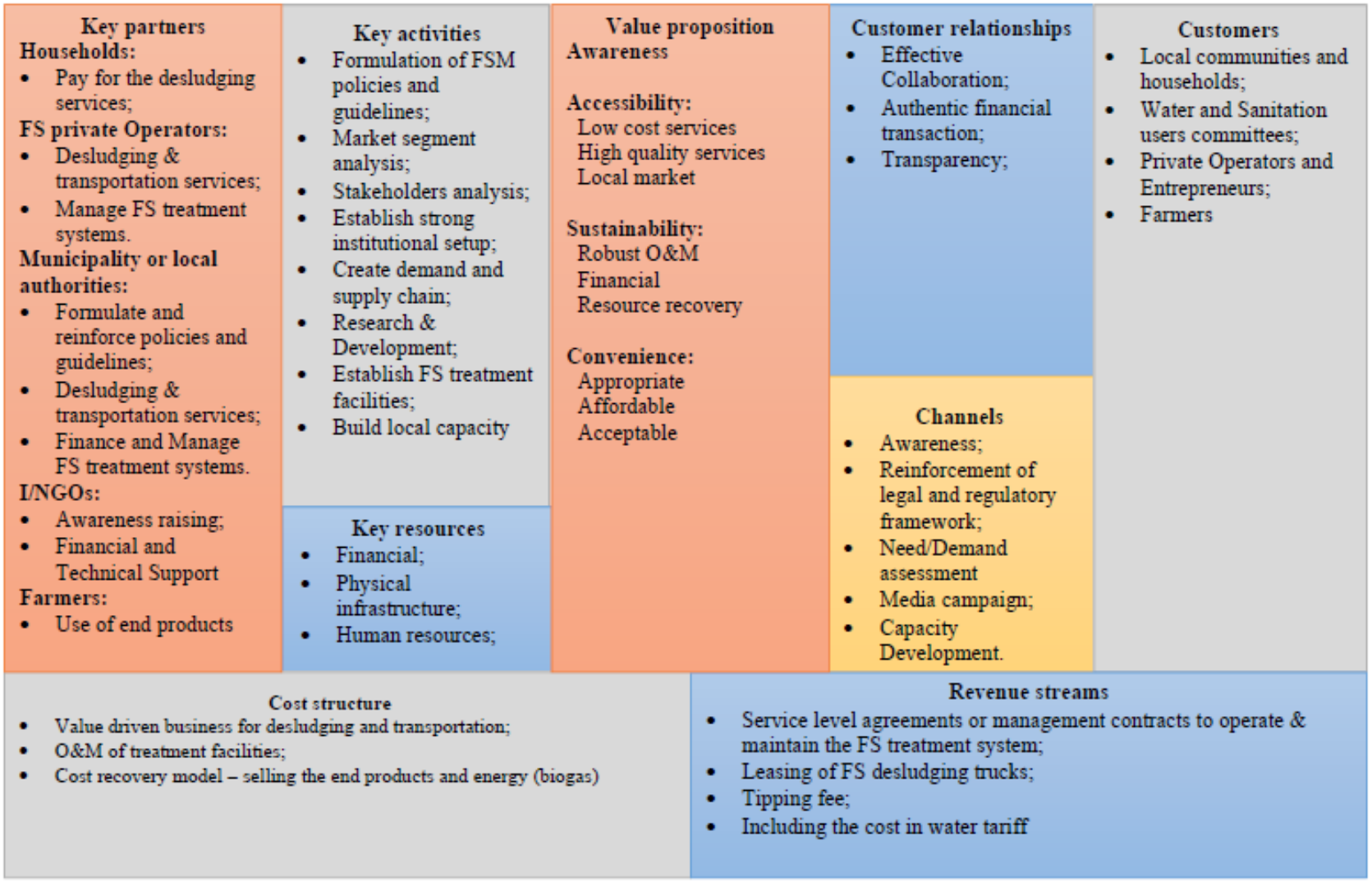


Figure 12: Figure: Specimen of Business Canvas Model for FSM

6.1.6 Stepwise approach to developing business case for Gorkha

Based on the above guidelines for developing a business case, this section provides an example of steps/actions and activities to be carried out while developing a FSM business plan for Gorkha Bazaar.

Potential project partners and responsibilities

Table 12 provides a draft outline of the potential stakeholders and their responsibilities while developing the FSM project case for Gorkha.

Table 12: Potential partners for developing FSM business plan in Gorkha

No	*Stakeholders*	*Potential responsibilities*	*Remarks*
A	***Local partners:***		
	Gorkha Municipality	Take lead of the FSM project, allocate budget and identify suitable land for establishment of treatment facilities, provide FS collection services, monitor overall operation of the FSM system, develop bylaws and enforce regulations	
	Gorkha Small Town Water User and Sanitation Committee	Take lead as the executing agency of the project, support in user mobilization, financial contribution, operation and maintenance	
	Private FS Operators	Provide FS collection services in the area	
	Manual FS operators	Upgrade FS emptying techniques and provide efficient services to households not reached by emptying trucks	
B	***Local Authority***		
	District Water Supply and Sanitation Office, Gorkha	Strategic guidance, advise technically in establishment of FSM systems, support in developing appropriate bylaws and management guidelines	
	District Development Committee (DDC)	Provide technical and financial assistance, assist in identifying suitable treatment locations	
	Small Town Water Supply and Sanitation Sector Project, Phase III	Share experience and knowledge of FSM projects from other towns, assist to coordinate with Gorkha WUSC, review strategic documents and report and advise the project	
B	***National & international partners:***		
	NGO Partner/ Consulting Firms	Facilitate overall project implementation, Liaison with local stakeholders and create enabling environment for project implementation, assist in capacity building and generating awareness, City Wide Sanitation Planning (CSP) involving baseline assessment, estimation of FS generation and service demand, technology selection, technical design and cost estimation, system design, business plan including operation and maintenance plan	These activities can be carried out either by the NGOs or the Consulting Firms or in partnerships
	Research Institutions or Independent researchers	Identify applied research topics which could be integrated in the project activities.	Research outcomes should be helpful to develop FSM system in the town

Action Plan for Gorkha FSM business case development

Table 13 provides a list of priority action and activities to be carried out to develop a FSM business case for Gorkha. Meanwhile, the activities or action outlined can be used to draw a project plan for Gorkha.

Table 13: Action Plan for developing business case on FSM for Gorkha

No	Aspects to consider	Output	Indicators
1	Understanding and agreement with Gorkha Municipality and the WSUC Committee and the project	MoU between different stakeholders involved in the project	Memorandum of Understanding or a Letter of Agreement between different key stakeholders
2	Selection of NGO partner and Consultant with their respective Scope of Works and ToRs	Implementing partner selected and assigned responsibilities for project	Project Agreement Document
3	Development of a City Wide Sanitation Planning documents	Developed a consolidated business plan which includes outputs from 3.1 to 3.	
3.1	Detailed Baseline Investigation but not limited to the following activities: i) estimation of FS generation, ii) FS demand, iii) type of sanitation systems, iv) stakeholder mapping, v) assessment of needs and priorities, vi) capacity assessments	Detailed situational analysis report with major focus on FSM situation, quantification of FS generation, demand, etc.	A document with detailing out the City Wide Sanitation Plan for Gorkha; number of planning workshop and events,
3.2	Identification of potential treatment systems & service combination for FS management	Developed detailed report with analysis of potential FS treatment and management options for Gorkha Bazaar	
4	Detail design and cost estimation to develop FSM treatment system	Developed a FSM design document with cost estimation, drawings and associated activities	Report on design and cost estimate of the selected treatment system and activities for Gorkha
5	Carry out capacity building and awareness activities on FSM based on the assessed needs in Gorkha	Generated awareness and developed capacity on FSM to various stakeholders	Number of events and proceedings from the trainings
6	Develop Implementation Action Plan together with local stakeholders based CSP, cost estimation and other needs for Gorkha	Developed a participatory action plan for implementation of the FSM project activities in Gorkha	Report on action plan; number of workshops,
7	Develop a business plan on FSM in Gorkha but not limiting to the following: i) market survey, ii) FS generation & collection, iii) willingness to pay, iv) financial analysis involving: investment costs, operating costs & revenue generation options, vi) operational plan	Developed an operational FSM business plan for Gorkha Bazaar	Business plan document which is operation and ready to implement

References

Montangero A, Strauss M (eds) (2004), Faecal Sludge Treatment, Swiss Federal Institute of Environmental Science and Technology (EAWAG)/SANDEC, Dubendorf, Switzerland

Koné, D. & Peter, S. (eds) 2008 Sandec Training Tool 1.0 – Module 5 Faecal Sludge Management (FSM). Eawag/Sandec (Department of Water and Sanitation in Developing Countries), P.O. 611, 8600 Dübendorf, Switzerland.

Sector Efficiency Improvement Unit 2014 Water Sanitation and Hygiene (WASH) Second Joint Sector Review (Technical Report). Ministry of Urban Development, Kathmandu, Nepal.

Koottatep, T. 2014 Practical Booklet on Technical Assessment and Planning Guidelines for Fecal Sludge Management. Asian Institute of Technology, Pathumthani, Thailand.

Final Report Sanitation Plan Amtali 2014 Asian Development Bank, Local Government and Engineering Department &Waste Concern Consultants, Bangladesh.

Creating Wealth from Waste: Business Plan (Draft) 2013 CGIAR Research Program on Water, Land & Ecosystems, Sri Lanka.

Government of Nepal Ministry of Physical Planning and Works 2009 National Urban Water Supply and Sanitation Sector Policy, Final Draft

Government of Nepal Ministry of Physical Planning and Works 2011 Water Supply, Sanitation and Hygiene Sector Status Report

Government of Nepal 2011 Sanitation and Hygiene Master Plan

Review of the Policy Environment, Legal Framework and Institutional Arrangements Related to Urban Sanitation and Hygiene in Nepal January 2014 (A study conducted for SNV Nepal) unpublished

Strauss, M. & Montangero, A. (date not known) Feacal Sludge Management Review of Practices, Problems and Initiatives. DFID/GHK/EAWAG-SANDEC

Government of Nepal 2013 Nepal Country Paper on Sanitation and Hygiene

6.2 For further readings

(General Documents, Journal Papers & Articles)

STRANDE, L., RONTELTAP, M., BRDJANOVIC, D. (Eds.) (2014) – Faecal Sludge Management: Systems Approach for Implementation and Operation (IWA publishing)
http://www.eawag.ch/forschung/sandec/gruppen/EWM/projects_ewm/fsm/index_EN
[Last accessed on 15 March, 2015]
This is the first book dedicated to faecal sludge management. It compiles the current state of knowledge of this rapidly evolving field, and presents an integrated approach that includes technology, management and planning. It addresses the planning and organization of the entire faecal sludge management service chain, from the collection and transport of sludge and treatment options, to the final end use or disposal of treated sludge. In addition to providing fundamentals and an overview of technologies, the book goes into details of operational, institutional and financial aspects, and provides guidance on how to plan a city-level faecal sludge management project with the involvement of all the stakeholders.

KONE, D., PETER, S. (Eds.) (2008): Faecal Sludge Management: Sandec Training Tool 1.0 – Moduel 5 (EAWAG/Sandec).
This training tool provides useful information on FS definition, characterizations, systems and technologies and other key aspects of FSM. The contents are very simple yet useful, particularly for the professionals those are new to FSM sector. At the end section, the general overview of FS technologies and systems has been well presented.

STRAUSS, M. & MONTANGERO, A. (2002): FS Management - Review of Practices, Problems and Initiatives. (Eawag/Sandec)
The report dedicated to overview of FS management including FSM practices, causes, problems and consequences. This report also describes the social and technical aspects of FSM and has presented some FSM case studies from developing countries.

KLINGEL, F., MONTANGERO, A., KONE, D., STRAUSS, M. (2002): Faecal Sludge Management in Developing Countries – A Planning Manual. (Eawag/Sandec)
This manual provides guidance on strategic planning of faecal sludge management for environmental planners and engineers, but will be useful as well for politicians and decision-makers. The manual is divided into two main parts: planning and tools. The "planning" chapter contains the strategic approach of the planning process. Step by step, the planning process is followed

and the possible actions are explained. The "engineering tools" chapter contains a collection of detailed technical information assisting the planning process.

COFIE, O., KONE, D., ROTHENBERGER, S., MOSER, D., ZUBRUEGG, C. (2009): Co-composting of faecal sludge and organic solid waste for agriculture: Process dynamics. In: Water Research 43, 4665-4675.

This research article describes the potentials and performance of combined treatment of faecal sludge (FS) and municipal solid waste (SW) through co-composting.

VALENCIA, R., HAMER, D. D., KOMBOI, J., LUBBERDING, H.J., GIJZEN, H.J. (2009): Alternative treatment for septic tank sludge: Co-digestion with municipal solid waste in bioreactor landfill simulators. In: Journal of Environmental Management 90 (2009) 940–945.

This research article explains the Co-disposal experiments carried out using the Bioreactor Landfill approach aiming to solve the environmental problems caused by indiscriminate and inadequate disposal of MSW and especially of septic tank sludge.

A.R. Kuffour, E. Awuah, F.O.K. Anyemedu, M. Strauss, D. Kone, O. Cofie (2009): Effect of using different particle sizes of sand as filter media for dewatering faecal sludge. In: Desalination 248 (2009) 308–314.

This research is aimed at investigating the effect of different particle sizes of sand for the dewatering of faecal sludge with respect to the dewatering time, contaminant load in the percolate, rate of clogging and quantity of biosolids produced

A. Panuvatvanicha, T. Koottatepa, D. Kone (2009): Influence of sand layer depth and percolate impounding regime on nitrogen transformation in vertical-flow constructed wetlands treating faecal sludge. In: Water Research 43 (2009) 2623-2630

This paper highlights the findings from the lab-scale experiment conducted for faecal sludge treatment through vertical flow constructed wetlands.

O.O. Cofie, S. Agbottaha, M. Strauss, H. Esseku, A. Montangero, E. Awuah, D. Kone: Solid–liquid separation of faecal sludge using drying beds in Ghana: Implications for nutrient recycling in urban agriculture. In: Water Research 40 (2006) 75-82.

This study investigated the possibility of recycling nutrients in human excreta and municipal solid waste for use in agriculture. It reports on the use of drying beds in separating solid and liquid fractions of faecal sludge (FS) so that the solids can be co-composted and the organic matter and part of the nutrients

	captured for urban agriculture. A.M. Ingallinella, G. Sanguinetti, T. Koottatep, A. Montangero, M. Strauss: The challenge of faecal sludge management in urban areas – strategies, regulations and treatment options. Water Science and Technology Vol 46 No 10 pp 285–294. *The authors describe the current situation and discuss selected issues of FS management. The paper further describes that the regulatory setting should take into account local economic, institutional and technical conditions. A separate section is devoted to the practice and to regulatory aspects of (faecal) sludge use in Argentina. An overview of treatment options, which may prove sustainable in less industrialized countries is provided.* U.S. EPA (1980): Design Manual - Onsite Wastewater Treatment and Disposal Systems. (=EPA 625/1-80-012). United States Environmental Protection Agency, Office of Water Office of Research and Development. Available at: http://water.epa.gov/infrastructure/septic/upload/septic_1980_osdm_all.pdf [Accessed: 2.03.2015] *Rather old design manual for onsite wastewater treatment options. However, it contains valuable information on well-established systems such as septic tanks, sand filters, aerobic treatment units (suspended growth and fixed film), disinfection, nutrient removal as well as wastewater segregation and recycling. Additional information is given on disposal methods and appurtenances.*
Case Studies	GHK (2005): Decentralised domestic wastewater and faecal sludge management in Bangladesh. http://r4d.dfid.gov.uk/PDF/Outputs/Water/R8056-Bangladesh_Case_Study.pdf [Accessed: 2.03.2015] *This report documents the findings from research activities undertaken in Bangladesh that were carried out as part of a project funded by the UK Government's Department for International Development (DFID) entitled "Capacity-building for Effective Decentralised Wastewater Management (DWWM)". The project was managed by GHK International and also involved a similar set of research activities in Vietnam. The aim of the research was to analyse decentralised approaches towards wastewater and faecal sludge management in Bangladesh and to assess the impacts of these schemes at the local level and their potential implications at the policy level information on how this*

	kind of treatment technology functions. USAID, EAWAG (2010): A rapid assessment of septage management in Asia. United States Agency for International Development http://www.waterlinks.org/sites/default/files/Regional_Septage_Report_0.pdf?lbisphpreq=1 [Accessed: 2.03.2015] *This report comprehensively documents the state of septage management for onsite sanitation systems, the main form of urban sanitation in many Asian cities. It provides a regional analysis of key challenges and existing good practices related to septage management, and highlights strategies through which governments, water and wastewater operators, and development assistance agencies can promote sustainable management practices.* Dr. T. B. Yousuf & W. (Eds.) (2011) Mahmud: A Study on Situation Analysis and Business model development of Faecal Sludge Management of Faridpur Municipality. Bangladesh: Practical Action and WaterAid http://practicalaction.org/media/download/43299 [Accessed: 10.03.2015] *This study was conducted to perform situation analysis on sludge management services in Faridpur Municipality and consumers' perspective to establish an improved system and development of a business plan in this regard.* WSP (2014): The Missing Link in Sanitation Service Delivery: A Review of Fecal Sludge Management in 12 Cities. World Bank, Water and Sanitation Programme *https://www.wsp.org/sites/wsp.org/files/publications/WSP-Fecal-Sludge-12-City-Review-Research-Brief.pdf* [Accessed: 10.03.2015] *This study seeks to assess the extent of FSM issue, and the major constraints that need to be overcome to improve faecal sludge management in 12 cities.*
Important Weblinks	http://www.eawag.ch/forschung/sandec/gruppen/EWM/projects_ewm/fame/index_EN [Accessed: 10.03.2015] *EAWAG's website dedicated to FSM study, research and activities from which several papers, articles and study reports can be downloaded.* http://wastewaterinfo.asia/ [Accessed: 10.03.2015]

	Wastewaterinfo.asia is an online resource for information on wastewater, FSM and sludge management, providing a wide variety of documents and data – all in one place. It is the platform for sharing knowledge and ideas for collective learning among sanitation experts and practitioners. http://www.sswm.info/ [Accessed: 10.03.2015] *A wide variety of resources on Sustainable Sanitation and Water Management including FSM and treatment technologies can be downloaded from this website.*

Annex

Annex I: **List of people consulted and interviews during the study**

No	List of people contacted	Designation and organisation	Contact numbers	Remarks
A	**Department of Water Supply and Sewerage**			
1	Mr. Ram Deep Sah	Director General		
2	Mr. Tiresh Khatri	Project Director, Small Town Water Supply and Sanitation Sector Project (STWSSSP), Phase II		
3	Late. Mr. Binay Shah	Project Management Office (PMO), STWSSSP, Phase II		
B	**Sub/Divisional District Water Supply and Sanitation Office**			
4	Mr. Hari Datta Poudel	Divisional Chief, Tanahu	98560 60 810, 9841 237 952 065 560 14 (Office)	Met on 14 Jan 2015 at his office in Tanahun, discussed from 4:00 to 6 pm, FS situation in the district, strategies adopted, initiatives, need, etc
5	Mr. Ram Chandra Kafle	Divisional Chief, Nawalparasi		
6	Mr. Narayan Prasad Acharya	Divisional Chief, Gorkha		
7	Mr. Radha Krishna Chaudhary	Design Consultant, IDRS, Byas Small Town Water Supply and Sanitation Project, Phase II	9844 042 406	Mr. Chaudhary is in charge of design and supervision of the proposed sludge drying bed in Byas Municipality.
8	Mr. Shekhar KC	Sub-Divisional Office, DWSO, Myagdi		Office is based in Beni, Myagdi
C	**Municipalities**			
9	Ms. Chandraa Thapa Magar	Executive Officer, Gorkha Municipality		
10	Hari Ram Nagila	Executive Officer, Shukla Gandaki Municipality, Tanahu	98560 62 018 hariramon@yahoo.co.uk	Met him at his office in Dulaigauda. Inquired about the plans about the newly established municipality, especially on FSM; Khairenitar is part of this municipality
11	Mr. Gaurav Panthi	Executive Officer, Bardaghat Municipality	9857086212	
12	Mr. Netra Adhikary	Pokhara Sub-metropolis		
13	Mr. Resam G.C.	Landfill Site Incharge Pokhara Sub-metropolis	9846042413	
14		Design Consultant, IDRS, Mukundapur		
15	Radha K. Chaudhary	Design Consultant, IDRS, Byas Municipality	9844042406	Responsible for construction of the FSTP in Byas Municipality from IDRS
D	**User Committees**			

	Khairenitar Small Town Water Supply and Sanitation Users Committee			
16	Mr. Sri Ram Subedi	Office Manager, Khairenitar Small Town Water Supply and Sanitation Users Committee, Khairenitar	98460 62 397	▪ Dynamic person, who helped us to connect with many people around ▪ Provided report on the wastewater management plan developed by Aqua Consulting Services
17	Mr. Mukti Nath Timilsina	Joint Secretary (Member, Federation of Community Forest User Group; Past Chairperson, Hariyoban Programme)		
18	Mr. Ram Chandra Upadhyaya	Treasurer	9856022196	
19	Mr. Bhanu Bhakta Subedi	Secretary	9856063422	
20	Mr. Yagya Bahadur Thapa	Ka. Sa.	9846067398	
	Bardaghat Small Town Water Supply and Sanitation Users Committee			
21	Mr. Kamaan Singh Thapa	Chairperson	9857080138	
22	Mr. Shyam Kumari Kunwar	Vice-chairperson	9847482874	
23	Mr. Indra Kumar Rana	Secretary	9857080488	
24	Mr. Kamal Thapa	Member	9857080170	
25	Mrs L alita Aryal	Member	9847148841	
26	Mr. Rajendra Sunar	Member	9857080305	
27	Mr. Bishnu Kumar Bhusal	Office Manager	9847025838	
28	Mr. Gaurav Panthi	Chief Executive Officer	9857086212	
	Lekhnath Small Town Water Supply and Sanitation Users Committee			
29	Bodhraj Lamichhane	Chairperson	9856023959	
30	Hari Prasad Lamichhane	Secretary	9856048488	
31	Kuldeep Baral	Treasurer	9846213417	
32	Khem Bahadur Pun	Member	9846004975	
33	Sharada Bastola	Member	9846061768	
34	Biswo Ram Bhandari	Administration Head	9846320808	
35	Ramesh Giri	Junior Engineer	9846320817	
	Bandipur Small Town Water Supply and Sanitation Users Committee			
36	Anand Man Joshi	Chairperson	9846046397	
37	Tanka Bahadur	Vice-chairperson	9846176198	
38	Dil Bahadur Thapa	Treasurer	9846163939	
39	Madav Bhattarai	Secretary	9846082370	
40	Dhapendra Thapa	Member	9846065299	
41	Ash Maya B.K.	Member	9841866114	
42	Laxmi Gurung	Member	9846080439	
	Gorkha Small Town Water Supply and Sanitation Users Committee			

43	Badri Bahadur Maskey	Chairperson	9851049551	
44	Ramji Shrestha	Vice-chairperson	9746009114	
45	Binod Babu Aryal	Treasurer	9856040037	
	Kawasoti Small Town Water Supply and Sanitation Users Committee			
46	Bishnu Prasad Bhusal			
47	Chet Bahadur Adhikari			
	Besishahar Water Supply and Sanitation Users Committee			
48	Krishna Pradhan	Chairperson	9856045301	
49	Lokendra Gurung	Vice-chairperson	9841428541	
50	Bhim Bahadur Adhikary	Treasurer	9846074654	
51	Bishnu Bahadur Adhikari	Office Secretary	9856045077	
52	*Beni Small Town Water Supply and Sanitation User Committee*			
53	Bhote Odar Water Supply and Sanitation Committee			