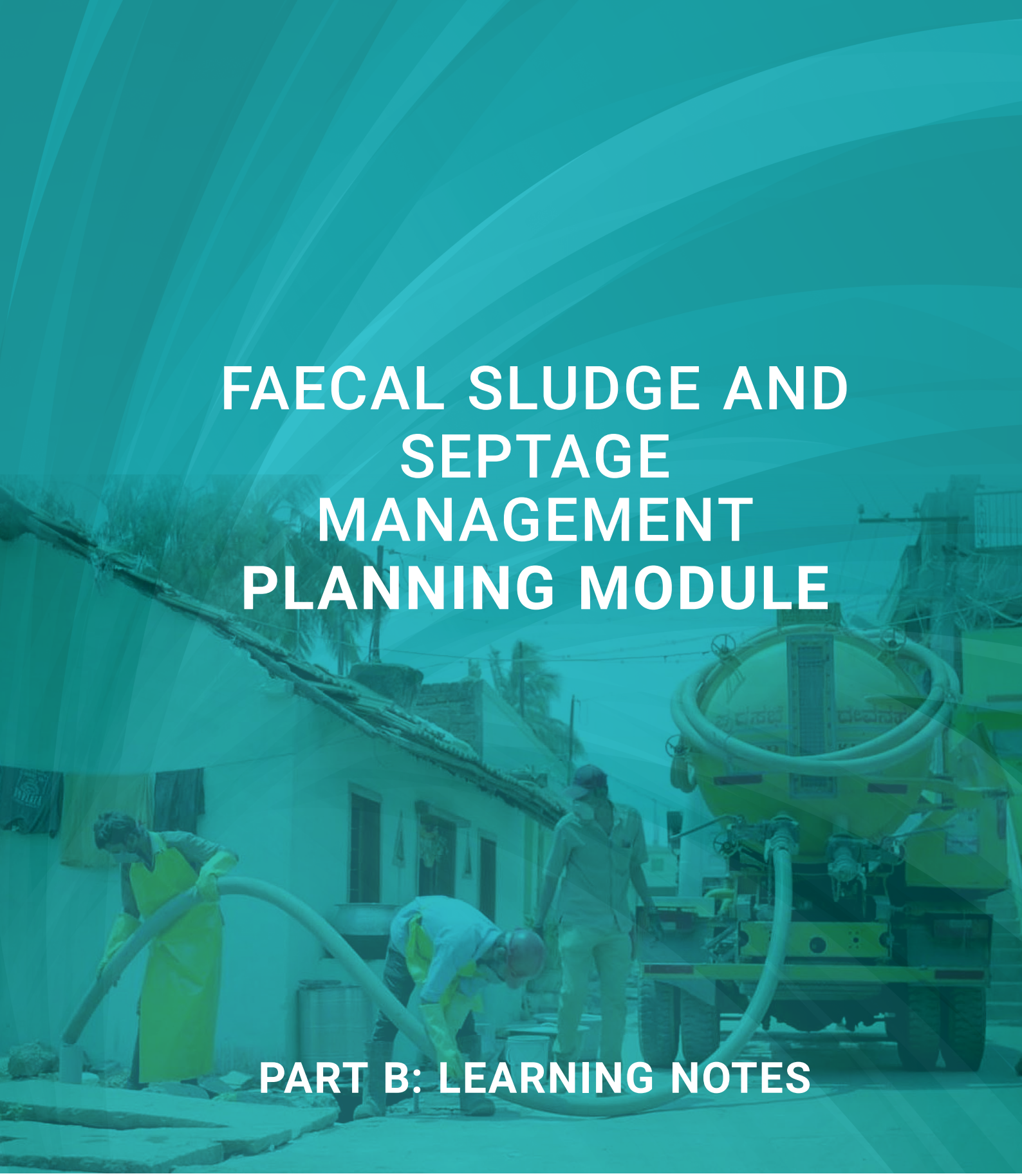
FAECAL SLUDGE AND SEPTAGE MANAGEMENT PLANNING MODULE



PART B: LEARNING NOTES

National Institute of Urban Affairs

NFSSM Alliance

ecosan SERVICES FOUNDATION

FAECAL SLUDGE AND SEPTAGE MANAGEMENT PLANNING MODULE

PART B:

LEARNING NOTES

Collaborative Effort Under Training Module Review Committee (TMRC)

National Institute of Urban Affairs

NFSSM Alliance

ecosan SERVICES FOUNDATION

TITLE

Faecal Sludge and Septage Management – Planning Module (Part B: Learning Notes)

PUBLISHER

National Institute of Urban Affairs, New Delhi

RESEARCH PROJECT

Sanitation Capacity Building Platform (SCBP)

GRAPHIC DESIGN

Deep Pahwa, Devender Singh Rawat, Bhavnesh Bhanot, Preeti Shukla

Year of publishing: 2021

CONTENT

The module has been developed with the collaborative effort of NFSSMA partner organisations under Training Module Review Committee (TMRC) anchored by NIUA.

Editor	Authors	Contributor and reviewer
National Institute of Urban Affairs (NIUA)	National Institute of Urban Affairs Ecosan Services Foundation	National Faecal Sludge and Septage Management Alliance (NFSSMA)

DISCLAIMER

While every effort has been made to ensure the correctness of data/information used in this training module, neither the authors nor NIUA accept any legal liability for the accuracy or inferences drawn from the material contained therein or for any consequences arising from the use of this material. No part of this module may be reproduced in any form (electronic or mechanical) without proper acknowledgement.

CONTACT

National Institute of Urban Affairs
1st and 2nd floor Core 4B,
India Habitat Centre,
Lodhi Road, New Delhi 110003, India
Website: www.niua.org, scbp.niua.org
E-Mail: scbp@niua.org

FAECAL SLUDGE AND SEPTAGE MANAGEMENT PLANNING MODULE

PART B:

LEARNING NOTES

Collaborative Effort Under Training Module Review Committee (TMRC)

National Institute of Urban Affairs

NFSSM Alliance

ecosan SERVICES FOUNDATION

Foreword

Acknowledgements

ABOUT NATIONAL FAECAL SLUDGE AND SEPTAGE MANAGEMENT ALLIANCE (NFSSMA)

The 'NFSSM Alliance' was formed with a vision to "Create an enabling environment which amplifies scaling of safe, sustainable and inclusive FSSM through knowledge, partnerships and innovative solutions by 2024."

Convened by Bill and Melinda Gates Foundation in 2016, the Alliance is a voluntary body that aims to:

- Build consensus and drive the discourse on FSSM at a policy level, and
- Promote peer learning among members to achieve synergies for scaled implementation and reduce duplication of efforts

The Alliance currently comprises 32 organizations across the country working towards solutions for Indian states and cities. The Alliance works in close collaboration with the Ministry of Housing and Urban Affairs (MoHUA) and several state and city governments through its members to support the progress and derive actions towards mainstreaming of FSSM at state and national level. The NFSSM Alliance works on all aspects of city sanitation plans to regulatory and institutional frameworks across the sanitation value chain. The NFSSM Alliance working in collaboration with the Ministry of Housing and Urban Affairs has been instrumental in the passage of India's First Policy on FSSM launched in 2017. This resulted in 19 out of 36 states adopting guidelines and policies for FSSM in India.

The strength of the Alliance lies in its diverse membership, which includes research institutes, academic institutions, think-tanks, quasi-government bodies, implementing organizations data experts, consultants and intermediaries. This enabled a multi-disciplinary view of urban sanitation, with members building on each other's expertise. The alliance has had enormous success in championing FSSM as a viable solution to the Government of India by broadly focussing on:

1. Influencing and informing policy
2. Demonstrating success through innovation and pilots
3. Building capacities of key stakeholders across the value chain

The collaborative effort continues to work towards promoting the FSSM agenda through policy recommendations and sharing best practices which are inclusive, comprehensive, and have buy-in from several stakeholders in the sector.

NFSSM Alliance

- ASCI
- Athena Infonomics
- BBC Media Action
- BMGF
- Borda
- CEPT University
- CSTEP
- CDD
- CPR
- CFAR
- CSE
- Dasra
- EY
- GIZ
- IIHS
- ISC
- IWMI
- KPMG
- NIUA
- PSI
- RTI International
- Tide Technocrafts
- UMC
- UNICEF
- USAID
- WASHi
- Water Aid
- World Bank Group

ABOUT TRAINING MODULE REVIEW COMMITTEE (TMRC)

To ensure quality control in content and delivery of trainings and capacity building efforts, a **Training Module Review Committee (TMRC)** was formed with the collaborative effort of all Alliance partners. TMRC which is **anchored by National Institute of Urban Affairs (NIUA)**, has the following broad objectives:

- Identification of priority stakeholders and accordingly training modules for Capacity Building
- Development of a Normative Framework – For Capacity Building at State Level
- Standardization of priority training modules – appropriate standardization of content with flexibility for customization based on State context
- Quality Control of Trainings – criteria for ensuring minimum quality of training content and delivery
- Strategy for measuring impact of trainings and capacity building efforts.

ABOUT THE PLANNING MODULE

Title	**Faecal Sludge and Septage Management - Planning Module**
Purpose	To build the capacities of ULB and state officials on planning of faecal sludge and septage management. This course will introduce the target audience to components of FSSM planning starting with approach and methodology for state and city level FSSM planning, aspects of FSSM, stakeholder's engagement, treatment approaches, financial aspects and O&M mechanisms. This module is crucial for officials of cities to be able to achieve the objectives under SBM-U 2.0 and AMRUT 2.0.
Target Audience	Decision makers from state and ULBs, experts/sector partners working as TSU/ PMUs, faculties from nodal training institutes with professional experience in Faecal Sludge and Septage Management.
Learning Objective	1. Understand the approaches and methodologies for preparing a state investment plan for FSSM. 2. Linking city level planning approaches with citywide inclusive sanitation. 3. Understanding the steps involved in carrying out the situation or feasibility assessment. 4. Leverage various funding avenues and understand business models for FSSM at city level. 5. Comprehend the aspects of FSSM, stakeholder's engagement, treatment approaches and financial and sustainability aspects.
Structure of the Module	The training module is based on case methodology where sessions are complemented with exercises based on real-life scenarios. This will help trainees to apply the knowledge grasped during the session and reinforce it further in their work. The module is structured and divided into the following parts: 1. Part A: This contains the slides used during the session in the presentation format. **2. Part B: This is a comprehensive compilation of the all the session briefs and further reading material which helps to strengthen the learning.** 3. Part C: This contains the exercise developed for training based on the real-life cases.
Duration	In a face-to-face training format, this training is conceptualized for two days without site visits and can be adopted for including the site visits depending upon the city where it is being conducted.

FAECAL SLUDGE AND SEPTAGE MANAGEMENT (FSSM)

Advanced Planning Module

AGENDA

Time Duration (Hours)	Session Title
Day 1	
9.00 - 09.30	Registration
9.30 - 10.00	Introduction, Setting ground rules, Understanding Expectation, Aims and Objectives of the training
10.00 - 11.00	Introduction to Urban Sanitation and Policies and Programmes
11.00 – 11.15	**Tea Break**
11.15 - 12.15	Approaches and Methodology of Planning
12.00 - 13.15	State Level Approaches for FSSM Planning
13.15 - 14.00	**Lunch Break**
14.00 - 14.45	Exercise on State Level FSSM Planning
14.45 - 15.45	City level approaches for FSSM Planning
15.45 - 16.00	**Tea Break**
16.00 - 17.00	FSSM: An Overview of Key Concepts

Time Duration (Hours)	Session Title
Day 2	
9.30 - 10.30	Stakeholders Engagement – Tools and Programs
10.30 - 11.00	Exercise on Stakeholders Analysis and Engagement
11.00 - 11.15	**Tea Break**
11.15 - 12.15	Situation Assessment – Introduction to Feasibility Assessment
12.15 - 13.15	Treatment approaches in FSSM
13.15 - 14.15	**Lunch Break**
14.15 - 15.15	Exercise on FSS Planning
15.15 - 15.30	**Tea Break**
15.30 - 16.00	Financial Aspects of FSSM
16.00 - 16.45	O&M Aspects of FSSM
16.45 - 17.00	Wrap-up & Way forward

GLOSSARY

Anaerobic Digestion	The process wherein the degradation and stabilization of organic compounds by microorganisms occurs in the absence of oxygen, leading to production of biogas is known as anaerobic digestion.
Biogas	Biogas is the mixture of gases released from anaerobic digestion. Biogas comprises methane (50 to 75%), carbon dioxide (25 to 50%) and varying quantities of nitrogen, hydrogen sulphide, water vapour and other components. Biogas can be collected and burned for fuel (like propane).
Biomass	Biomass refers to plants or animals cultivated using the water and/or nutrients flowing through a sanitation system. The term biomass may include fish, insects, vegetables, fruit, forage or other beneficial crops that can be utilized for food, feed, fibre and fuel production.
Blackwater	Blackwater is the mixture of urine, faeces, and flush water or anal cleansing materials. It contains the pathogens and organic matter of faeces as well as the nutrients of urine.
Collection and Storage/ Treatment	It is the way of collecting, storing, and sometimes treating the products generated at the user interface or containment level. The treatment provided by these technologies is often a function of storage and is usually passive (e.g., requiring no energy input). Thus, products that are 'treated' by these technologies often require subsequent treatment before reuse and/or disposal.
Conveyance	Conveyance describes the transport of products from one functional group to another. Although products may need to be transferred in various ways between functional groups, the longest and most important gap is between user interface or collection and storage/treatment and centralized treatment. Therefore, for the sake of simplicity, conveyance only describes the technologies used to transport products between these functional groups.
Centralized treatment	Centralized treatment refers to treatment technologies that are generally appropriate for large user groups (i.e., neighbourhood to city level applications). The operation, maintenance, and energy requirements of technologies within this functional group are generally higher than for smaller-scale technologies at the collection and storage/ treatment level.
Dewatering	The process of reducing the water content from sludge or slurry is termed as dewatering. Dewatered sludge may still have a significant moisture content, but it typically is dry enough to be conveyed as a solid (e.g., shovelled).
Effluent	Effluent refers to a liquid that leaves a technology, typically after blackwater or sludge has undergone a basic form of treatment like solid-separation. It originates either from the collection and storage/treatment step or at the outlet of centralized treatment technology. Depending on the type of treatment, the effluent may be completely sanitized or may require further treatment before it can be used or disposed of.
Excreta	Excreta consists of urine and faeces that is not mixed with any form of water. It is relatively small in volume, but concentrated in both nutrients and pathogens. Depending on the quality and quantity of the faeces, it has either a soft or runny consistency.
Faecal sludge	Faecal sludge is the raw or partially digested wastewater, in a slurry or semi-solid form, found in the collection, storage or treatment unit. It mainly contains a mixture of excreta and blackwater, with or without greywater.
Faeces	Faeces refers to excrement that is not mixed with urine or water. Depending on diet, each person produces approximately 50 L per year of faecal matter. Fresh feces contain about 80% water. Of the total nutrients excreted, feces can contain about 12% N, 39% P, 26% K and have 107 to 109 faecal coliforms in 100 ml.
Flush water	The water discharged into the user interface to transport the content into the containment unit or a conveying system and/or clean it. Freshwater, rainwater, recycled greywater, or any combination of the three can be used as a flush water source.
Greywater	The total volume of water generated from washing food, clothes and dishware, as well as from bathing, but not from toilets. It may contain traces of excreta (e.g., from washing diapers) and, therefore, some pathogens. Greywater accounts for approximately 65% of the wastewater produced in households with flush toilets.

Nutrient	Nutrient refers to any substance that is used for growth. Nitrogen (N), phosphorus (P), and potassium (K) are the main nutrients contained in agricultural fertilizers. N and P are also primarily responsible for the eutrophication of water bodies.
Sanitation	Sanitation is the means of safely collecting and hygienically disposing of excreta and liquid wastes for the protection of public health and the preservation of the quality of public water bodies and, more generally, of the environment.
Septage	Septage is the liquid and solid material that is collected from a septic tank, cesspool, or such onsite treatment facility after it has accumulated over a period of time. It has gone under a high degree of digestion as compared to faecal sludge.
Septic tank	Septic tank is an underground tank that treats sewage by a combination of solids settling and anaerobic digestion. The effluent may be discharged into soak pits or small-bore sewers, and the solids have to be pumped out periodically.
Sewage	Sewage is the wastewater containing human body waste matter (faeces and urine etc), either dissolved or undissolved, discharged from toilets and other receptacles intended to receive or retain such human body wastes.
Sewerage system	The underground conduit for the collection of sewage is called sewer. A network of sewer appurtenances intended for the collection and conveyance of sewage from the source to a sewage pumping station for pumping to sewage treatment plant for further treatment and disposal is called sewerage system.
User interface	User interface refers to the type of toilet, pedestal, pan, or urinal with which the user comes in contact; it is the way by which the user accesses the sanitation system. In many cases, the choice of user interface will depend on the availability of water.
Use and/or Disposal	Use and/or disposal refers to the methods by which products are ultimately returned to the environment, either as useful resources or reduced-risk materials. Furthermore, products can also be cycled back into a system (e.g., by using treated greywater for flushing).

ABBREVIATIONS

AMRUT	Atal Mission for Rejuvenation and Urban Transformation
CAPEX	Capital Expenditure
CPHEEO	Central Public Health and Environmental Engineering Organisation
CSP	City Sanitation Plan
CSZ	Core Sanitation Zone
CWIS	City Wide Inclusive Sanitation
CWWIS	City Waste-Water Infrastructure Status
DPR	Detailed Project Report
ESF	Ecosan Services Foundation
FSS	Faecal Sludge and Septage
FSSM	Faecal Sludge and Septage Management
FSTP	Faecal sludge and Septage Treatment Plant
IHHT	Individual Household Toilet
IWSM	Integrated Wastewater and Septage Management
LCC	Life Cycle Cost
LCCA	Life-Cycle Cost Analysis
MBBR	Moving Bed Bio Reactor
MoHUA	Ministry of Housing and Urban Affairs
NIUA	National Institute of Urban Affairs
NMCG	National Mission for Clean Ganga
O&M	Operation & Maintenance
OPEX	Operational Expenditure
PE	Private Enterprise
SBM (U)	Swachh Bharat Mission (Urban)
SRT	Solid Retention Time
STP	Sewage Treatment Plant
SCBP	Sanitation Capacity Building Platform
SPCB	State Pollution Control Board
ULB	Urban Local Body
WWM	Wastewater Management
WHO	World Health Organisation

LIST OF FIGURES

Figure 1: Bar diagram shows growth of urban population 1901-2021 4
Figure 2: Population distribution in India 4
Figure 3: Venn diagram depicting sewage generation, installed treatment capacity, operational capacity, actual utilization and complied treatment capacity 6
Figure 4: Growing Recognition of FSSM in India 11
Figure 5: Source across the sanitation value chain 16
Figure 6: City Sanitation Plan (CSP) 23
Figure 7: Framework for the CSP: Integrated approach to inclusive sanitation 24
Figure 8: A Participatory, Multi-stakeholder Consultative Process adopted 25
Figure 9: Citywide Inclusive Sanitation (CWIS) 26
Figure 10: Sanitation Service Chain at Warangal – Before CWIS 27
Figure 11: Sanitation Service Chain at Warangal – After CWIS 28
Figure 12: Stages of the planning process 29
Figure 13: Normative framework for operationalizing FSSM at State Level 34
Figure 14: Institutional framework for Sanitation in states of India. 34
Figure 15: Roadmap for Promoting Urban Sanitation in Tamil Nadu 38
Figure 16: Step taken by Madhya Pradesh for mainstreaming CWIS 50
Figure 17: Steps of CWIS planning in Madhya Pradesh 50
Figure 18: Evidence based planning of Nagda City, MP – Primary Analysis 51
Figure 19: Evidence based planning of Nagda City, MP – Secondary Analysis 51
Figure 20: Evidence based planning of Nagda City, MP – Tertiary Analysis 52
Figure 21: Evidence based planning of Nagda City, MP – Feasibility Assessment 53
Figure 22: Classification of sanitation system 62
Figure 23: Wet sanitation system and its types 63
Figure 24: User Interface Options 64
Figure 25: Conveyance systems in sanitation 65
Figure 26: Technologies for semi-centralized treatment 66
Figure 28: Need of FSSM 68
Figure 27: Sanitation Value Chain 67
Figure 29: FSSM Quality Indicators 72
Figure 30: Key Stakeholders in FSSM 80
Figure 31: Example of targeted IEC campaign poster for sustaining ODF status 85

Figure 32: List of tools which can be used in a IEC and BCC campaign 85
Figure 33: Pictures from the IEC campaign carried out in local languages on Malasur 86
Figure 34: Two-fold approach by Odisha state for creating enabling environment. 87
Figure 35: Use of tools and local language for ease of understanding by locals in remote places 88
Figure 36: Assessment of Initial Situation 94
Figure 37: Tools and Method of Data Collection 95
Figure 38: SWOT Matrix and its example 97
Figure 39: Stages of treatment in faecal sludge and septage 104
Figure 40: FSSM Approach based on existing assets within the ULB 105
Figure 41: Addition points of faecal sludge and septage at the STP 106
Figure 42: Co-composting of dewatered faecal sludge and septage with organic waste 107
Figure 43: Temperature profile during the composting process 108
Figure 44: Discrete Collection and Treatment 116
Figure 45: Use of Discrete Collection and Treatment Model in Dehradun, Uttarakhand. 117
Figure 46: Integrated collection, transport and treatment model 117
Figure 47: Integrated collection, transport and treatment model at Leh, India. 118
Figure 48: Sanitation tax model 119
Figure 49: Sanitation tax model at Wai (India) and Philippines 120
Figure 50: Licensing Model 121
Figure 51: Licensing model in ULBs across Tamil Nadu 121
Figure 52: Life Cycle Cost 122
Figure 53: Total LCC Across FSTPs 123
Figure 54: NPV of LCC Across FSTPs 123
Figure 55: Chain of custody forms for sampling 130
Figure 56: Inspection Sheet 131
Figure 57: Engaging Women led SHGs through National Urban Livelihood Mission for O&M of the sanitation facility and treatment plants 133

LIST OF TABLES

Table 1: Comparative Statistics on the Inventory for the years 2014 and 2020 7
Table 2 Key comparisons across the MDGs and SDGs 10
Table 3: Financial aspects across the sanitation value chain for planning of FSSM.....16
Table 4: Data Collection at City Level.....23
Table 5: Overview of key state institutions and their roles 41
Table 6: Comparison between septage and sewage 60
Table 7: Characterization ratios of faecal sludge, septage and sewage 61
Table 8: Challenges in FSSM 69
Table 9: Scheduled and demand-based desludging 71
Table 10: Example of stakeholder's analysis 81
Table 11: Influence-Interest Matrix to Identify Involvement Needs and Participation Levels ..82
Table 12: Stakeholders Participation Matrix 83
Table 13: Aspects for selection of Involvement Tools 84
Table 14: Information required of Existing Sanitation Services 98
Table 15: Selection criteria for treatment mechanisms 102
Table 16: Assessment of CAPEX and OPEX across FSSM Value Chain..... 114
Table 17: Pros and Cons of Discrete Collection and Treatment..... 117
Table 18: Pros and Cons of Integrated collection, transport and treatment model..... 118
Table 19: Pros and Cons of sanitation tax model..... 120
Table 20: Pros and Cons of Licensing Model 122

Contents

ABOUT NATIONAL FAECAL SLUDGE AND SEPTAGE MANAGEMENT ALLIANCE (NFSSMA) vi
ABOUT TRAINING MODULE REVIEW COMMITTEE (TMRC) vii
ABOUT THE PLANNING MODULE ix
AGENDA xi
GLOSSARY xiii
ABBREVIATIONS xv
1. Introduction to Urban Sanitation and Policies and Programmes 1
2. Approaches and Methodology of Planning 19
2.1 Learning Objectives 21
2.2 Session Plan 21
2.3 Key Facts 21
2.4 Learning Notes 21
2.5 Notes for Trainer 30
2.6 Bibliography 30
2.7 Further Reading 30

3. State level Approaches for FSSM planning 31
3.1 Learning Objectives 33
3.2 Session Plan 33
3.3 Key facts 33
3.4 Learning notes 33
3.1 Notes for Trainer 42
3.2 Bibliography 42

4. City level Approaches for FSSM planning 43
4.1 Learning Objectives 45
4.2 Session Plan 45
4.3 Key facts 45
4.4 Learning notes 45
4.5 Notes for trainer 54
4.6 Bibliography 54
4.7 Further Reading 54

5 Faecal Sludge and Septage Management - An overview of key concepts 55
5.1 Learning Objectives 57
5.2 Session Plan 57
5.3 Key facts 57
5.4 Learning notes 57
5.5 Notes for trainer 74
5.6 Bibliography 74

6. Stakeholder Engagement Tools and Programs 77
6.1 Learning objectives 79
6.2 Session plan 79
5.3 Key facts 79
5.4 Learning notes 79
6.5 Notes for Trainer 89
6.6 Bibliography 89
6.7 Further Reading 89

7. Situation assessment- Introduction to feasibility assessment 91
7.1 Learning objectives 93
7.2 Session plan 93
7.3 Key facts 93
7.4 Learning notes 93
7.5 Notes for trainer 98
7.6 Bibliography' 98

8. Treatment approaches in FSSM 99
8.1 Learning Objectives 101
8.2 Session Plan 101
8.3 Key Facts 101
8.4 Learning Notes 101
8.5 Notes for trainer 109
8.6 Bibliography 109
8.7 Further reading 109

9. Financing Aspects of FSSM 111
9.1 Learning Objectives 113
9.2 Session Plan 113
9.3 Key Facts 113
9.4 Learning Notes 113
9.5 Notes for trainer 124
9.6 Bibliography 124
9.7 Further Reading 124

10. O&M Aspects of FSSM 125
10.1 Learning objectives 127
10.2 Session plan 127
10.3 Key facts 127
10.4 Learning notes 127
10.5 Notes for trainer 134
10.6 Bibliography 134
10.7 Further Reading 134

Session

01

Introduction to Urban Sanitation and Policies and Programmes

1. Introduction to Urban Sanitation and Policies and Programmes

1.1 Learning objectives

- To understand urbanization and its associated challenges in India
- To analyze the urban sanitation policy and programs at national level
- To know the funding opportunities for operationalizing FSSM

1.2 Session plan

Duration - 45 minutes

Topics	Time	Material/Method
Urban Sanitation – National trend	10 min	Powerpoint presentation
Issues and Challenges Urban Sanitation Sector in India	10 min	Powerpoint presentation
Urban Sanitation Policy and Programs in India	10 min	Powerpoint presentation
Funding opportunities for FSSM	10 min	Powerpoint presentation
Q&A	5 min	Discussion

1.3 Key facts

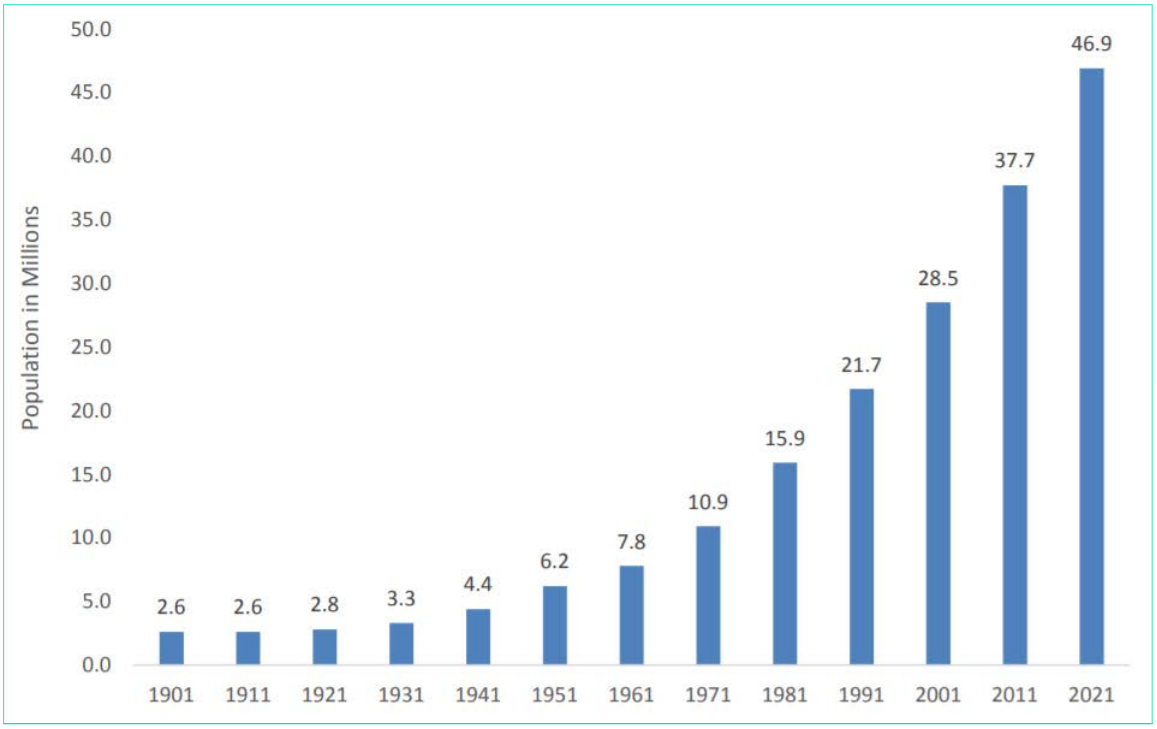
- By 2030, an approximate of 60% of the world's population will be residing in the urban centers of the developing countries.
- Increasing urban population puts the national government and ULBs under tremendous pressure.
- Cities are unable to plan and implement the sanitation infrastructure at the rate with which population is increasing.
- Funding for different functional group in sanitation service chain is provided through national programs like Swachh Bharat Mission (Urban) 2.0, Atal Mission for Rejuvenation and Urban Transformation (AMRUT) mission, 15th Finance Commission, etc.

1.4 Learning notes

1.4.1 Urban Sanitation – National Trend

Urbanisation is a world-wide phenomenon and it is neither unique nor exclusive when it comes to India. Indian urbanisation has continued as a part and product of economic change in the past few decades. It is very important to understand nature i.e., the shape and pattern of urban growth.

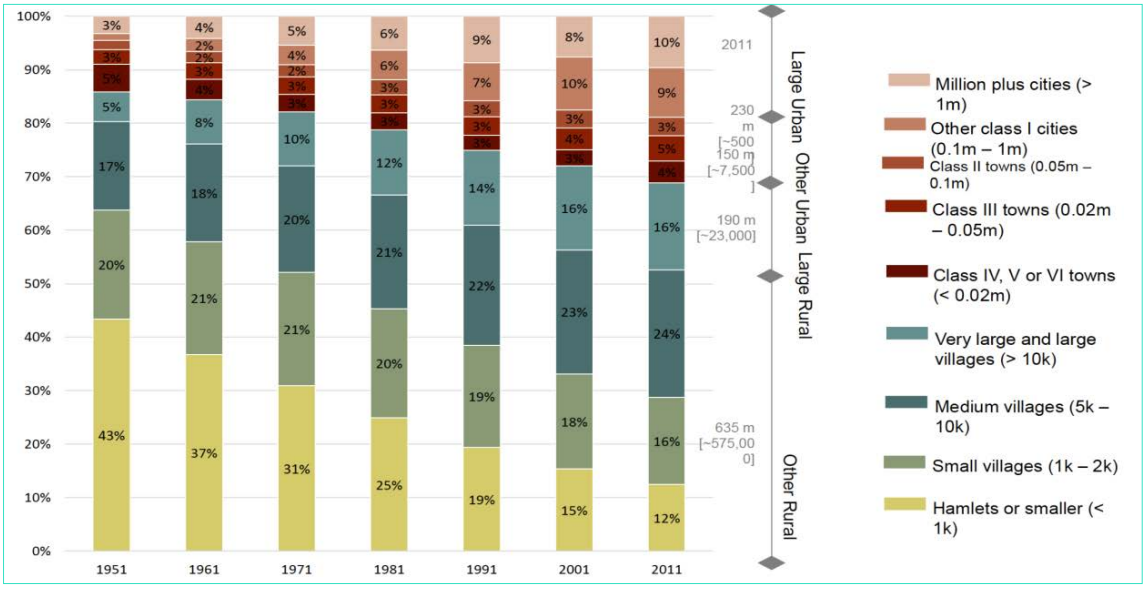
Figure 1: Bar diagram shows growth of urban population 1901-2021



Source - National Inventory of Sewage Treatment Plants, CPCB Report March 2021

The distribution of the population in the various class of towns have changed significantly. As per the paper on Urbanization by K. C. Siva Ramakrishnan and B. N. Singh and published by Niti Ayog, in 1991, there were 3768 towns and approximately the population was equally distributed among the 23 metropolitan cities, 277 Class I cities and in the remaining 3468 towns. In 2001, there were 4368 towns and approximately 38% of the total urban population resided 35 metro cities, 30.6% in the remaining 358 Class I cities and 3975 towns. The analysis of urbanisation pattern and projections for the next 20 years indicates that the bulk of the urban population will be living in metropolitan regions and the growth will be seen on the periphery of the large metro cities.

Figure 2: Population distribution in India



Source: Analysis Census of India by IIHS

A growing number of rural settlements are emerging as urban (also called as rurban). The delimitation of the boundaries of large cities is done by the town planning department to accommodate the partially urbanized villages on its periphery. Due to this, there is a reduction in the agricultural farmlands and occupational patterns of the villagers are changing. Another phenomenon worth noticing is that the large cities are becoming saturated and accumulation of population is observed in the second-tier cities.

After the 2011 census of India, there was a notable demographic shift towards urban centres. In the period from 2001-11 the population growth in the urban India was slightly higher than the rural India. The United Nation, highlights that India's urban population size will nearly double between 2018 and 2050, from 461 to 877 million. The National Commission on Population in India has predicted that in the next 15 years i.e., by 2036, up to 40% of Indians will live in urban areas. The prevailing trends suggest that India is on a steady path of urbanization (Aijaz R.: 2021).

There will be a tremendous impact of all this growth on space, environment and quality of life. The urban environment, particularly in large cities, is deteriorating very rapidly. The reasons being the rate of provision of infrastructural facilities required to support such a large concentration of population is lagging far behind the rate of urbanisation. All cities have severe shortage of basic environmental services whose level, quality and distribution have been very poor and unequal. Poor and unequal distribution of sanitation services have resulted into serious health impacts particularly affecting the urban poor.

The process of rapid urbanisation poses serious challenges to the natural environment of the towns, which are struggling to provide and maintain the already inadequate level of urban sanitation services. In recent years, the urban environment has become a major subject of concern; among the major environmental problems faced by urban areas are air, water, and soil pollution and growing volume of wastes including hazardous waste. The metro cities are experiencing critical environmental degradation and pushing to the limit their ability to sustain human life. Although the entire urban population is affected, the urban poor are the most vulnerable. It is the poor performance of local governments in the delivery of basic urban services that lead to environmental degradation and lower quality of life in urban areas.

1.4.2 Issues and Challenges Urban Sanitation Sector in India

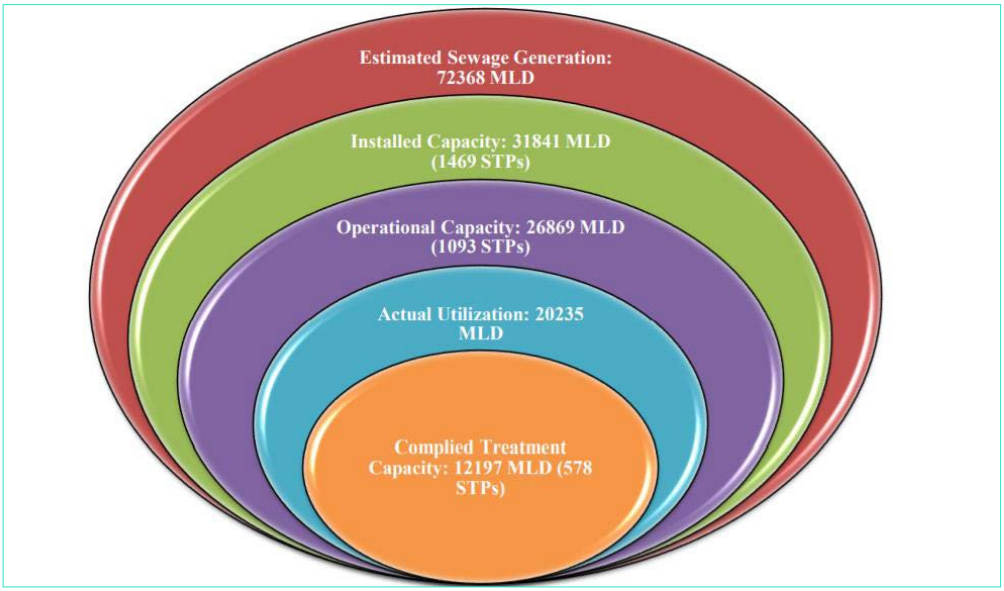
"More Indians have mobile phones than toilets". This news first made headlines in 2010 in both Indian and international media and has since been featured in the media with striking regularity. The government launched a program – Swachh Bharat Mission (SBM) in 2014, including a public campaign around environmental sanitation and cleanliness. Sanitation appears finally to be getting the attention it deserves. But it is imperative that urban India needs to address not just toilets but the full cycle of sanitation if it wishes to meet the environmental and public health challenges.

Urban sanitation in India faces many challenges. Many urban areas lack access to improved sanitation arrangements, and nearly two-thirds of wastewater is let out untreated into the environment, polluting land and water bodies. To respond to these environmental and public health challenges, urban India will need to address the full cycle of sanitation, i.e., universal access to toilets, with safe collection, conveyance and treatment & reuse of human excreta. In the absence of adequate sanitation, interventions that improve water or hygiene are less effective than they would be if sanitation were improved. The urban poor suffer disproportionately from the lack of adequate sanitation.

The growth of cities into metropolitan cities exerts pressure on water resources in two ways : (a) the increasing need for water to meet the domestic requirements and (b) impact of resultant wastewater discharge on the receiving waters have a cumulative effect in deteriorating the quality of receiving water. Water Supply and Sanitation are the basic necessities of urban centres and various schemes are devised by Government of India to provide these basic amenities.

In the last few decades, rapid urbanization in urban India has essentially led to rise in water demand and adequate sanitation. In different regions of urban centres, wastewater is let out untreated due to the lack/unavailability of sewerage network and discharged into the natural drainage system causing pollution in downstream areas. Clearly there is a need to emphasize on creating infrastructure for collection, conveyance and proper disposal of the wastewater (Wankhede K.; 2015).

Figure 3: Venn diagram depicting sewage generation, installed treatment capacity, operational capacity, actual utilization and complied treatment capacity



Source - National Inventory of Sewage Treatment Plants, CPCB Report March 2021

The population in the urban agglomeration increased from 28 crores in 2001 to 37 crores in 2011. As per the report on inventorisation of the Sewage Treatment Plants (STPs) in India by Central Pollution Control Board in 2014, 816 STPs were installed in different States/UTs in the country and sewage treatment capacity developed during that period was only 23,277 MLD. Traditionally, STPs were designed on conventional technologies which can treat the wastewater to meet the non-potable requirement.

As per CPCB report, a comparison with previous inventory of STPs of 2014 is made and it is observed that sewage treatment capacity has enhanced by 50%. Comparative statistics pertaining to the years 2014 and 2020 are presented in Table 1.

Table 1: Comparative Statistics on the Inventory for the years 2014 and 2020

Sr. No.	STP Status	2014		2020	
		Nos. of STPs	Capacity (MLD)	Nos. of STPs	Capacity (MLD)
1	Operational	522	18883	1093	26869
2	Actual Utilization	-	-	1093	20235
3	Compliance	-	-	578	12197
4	Non-operational	79	1237	102	1406
5	Under Construction	145	2528	274	3566
Total (Sl. No. 1+4+5)		746	22648	1469	31841
6	Proposed	70	628	162	4827

Source- National Inventory of Sewage Treatment Plants March 2021, CPCB

Sectoral demands for water are growing rapidly in India owing mainly to urbanization and it is estimated that by 2041, more than 50% of the country's population will live in cities and towns. Population increase, rising incomes, and industrial growth are also responsible for this dramatic shift. In rural areas, local government institutions operating and maintaining the infrastructure are seen as weak and lack the financial resources to carry out their functions. In addition, no major city in India is known to have a continuous water supply and an estimated 72% of Indians still lack access to improved sanitation facilities (Ganesh S Kumar et.al., 2011).

Environmental pollution and increasing water scarcity are two main features of the urban landscape of many Indian cities today. The expansion of sewerage networks in centralized wastewater management approach cannot keep up with city growth, and alternative sanitation systems are needed for City-Wide Inclusive Sanitation (CWIS). Based on the Sustainable Development Goals, urban sanitation services should yield safe, equitable, and sustained sanitation outcomes for everyone, prioritizing vulnerable groups. Urban sanitation service expansion, however, has been slow and uneven. The crisis of urban sanitation in India is established by the predominant septic tanks-based sanitation systems that far exceed the coverage of households provided by centralised sewerage-based systems. Centralised networked sanitation systems have been the standard recommended approach for addressing urban wastewater management. Centralised sanitation systems are the most expensive systems, both in terms of capital expenditure (CAPEX) and operating expense (OPEX).

Faecal Sludge Treatment Plant (FSTP) are relatively low-cost and most appropriate in terms of meeting the immediate needs of urban sanitation for small and medium towns. They are expensive if converted into equivalent MLD treatment capacity. Rethinking of current wastewater management approaches is required to find holistic and sustainable solutions for the increasing water demand. There is a need to transform the perspective on wastewater management from a linear 'use and dispose' model to a more sustainable circular model, attaching values to the resources in wastewater flows (Goswami S. et. Al. 2018).

Despite considerable investments, several issues have held back progress on sanitation services in cities. This includes the lack of capacity at the local or municipality level to operate and maintain sewerage systems and wastewater treatment plants, which are also linked to other underlying issues such as poor design or inappropriate technology choices, lack of finance for operation and maintenance, and low political priority.

Moreover, most investments have been for centralized wastewater treatment and sewerage, which often do not serve newer or informal settlements. Extending such sewer systems to low income and informal settlements can be challenging, costly, and may not be the most suitable and effective for the local context.

As per the report "Solving Urban Challenges with City Wide Inclusive Sanitation" published by the Asian Development Bank in April 2021, there are four categories of challenges in scaling of conventional centralized wastewater management approach :

- Low infrastructure coverage
- Service coverage
- Low service usage
- Weak institutional arrangements

Low Infrastructure Coverage
India is still struggling with wastewater management in the urban cities. Although the cumulative treatment capacity was increased, the real problem was in the collection and conveyance system for wastewater. It may take several decades for sewerage and other sanitation services to become available to all of urban India. In the meantime, the vast majority of urban residents will remain dependent on on-site sanitation facilities such as pour flush toilets discharging to leach pits or septic tanks. Municipal sanitation plans should, therefore, include measures to complete and improve on-site sanitation in order to meet the needs of the city.

The cities should recognize that the worst sanitary conditions are prevalent in poor areas. Construction of a toilet is generally regarded as the householder's responsibility but, for poor households, investments in sanitation are often constrained by multiple issues such as affordability, land tenure, space constraints and low priority to sanitation.

Therefore, special measures may be needed to support service improvements for the poorest sections of the community. The need is to look beyond subsidies and awareness campaigns; and develop technology options that suit the physical conditions in poor neighbourhoods.

Limited Access to Services
The statistical numbers and dashboards are not sufficient to provide a full picture regarding access to sanitation services. The existing infrastructure and its allied services are deficient in many ways. Often it is seen that the functionality and upkeep of the sanitation facilities is a challenge due to inappropriate design and construction. Thus, the facilities become inconvenient, unpleasant and unhygienic and soon dysfunctional. This is often the problem with community toilet located in urban slums of large cities. In many cities, the sewerage is laid however, the households are not connected to it. Due to the low affordability of the households, they are not able to pay the sewerage connection charges. Moreover, the households know that once the connection is done, regular payment of taxes will be needed. Currently, due to incomplete onsite sanitation system, the septic effluent and grey water find its way into the stormwater drains which essentially only relocate the waste to the lowest point in the community of the city. "Out of sight, out of mind!" - Households do not realize the wider impact of unsafe disposal of wastewater.

Low Service Usage
In some places – especially in rural areas or small towns, where toilets are available, they are not used or underused. Household members tend to provide several reasons for not using the toilet. In general, it is seen that households do not like to share the toilets and tend to underuse because they lack the understanding of functioning and maintenance.

For example, in the case of twin-pit pour-flush toilets, some people fear that the pits will fill rapidly if the toilet is used too often; and they may not know that the contents of a full pit can safely be removed manually once they have been given time to degrade. Such problems indicate the need for effective communication in sanitation programs, so that community awareness, preferences, and behaviour are appropriately understood and then addressed through information, advice, and hygiene promotion.

Weak Institutional Arrangements
State agencies and municipalities sometimes make huge investments in sanitation infrastructure, but these do not always deliver their intended benefits. Involvement of multiple agencies during the execution of the project starting with planning, implementation and O&M is essential. Most of the time, the over arching strategy of these different agencies do not align properly and investments are made whenever the funds are available. Responsibilities for different aspects of sanitation are often assigned to many agencies, and coordination between them is not always good. There have been cases, for example, where a state agency has developed a sewage treatment plant even when there are no sewers in the town, then handed it over to a municipality that does not have the technical capacity or financial resources to operate and maintain it. Very less thought is given to the O&M cost of the project and its recovery from the beneficiaries.

Lot of times, the selection of technology for treatment is governed by the company preparing the detailed project report and the engineers of the parastatal bodies or the ULBs. Local conditions and resources are not taken into consideration, because of which the challenges in O&M are faced at a very early stage and the facilities do not function properly. Especially in smaller towns, municipal and line agency staff tend to have limited technical expertise or awareness of the range of non-technical factors that affect the outcome of sanitation investments.

1.4.3 Urban Sanitation- Policies and Programmes
Sanitation has been at the forefront of urban policy in India in recent times; however, the need to improve sanitation was realised much earlier. Post-independent India was constantly struggling with its image as the symbol of insanitary living conditions.

Goal 6 of the Sustainable Development Goals (SDGs) is to ‘ensure availability and sustainable management of water and sanitation for all’, with specific targets for universal access to safe drinking water and sanitation facilities, enhancing water efficiency, improvement of water quality, integrated water resources management and restoration of water-related ecosystems.

During the Millennium Development Goals (MDG) time frame (1990 to 2015), the primary investments for water and sanitation in urban India were made through the Jawaharlal Nehru National Urban Renewal Mission (JNNURM). While JNNURM prioritised universal coverage, it did not set a target date to achieve this. It did not have any provision for individual toilets, and most of the investments were dedicated to the piecemeal construction of pipes and treatment systems.

The targets for water and sanitation as articulated in Goal 6 of the SDGs mark a substantial move forward from those articulated in the MDGs. 'Water and Sanitation' is a distinct goal in itself, instead of being nested as a target within another goal. SDG 6 moves beyond the singular focus of the MDGs on access (to water and sanitation), and attempts to widen its scope by looking at the entire cycle of water and sanitation. In terms of access, it has set a much more ambitious target of universal access to both water and sanitation.

Table 2 Key comparisons across the MDGs and SDGs

Sr. No.	Parameter	MDG	SDG
1	Scope	Access to water and sanitation	• Access to water and sanitation • Improvement in water quality • Improvement in water efficiency • Integrated water resources management
2	Target	Halve the number of people without access to water and sanitation	• Universal Coverage for access to both water and sanitation, i.e., 100% • Reducing by half, the proportion of untreated wastewater • Recycling, improvements in water efficiency (targets not specified)

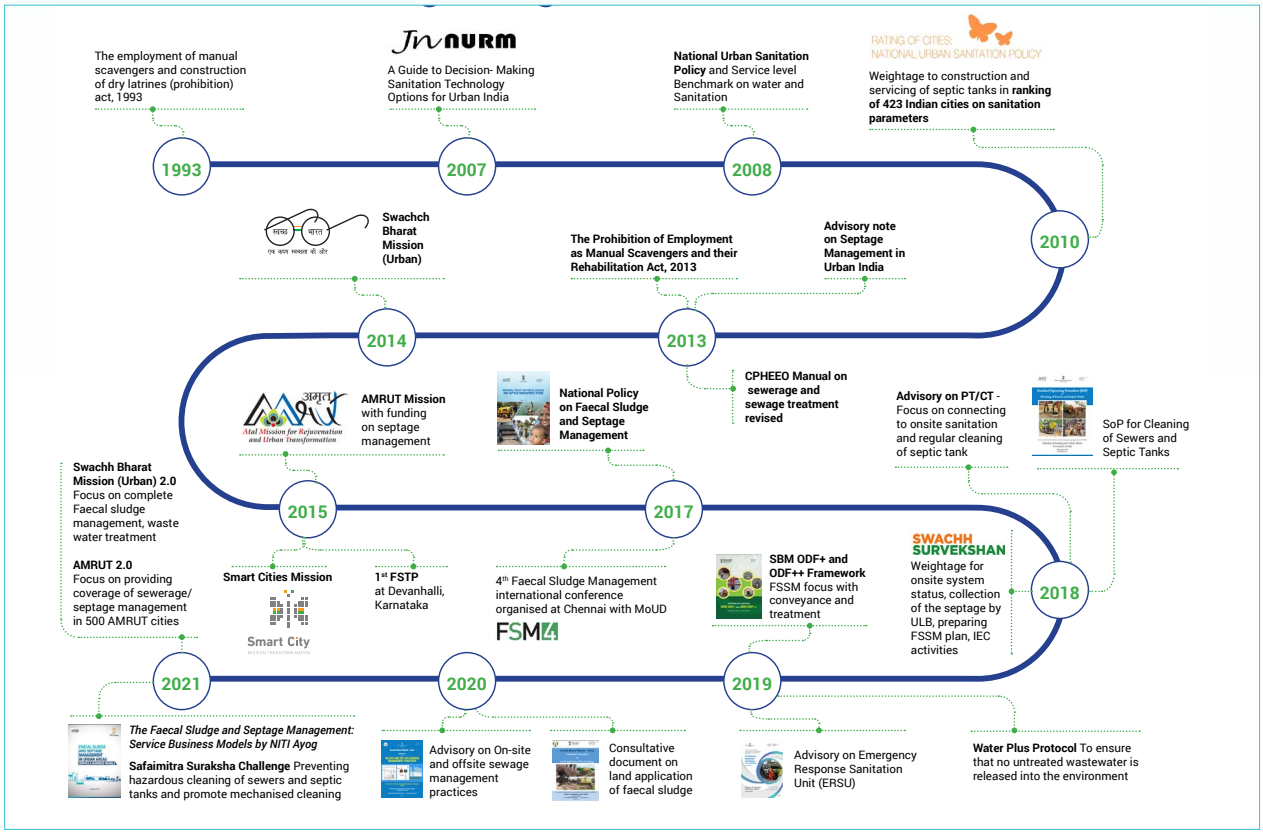
Source Operationalizing SDG 6 in Urban India, IIHS 2016

India's policies have recognised the significance of urban water and sanitation for achieving public health improvements since the 2000s, resulting in a series of significant initiatives for water and sanitation. These initiatives have taken different forms as policies - National Urban Sanitation Policy (2008), programs such as JNNURM, Swachh Bharat Mission (SBM), Atal Mission for Rejuvenation and Urban Transformation (AMRUT), and other state level programs, Service Level Benchmarking, advisories, guidelines and so on. Water and sanitation have seen increased visibility in public discourse and an increase in budgetary allocations. Urban sanitation has received strong boost from the current national government, the Swachh Bharat Mission (covering both rural and urban areas) being one of the flagship projects (Wankhede K.; 2012).

History of Sanitation Efforts and the Shifting Paradigm towards FSSM

Sanitation was included as an agenda item in the Government of India's First Five Year Plan (1951-56), but the focus of the Central Government in the fifties was largely on housing and redevelopment of slums. The Slum (Clearance and Improvement) Act was formulated during this period. In the sixties and seventies, urban policy in India began taking a more concrete shape. There was a huge focus on promoting planned development of cities through the implementation of master plans. Census revealed that 23.3% of Indian population lived in cities, most cities were characterized by a lack of infrastructure, planning and unimproved sanitation facilities.

Figure 4: Growing Recognition of FSSM in India



Source: Author

Central government shifted from urban policy to infrastructure development. Sanitation became a right of the local governments only with the passage of the landmark 74th Constitutional Amendment Act in 1992 that recognized cities and towns as the third tier of government through the constitution of ULBs. The JNNURM, a massive urban renewal program targeting integrated development of urban infrastructure in 63 identified cities, mandated reforms and preparation of City Development Plans that projected out plans by cities as to how they would develop land-use, transport and other basic infrastructure including sanitation; however, sadly most of the allocated funds were utilised to implement centralized wastewater management system without feasibility and sustainability assessment of the projects.

National Programs and Policies

A. Swachh Bharat Mission – Urban (SBM U)

The urban component of the Swachh Bharat Mission was launched in 2014 to eliminate open defecation, eradicate manual scavenging as well as implement modern and scientific SWM, generate awareness about sanitation and its linkages to public health, capacity augmentation for ULBs and to create an enabling environment for private sector participation in projects. The mission was implemented by the Ministry of Housing and Urban Affairs and was supposed to cover 4,041 statutory towns in India till 2019.

Key thrust areas of the mission include:

- Elimination of open defecation
- Eradication of Manual Scavenging by converting insanitary toilets to sanitary
- Modern and Scientific Municipal Solid Waste Management
- Effecting behavioral change regarding healthy sanitation practices
- Awareness generation about sanitation and its linkage with public health
- Capacity Augmentation for ULBs to create an enabling environment for private sector participation

In continuation to SBM(U), the Ministry of Housing and Urban Affairs launched SBM (U) 2.0 in 2021 with a focus on complete faecal sludge and septage management, wastewater treatment, source segregation of garbage, reduction in single use plastic, reduction in air pollution by effectively managing waste from construction and demolition activities, and bioremediation of all legacy dumpsites. At the end of the mission, it is aimed that all statutory towns in India will become ODF+ certified.

Under the Swachh Bharat Mission – Urban 2.0 (SBM-U 2.0) the following objectives are targeted to be achieved:

a. Sustainable Sanitation and treatment of Wastewater
    - Holistic Sanitation
    - Eradication of hazardous entry into sewers and septic tanks, and sustaining elimination of manual scavenging
    - Treatment of wastewater before discharge into water bodies, and maximum reuse of wastewater

b. Sustainable Solid Waste Management
    - Ensuring cleanliness and hygiene in public places
    - Air pollution arising out of SWM activities brought under notified norms of CPCB
    - Phased reduction in use of single-use plastic

c. Awareness creation along with large scale citizen outreach to create 'Jan Andolan'
d. Creating Institutional capacity

Under SBM 2.0 envisioned the following outcomes to be achieved :

- All statutory towns will become ODF+ certified.
- All statutory towns with less than 1 lakh population will become ODF++ certified,
- 50% of all statutory towns with less than 1 lakh population will become Water+ certified
- All statutory towns will be at least 3-star Garbage Free rated as per MoHUA's Star Rating Protocol for Garbage Free cities
- Bioremediation of all legacy dumpsites.

B. Water Plus Protocol

- The water plus protocol demands that in addition to the ODF++ status, the city shall focus on ensuring that no untreated wastewater is discharged into the environment. Currently, it is one of the highest certification which a city can achieve in terms of sanitation by focusing on recycle and reuse of treated wastewater. The assessment of the city will be done by a third party appointed by the state and national government. There are 11

locations and nine indicators which the third party assessors are going to check during the assessment in the city. As per the protocol, (a) the ULB shall have sewage treatment capacity to cater to 70% of its current population, (b) the ULB shall have adequate equipment for faecal sludge and septage conveyance from the non-sewered areas and (c) the O&M cost of the FSTP shall be recovered from the pre-defined revenue streams such as tipping fee and sale of by products such as methane gas or treated end products such as soil conditioner and treated water.

C. Atal Mission for Rejuvenation and Urban Transformation

The Atal Mission for Rejuvenation and Urban Transformation (AMRUT) mission was initiated in June 2015 which aimed to provide basic services (e.g., water supply, sewerage, urban transport) to households and build amenities in cities which will improve the quality of life for all, especially the poor and the disadvantaged is a national priority.

The purpose of AMRUT is to:

- Ensure that every household has access to a tap with the assured supply of water and a sewerage connection.
- Increase the amenity value of cities by developing greenery and well-maintained open spaces (e.g., parks) and
- Reduce pollution by switching to public transport or constructing facilities for non-motorized transport (e.g., walking and cycling). All these outcomes are valued by citizens, particularly women, and indicators and standards have been prescribed by the Ministry of Housing and Urban Affairs in the form of Service Level Benchmarks.

The Priority zone of the mission is water supply followed by sewerage. The components of the AMRUT consist of capacity building, reform implementation, water supply, sewerage and septage management, storm water drainage, urban transport and development of green spaces and parks. During planning, the Urban Local Bodies (ULBs) will strive to include some smart features in the physical infrastructure components.

In continuation to AMRUT, the Ministry of Housing and Urban Affairs launched **AMRUT 2.0.** The objective of AMRUT 2.0 is to provide 100% coverage of water supply to all households, by providing 2.68 crore urban household tap connections, thereby benefitting around 10.7 crores people. It will provide 100% coverage of sewerage and septage in 500 AMRUT cities, by providing 2.64 crore sewer connections/ septage connections, thereby benefitting around 10.6 crores people. Rejuvenation of water bodies and urban aquifer management will be undertaken to augment sustainable fresh water supply. Recycle and reuse of treated wastewater is expected to cater to 20% of total water needs of the cities and 40% of industrial demand. Under the Mission, fresh water bodies will be protected from getting polluted to make natural resources sustainable.

There will be several defining features of AMRUT-2.0. These include upscaling from 500 cities covered under AMRUT with 1 lakh+ population to all 4,800 cities, covering 100% urban India. It will promote circular economy of water through formulation of City Water Balance Plan (CWBP) for each city, focusing on recycle/reuse of treated sewage, rejuvenation of water bodies and water conservation. Digital economy will be promoted through being a Paperless Mission. Pey Jal Survekshan will be conducted in cities to ascertain equitable distribution of water, reuse of wastewater and mapping of water bodies w.r.t. quantity and quality of water through a challenge

process. Technology Sub-Mission for water will leverage latest global technologies in the field of water.

AMRUT 2.0 aims to make all the towns 'water secure'. It will build upon the progress of AMRUT to address water needs, rejuvenate water bodies, better manage aquifers, reuse treated wastewater, thereby promoting a circular economy of water. The total outlay of AMRUT 2.0 is Rs.2,77,000 crores, including central share of Rs. 76,760 crores. This includes Rs.10,000 crores Central share and another Rs.10,000 crores states' share for continuing financial support to AMRUT Mission up to March 2023.

The AMRUT 2.0 Mission will promote Public Private Partnership (PPP). It has been mandated for cities having million plus population to take up PPP projects worth a minimum of 10 percent of their total project fund allocation which could be on Annuity/ Hybrid Annuity / BOT Model.

D. Smart City Mission

The Smart Cities Mission of the Government was initiated in June 2015 was a bold, new initiative. It is meant to set examples that can be replicated both within and outside the Smart City, catalysing the creation of similar Smart Cities in various regions and parts of the country. The objective is to promote cities that provide core infrastructure and give a decent quality of life to their citizens, a clean and sustainable environment and application of 'Smart' Solutions.

The Smart Cities Mission is guided by following core principles:

- **Citizens at the core:** Citizens are involved in every stage of Smart City development.
- More from less: Smart Cities strive to generate more impact and outcomes from use of less resources- energy, finance and others.
- **Cooperative and competitive federalism:** cooperative collaboration and healthy competition between States and cities.
- **Convergence:** Smart Cities are focused on creating integrated infrastructure and services, promoting circular economy and sustainable habitats through convergence of financial resources and programs.
- **Technology as a means, and not the goal:** Technology enables and provides speed and scale but is not the end result of smart city development.
- **Inclusiveness:** Cities are for all people irrespective of age, gender, background and ability and hence they have to be inclusive to be smart.

D. National Policy on Faecal Sludge and Septage management

In 2017, the Ministry of Housing and Urban Affairs recognized that the end objectives and corresponding benefits of SBM cannot be achieved without proper FSSM across the sanitation service chain. Further, it is well understood that sewerage coverage will not meet the complete sanitation needs in all areas of a city, and a strategy that combines onsite and off-site (decentralised and centralised) must co-exist in all cities and must be given equal attention. Over time the relative proportions of coverage by onsite sanitation and off- site systems may change but both will need to be managed well. However, the current policies are not explicit enough and also do not provide an outcome-focused direction on this issue.

The key objective of the urban FSSM Policy is to set the context, priorities, and direction for, and to facilitate, nationwide implementation of FSSM services in all ULBs such that safe and sustainable sanitation becomes a reality for all in each and every household, street, town and city. Only on-site sanitation facilities and areas served by such facilities would fall under the purview of this FSSM Policy. It addresses synergies between FSSM and sewerage systems or municipal solid waste

(MSW) management, e.g., co-treatment of faecal sludge and septage at sewage treatment plants or co-treatment and management of faecal sludge and septage, and MSW.

Unless otherwise specified, the scope of this Policy extends to all the projects, programs and schemes of the -Central Government that facilitate and support sanitation services, urban development and improved delivery of services in urban and peri-urban areas of India. It also covers the initiatives undertaken and/or supported by all Central Government Ministries, Departments, Agencies, Authorities and Public Sector Undertakings that have a bearing on sanitation services in urban and peri-urban areas. Further, the Policy applies to every urban local body, outgrowths in urban agglomerations, census towns as declared by the Registrar General and Census Commissioner of India, notified areas, notified industrial townships, areas under the control of Indian Railways, airports, airbases, ports and harbours, defence establishments, special economic zones, State and Central Government organisations, places of pilgrimage, religious and historical importance as may be notified by respective State Government from time to time.

E. SBM ODF+ and ODF++ Framework

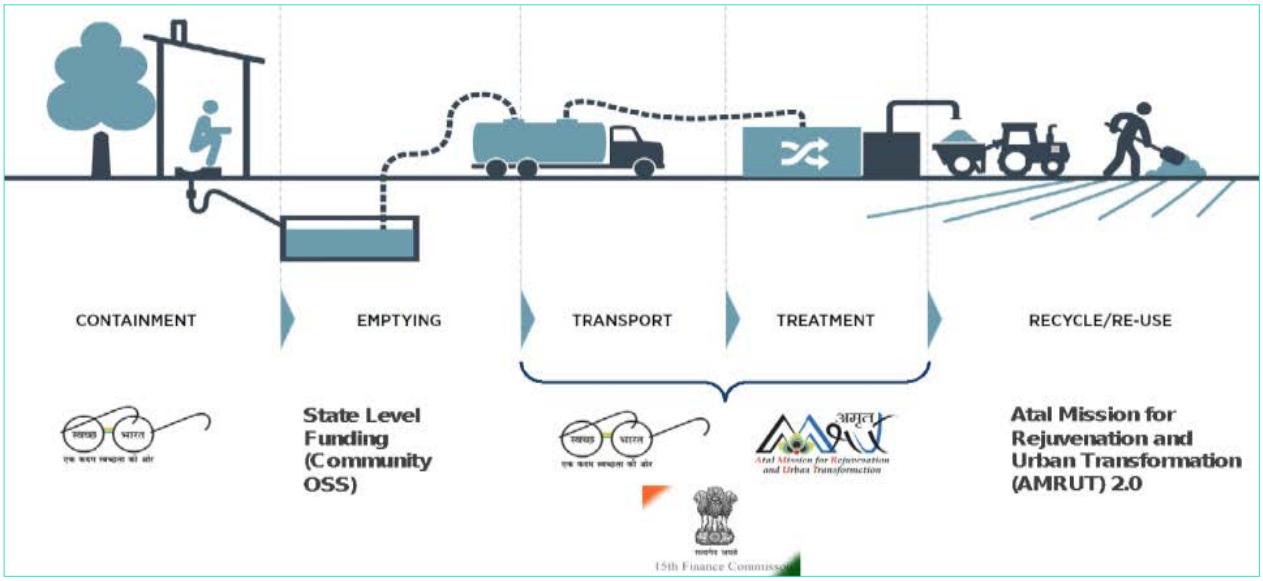
The Ministry of Housing & Urban Affairs has commissioned Quality Council of India (QCI) to certify 4379 Urban Local Bodies of India as Open Defecation Free by October 2019 under the Swachh Bharat Mission. The Swachh Bharat Mission-Urban aims to fulfil the objective of 100% Open Defecation Free status in all Urban Local Bodies (ULBs) in the country by 2019. This will entail providing access to clean and usable toilet facilities for the citizens. In larger prospect, ODF flagship is taken ahead by ODF+ and ODF++. The SBM-ODF+ and SBM-ODF++ protocols build upon the ODF protocols while keeping true to its provisions, so as to provide a platform for cities and towns to improve sanitation sustainability. These protocols are incremental in nature and reflect on-ground realities present in India. Cities that have been certified ODF at least once on the basis of the ODF protocols laid down by the Ministry shall be eligible to declare themselves as SBM-ODF+ & SBM-ODF++ and apply for this certification. With correct on ground implementation of these schemes, India can be ensured a safe and hygienic sanitary condition[1].

1.4.4 Financing Opportunities for FSSM

Funds are required at every stage of the sanitation service chain in FSSM and is essential to identify the possible financial sources to implement the FSSM plan in the city. Currently, SBM Urban and AMRUT are the missions which have fund allocation for implementing FSSM in the city. Funds can be availed from the SBM for the construction of user interface such as individual toilets, public toilets, community toilets, containment unit such as septic tank and disposal units such as soak pits. Whereas fund for procuring vehicles and equipment for conveyance of septage, establishing treatment plant and disposal site, can be availed from the Smart Cities Mission and AMRUT mission and services which accomplish in this section of the chain, as shown in the figure below;

1. Ministry of Housing and Urban Affairs, Government of India

Figure 5: Source across the sanitation value chain



Apart from the programs mentioned above, private operators can avail loan for procurement of desludging vehicle under Swachhta Udyami Yojana and/or National Safai Karmachari Finance and Development Corporation (NSKFDC) programs.

The ULB needs to assess the requirement of CAPEX and OPEX across the value chain for better planning of FSSM.

Table 3: Financial aspects across the sanitation value chain for planning of FSSM

Financial Aspects	Sanitation Value Chain			
	User Interface	Containment	Conveyance	Treatment/Disposal
CAPEX	Construction of new individual toilets, PTs and CTs	Construction of new septic tanks and refurbishments of septic tanks	Procurement of new suction emptier trucks	Land cost and construction cost of treatment plant
OPEX	Fuel cost for emptier trucks, salaries of drivers, maintenance of machines etc.		Fuel cost for emptier trucks, salaries of drivers, maintenance of machines etc.	Operations of the treatment facility: Staff salaries, electricity bill etc.

Assessing capacity for financing of CAPEX and OPEX over the planned period is essential for sustainability of the FSSM project. Tariff restructuring might be required for to recover the OPEX from the end beneficiaries. Assessment helps to estimate the number of vehicles required, their type and size. It also helps to understand the quantity of the faecal sludge and septage to be managed on daily basis. The assessment also provides guidance on potential sources of finance for meeting these expenditures including funding through external grants, private sector investments, user contributions, external debt or through local government internal resources

The ULB needs to identify the potential financial sources available to avail fund for CAPEX across the value chain. For construction of new septic tanks, possible sources for supporting CAPEX include HHs, government subsidy and CSR funds. For refurbishment of septic tanks, which is a part of containment, the predominant source of CAPEX would be government subsidy or HHs have

to borne the CAPEX. For conveyance of septage, CAPEX can be sought from central or state grants, and under local government schemes. Private sector participation is also a potential source for CAPEX to procure vehicles. Establishing the FSTP and the disposal site are major areas requiring more funds if any private land needs to be procured. Possible sources from where CAPEX can be obtained would be grants from central and state governments, funds from local government and CSR funds. Private sector participation is also a potential source of finance but willingness of the private sector is to be assessed. The government typically will support only for the CAPEX and not for OPEX; the ULBs have to explore possible sources to cover OPEX costs. Potential sources for OPEX may include housing society fees, annual sanitation tax, and desludging fees are taken from the property owners on the request of desludging their OSS systems. Revenue generated by selling product after the treatment of septage will also feed into OPEX revenues.

Identification of Revenue Sources
The ULB can decide to levy taxes/user charges or both, on the HHs for FSSM services. OPEX can be recovered by levying taxes and user charges from HHs. The ULBs could introduce a sanitation tax (conservancy tax). Such sanitation tax will be paid by the HHs to the ULB as part of annual property taxes. An exercise is designed on how to fix the amount of tariff for sanitation tax for the properties.

1.5 Notes for trainer

This session acts as an introduction for understanding the Urban Sanitation and Policies and Programmes along with the different challenges which India face in sanitation sector. It gives information's on Urban Sanitation Policy and Programs in India under government authorities and various funding options for FSSM planning and implementation.

There are no specific case studies, but depending upon the audience examples can be given of how various states have identified and converged funds from different programs.

1.6 Bibliography

Ganesh S Kumar, Sitanshu Sekhar Kar, and Animesh Jain (2011), Health and environmental sanitation in India: Issues for prioritizing control strategies, Indian Journal of Occupational and Environmental Medicine.

National Inventory of Sewage Treatment Plants, CPCB, March 2021.

Rumi Aijaz (2021), Managing India's urban transition in 2021, Urban Futures, Observer Research Foundation

Sahana Goswami and Kristina Egge, From Linear to Circular: A Paradigm Shift in Wastewater Management, WRI India, January 2018

Urban sanitation in India: key shifts in the national policy frame - Environment & Urbanization, International Institute for Environment and Development (IIED), 2015.

Wankhade, K (2012), JNNURM: An Opportunity for Sustainable Urbanisation, Indian Institute for human Settlements.

Wankhade, K (2015), Urban sanitation in India: key shifts in the national policy frame, Environment & Urbanization, International Institute for Environmental and Development (IIED)

Wankhade, K (2017), Operationalizing SDG 6 in Urban India, Indian Institute for human Settlements.

1.7 Further Reading

Depinder Kapur (2021), Swachh Bharat Mission 2: The pitfalls — and the lure — of centralised urban sanitation system, Down to Earth.

Declaring your City/Town SBM ODF+ and SBM ODF++ In Toolkit for Urban Local Bodies. New Delhi, India: Ministry of Housing and Urban Affairs, Government of India, 2018.

Faecal Sludge and Septage Management, An Orientation Module, National Institute of Urban Affairs, New Delhi and UMC, 2018.

Faecal Sludge and Septage Management — Orientation Module (Part B: Learning Notes), National Institute of Urban Affairs, Delhi and Ecosan Services Foundation, Pune, 2019.

Faecal Sludge and Septage Management in Urban Areas, Service & Business Models, NITI Aayog, January 2021.

Financing Faecal Sludge and Septage Management (FSSM) A landscape study of four Indian states, Centre for Water and Sanitation (C-WAS), Centre for Research and Development Foundation (CRDF), CEPT University, June 2019.

Guidelines for Swachh Bharat Mission – Urban, October 2017.

National Policy on Faecal Sludge and Septage Management (FSSM), Ministry of Housing and Urban Affairs (MoHUA), Government of India, February 2017.

Peter Hawkins, Isabel Blackett, and Chris Heymans (2013), Poor-Inclusive Urban Sanitation: An Overview, Water and Sanitation Program.

Philippe Reymond, Rohit Chandragiri and Lukas Ulrich (2020), Governance Arrangements for the Scaling Up of Small-Scale Wastewater Treatment and Reuse Systems – Lessons from India, Citywide Inclusive Sanitation: The Urban Sustainability Challenge, Frontiers in Environmental Science.

Sustaining Policy Momentum - Urban Water Supply & Sanitation in India, IIHS RF Paper on Water Supply and Sanitation, 2014.

Session

02

Approaches and Methodology of Planning

2. Approaches and Methodology of Planning

2.1 Learning Objectives

- Gain knowledge about the various approaches used in faecal sludge and septage management planning.
- Understand the importance of integrated planning for faecal sludge and septage management.
- Understand what is included in the planning process for faecal sludge and septage management.

2.2 Session Plan

Duration- 45 minutes

Topics	Time	Material/Method
Approaches of Planning	20 min	Powerpoint presentation
Stages of Planning	15 min	Powerpoint presentation
Q&A	10 min	Discussion

2.3 Key Facts

- Out of the many planning approaches, City Sanitation Plan (CSP) and CWIS based approach is very comprehensive.
- CSP considers all the environmental services (utilities) and their interdependency.
- CWIS promotes social and economic equitable planning including centralized and decentralized approach.
- Stages in planning with pilot projects helps to mitigate the risk of failure of infrastructure project.

2.4 Learning Notes

2.4.1 Approaches of Planning

Planning is the process of thinking about the activities required to achieve a desired goal. It is the first activity to achieve desired results. It involves the creation and implementation of a plan, such as psychological aspects that require conceptual skills. Strategic planning relies on a number of methods and tools to define and interpret information for comparing alternatives. In general, there are four purposes of planning – to clarify issues and problems, to examine spatial and inter sectoral relationships, social, environmental and economic analysis, to discuss the future.

Urban sanitation is complex, as one needs to balance the demand and supply for sanitation services and also other sectors such as planning, housing, health, other infrastructure etc. While doing so it is critical to safely manage the whole sanitation chain. Many approaches have been developed in the past ranging from a very formal way of planning to community driven approach. The feasibility and success deployment of the approaches vary from case-to-case basis. Numerous tools have been developed which assist the stakeholders to visualise the data in a better way and to understand it with ease. Many tools focus on non-sewered sanitation, such as decentralised systems and FSSM (Blackett, I., et. al., 2019).

Sanitation Approach

As per the Guidelines on Sanitation and Health published by World Health Organization in 2018, over the period multiple sanitation approaches have been developed. The appropriateness of the approach depends on the culture, population density, geography and also the existing norms, policies and regulations.

Rigorous research is needed for selecting an approach or to combine different approaches in order to be able to provide deeper understanding of the context and current WASH behaviours. The most appropriate approaches should be able to work at scale, reach everyone including the most marginalised and lead to sustainable change. There is deep connection of these approaches to the objective of sanitation – reduce faecal oral transmission of pathogens. Hence, the approach should not treat the subject in isolation from hygiene behaviour change.

Various sanitation approaches are as follows:

- Strategic Sanitation Approach and Planning (1989)
- Household Centered Environmental Sanitation (HCES) (2000)
- City Sanitation Plan (2008)
- Community-Led Urban Environmental Sanitation (CLUES) (2011)
- Sanitation 21 (2005 and 2014)
- Citywide pathway to sanitation & SUWASA program (2015)
- Citywide Inclusive Sanitation (2016)

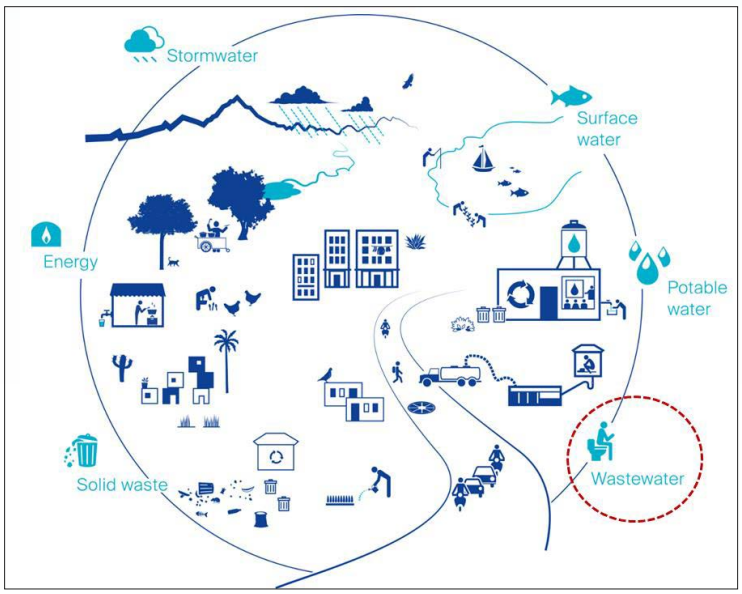
City Sanitation Plans

CSP of a city is a comprehensive document that describes the short, medium and long-term measures for the issues related to governance, technical, financial, capacity enhancement, awareness raising and pro-poor interventions to achieve the goal of National Urban Sanitation Policy to create community driven, totally sanitised, healthy and liveable cities and towns.

The objectives of the CSP are:

- To achieve the goal of universal sanitation.
- To develop access to safe and hygienic sanitation facility and arrangements (individual or community toilets) to all urban population so that no one defecates in the open.
- To develop adequate availability and 100% upkeep and management of Public Sanitation facilities in all urban areas like commercial areas, offices, institutions and service empty space.
- To ensure scientific collection, treatment and safe disposal and establish appropriate and feasible technology of disposal system for human excreta & liquid waste from all sanitation facilities and establish an appropriate system of operation & maintenance of the disposal system.

Figure 6: City Sanitation Plan (CSP)



Source: Integrated Sanitation Approach, BORDA, 2020

The purpose of the plan is to support the key stakeholders of WASH such as ULB, NGOs, CBOs, citizens and private sector agencies to take concrete steps to achieve 100% sanitation. Each city needs to prepare a framework customized to its needs and local situation. Broadly there are three stages in preparing the CSP: (a) initiating the CSP, (b) situation assessment and (c) finalization of the plan. Stakeholder involvement is key at each stage so that the plan is sustainable and has a long-lasting impact.

CSP must contain a gap analysis in sewage and as per the Manual on Preparation of CSP published in line with NUSP in 2008, following data needs to be collected to make CSP for city.

Table 4: Data Collection at City Level

Description	Activities
Baseline Information	Details of the city – Maps, locations etc. Demography – Census data & growth Land use pattern – Population settings
Technical Information – Sanitation Facilities	Access to toilets – IHHT, CT, PT Existing Sewage Infrastructure – STPs, Drains, sewers etc. Sewage Management
Institutional & Governance	Regulatory Framework Institutional Arrangement Governance & Reforms
Capacity Enhancement	Human Resource Development
Gap Analysis & Conclusion	I&D & STP cum FSTP Sewer network Storm water drainage system Recycle & reuse projects

City Sanitation Plan of Kochi City

The CSP formulation for Kochi was supported by Gesellschaft für Internationale Zusammenarbeit (GIZ), the German Agency for Technical Co-operation under its Advisory Services in Environmental Management (ASEM) program. The ASEM program was set up following the recognition of Environment and Sustainable Development as important areas of bi-lateral cooperation between the Government of India (GoI) and the Government of Germany and is being implemented by GIZ.

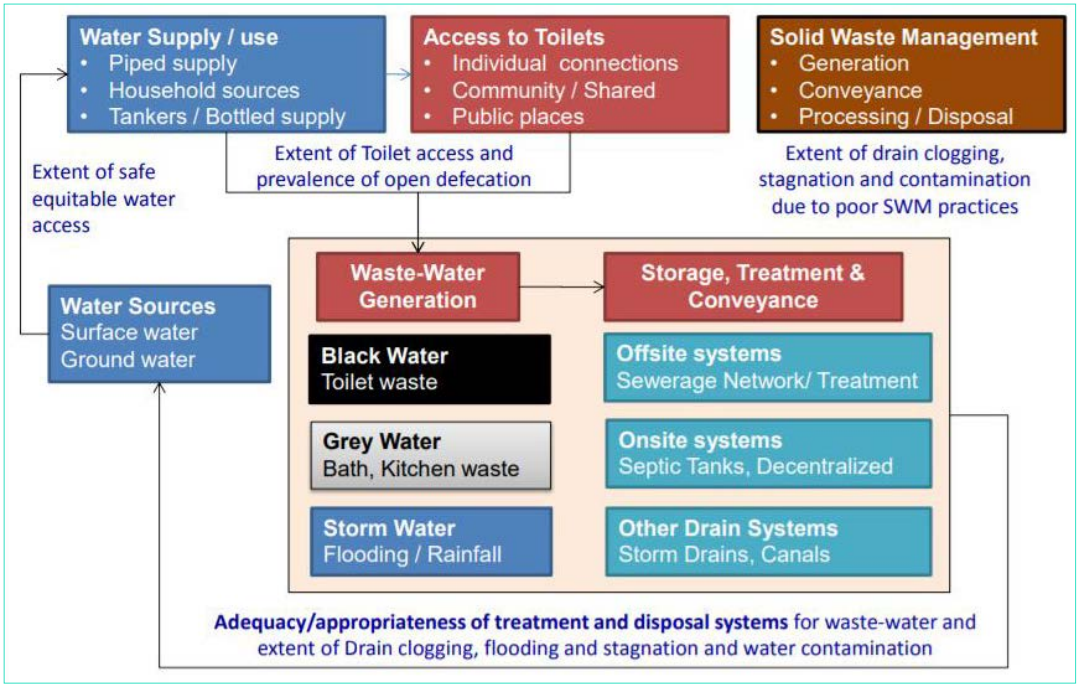
Following launch of NUSP and request from MoHUA and these ULBs, GIZ committed to support preparation of CSPs in six cities, namely, Kochi, Nashik, Raipur, Shimla, Tirupati and Varanasi and retained ICRA Management Consulting Services Limited (IMaCS) to assist in CSP formulation for Kochi in collaboration with the Corporation of Cochin. The following activities were undertaken during the preparation of the CSP for Kochi city.

- Formation of a City Task Force
- Carrying out a baseline review
- Support awareness generation and a sanitation campaign
- Identifying technology options
- Enhancing capacity and knowledge management:
- Formulate a City Sanitation Plan

The formulation of the CSP involved an information-based, action-led consultative approach and was guided by the following considerations:

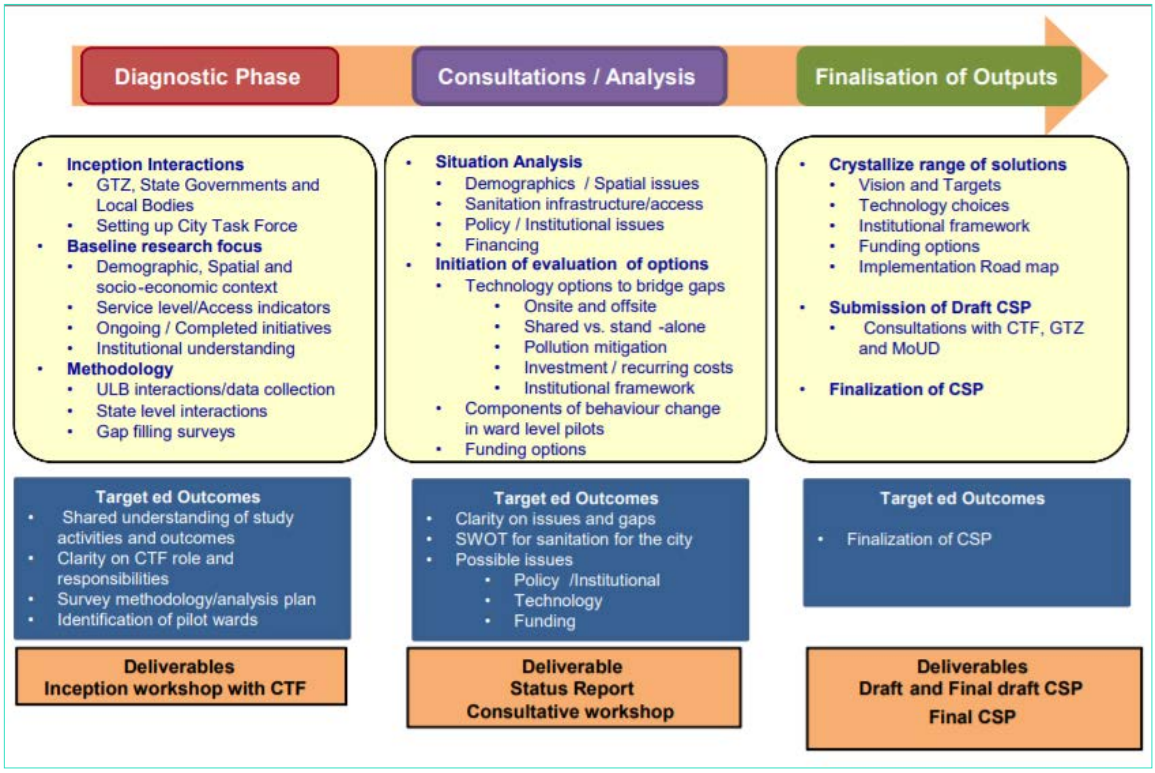
- Consistency with NUSP
- Build on existing work
- Integrated perspective on inclusive sanitation
- Strategic support pillars for inclusive sanitation

Figure 7: Framework for the CSP: Integrated approach to inclusive sanitation



The CSP was an effort to generate much-needed momentum within government and civil society in a segment of urban infrastructure that requires demand-led planning and renewed attention. To this end, a structured, participatory and multi-stakeholder engaging consultative process was adopted through creation of a City Task Force (CTF) and engaging with different stakeholders including staff of the Municipal Corporation, departments, parastatal agencies and other state and local institutions, policy makers and citizens.

Figure 8: A Participatory, Multi-stakeholder Consultative Process adopted



City Wide Inclusive Sanitation

Citywide inclusive sanitation (CWIS) emphasizes on :

(1) Everybody benefits from adequate sanitation service delivery outcomes; (2) Human waste is safely managed along the whole sanitation service chain; (3) Effective resource recovery and re-use are considered; (4) A diversity of technical solutions is embraced for adaptive, mixed and incremental approaches; and (5) Onsite and sewerage solutions are combined, in either centralized or decentralized systems, to better respond to the realities found in developing country cities. Cities need to develop comprehensive approaches to sanitation improvement that encompass long-term planning, technical innovation, institutional reforms and financial mobilization.

CWIS requires collaboration between many actors, including: national, sub-national and city/ municipal governments; utilities and municipal service providers; business and the private sector; civil society, local and international NGOs; donors, bilateral and multilateral agencies and private foundations; as well as academia and, importantly, households themselves. Each city is organized uniquely. Local actors need to acknowledge shared responsibilities and work collaboratively to chart their path to providing urban sanitation to all.

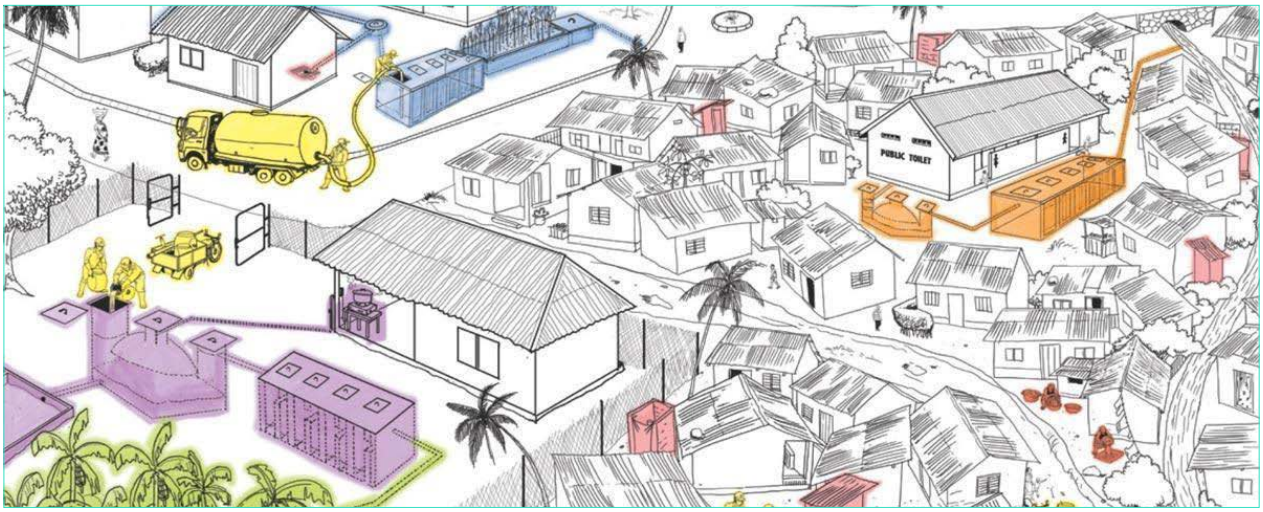
There are seven principles of CWIS that helps in achieving objectives of safe and proper sanitation systems in city.

- Everyone in an urban area, including the urban poor, benefits from equitable safe sanitation services
- Gender and social equity are designed into planning, management, monitoring
- Human waste id safely managed along sanitation services chain, starting with containment
- Authorities operate with a clear, inclusive mandate, performance targets, resources and accountability
- Authorities deploy a range of funding, business and hardware approaches – sewered/non-sewered to meet goals
- Long term planning demand for innovation and is informed by analysis of needs/resources
- Political will and accountability systems incentivize service improvements in planning, capacity and leadership

The four CWIS building blocks are:

- Prioritization of the right of all to sanitation, with inclusive strategies reaching informal settlements and vulnerable populations, especially women and children,
- Delivery of "safe management" along the entire sanitation service chain by focusing on service outcomes rather than technologies, and by embracing innovation and incrementalism.
- Recognition of the role played by sanitation to a thriving urban economy by its integration into urban planning, reforming regulatory policies, and embracing resource recovery and reuse.
- Commitment to work in partnership across sectors and stakeholders to make progress through clear institutions with accountability and embedding sanitation within urban governance systems.

Figure 9: Citywide Inclusive Sanitation (CWIS)



Source: Sanitation Action Plan, BORDA South Asia, 2020

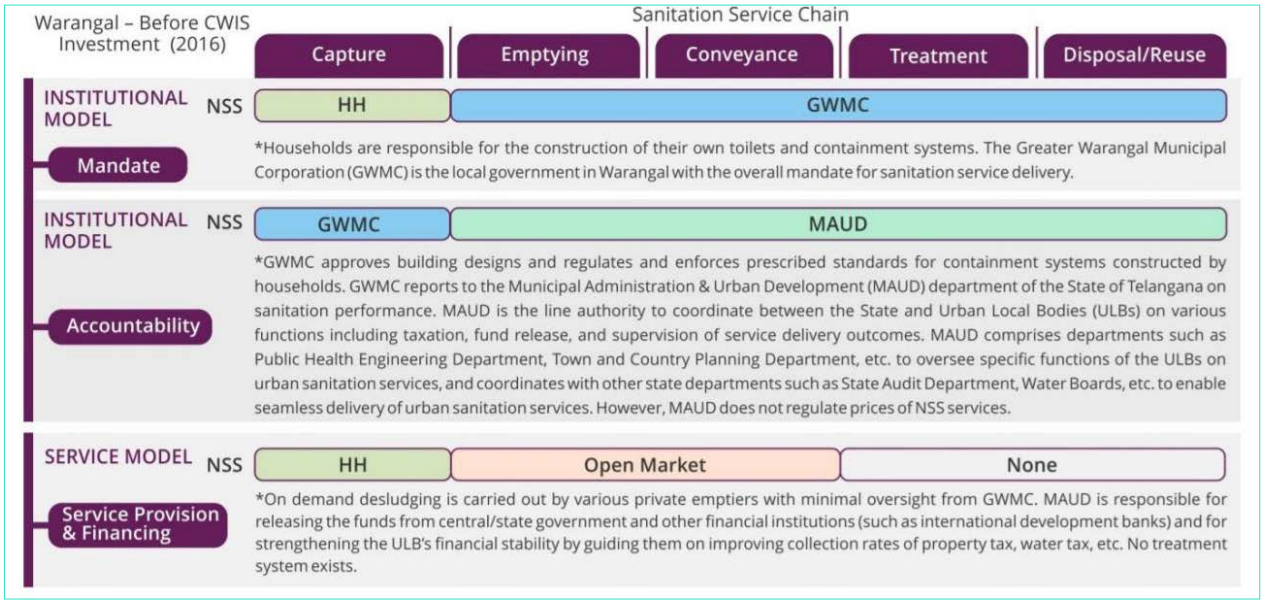
Citywide inclusive sanitation is explicitly agnostic about technology choice. Clear service outcomes – for all residents, in sewered and non-sewered areas – and system feasibility considerations (e.g., financial, environmental, political, organizational capacity, cultural, and other factors) inform system design and technology choice. CWIS is based on the fundamental understanding that urban

human waste management is characterized by inherent market failures, and therefore must be organized as a public service – including ensuring safe containment – to achieve public interest components of sanitation (i.e., safety and inclusivity). This requires government engagement in market structuring. At the same time, it does not preclude or diminish the role of the private sector. For service authorities to achieve the outcomes embedded within their legal mandates, they must ensure services are well executed. This expands opportunities for private sector participation by creating market incentives for investment and innovation.

City Wide Inclusive Sanitation at Warangal City, India

Developing a sustainable sanitation model has been one of the biggest challenges faced by growing cities in India. Over the last few years, the city of Warangal in Telangana has transformed its sanitation systems and has become a model for rest of the country. The model for sanitation used in Warangal involves communities and also actively engages with the government. The Greater Warangal Municipal Corporation (GWMC)) has been working closely with the Administrative Staff College of India (ASCI) on multiple aspects of sanitation such as access to toilets, waste treatment and transportation of the toilet waste. The city of Warangal is a great example of how a complete sanitation solution can work for any city. Deep government engagement, use of on ground data and private sector involvement helps to empower all aspects of the sanitation value chain. Warangal city scored a dismal 26.36 out of 100 in the city sanitation rating in 2010. The objective of the project was to make Warangal a perfect city in terms of sanitation and rank it among the top cities in the sanitation rating given by GoI.

Figure 10: Sanitation Service Chain at Warangal – Before CWIS



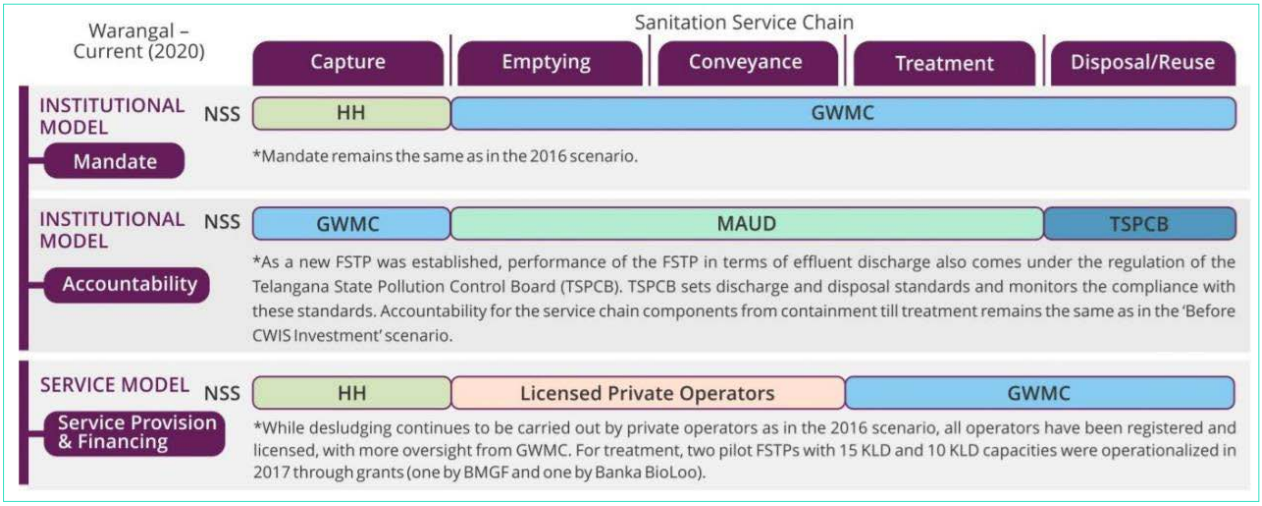
Source: CWIS City Snapshot- ASCI

Enabling conditions and actions took to make CWIS successful and sustainable are given as follows:

- Non-sewer Sanitation – Policy & Regulatory Framework
- Institutional Accountability – Roles and Responsibilities
- Institutional Accountability – Agencies and Coordination Mechanisms
- Public Private Partnerships with well-defined service level agreements
- Regulating the unregulated

- Sanitation for the poor and vulnerable population
- Citizen Engagement: Sanitation Helpline (S-line)
- Engaging citizens: BCC campaigns
- Gender Mainstreaming in Sanitation
- Innovations & Technology Transformation
- ICT based monitoring for sustainability and impact
- Capacity building for sustainability

Figure 11: Sanitation Service Chain at Warangal – After CWIS



Source: CWIS City Snapshot- ASCI

Case study videos on CWIS

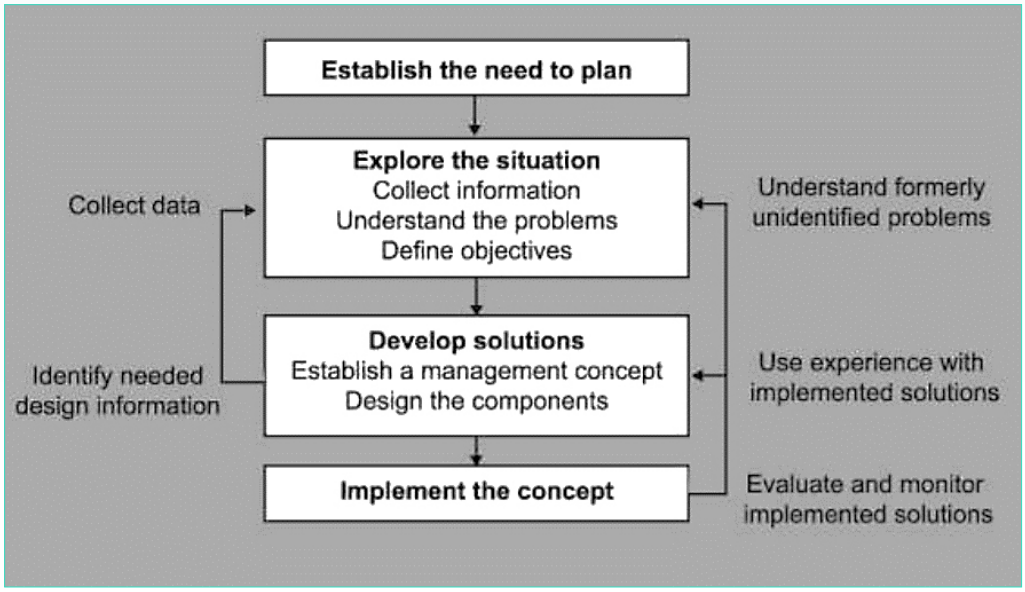
Click on the link in pdf to watch the video online

Citywide Inclusive Sanitation in Wai City
Towards City Wide Inclusive Sanitation - Dhaka
Towards City Wide Inclusive Sanitation – Manila, Philippines
Towards City Wide Inclusive Sanitation – Kathmandu
Towards City Wide Inclusive Sanitation - Kampala
Towards City Wide Inclusive Sanitation – Lusaka

2.4.2 Stages of Planning

The core piece of the planning process is to develop a future management concept. The planning process should follow logical stages: (a) a consensus about the need to plan has to be established among the key stakeholders, (b) the situation has to be analysed thoroughly to identify all existing problems, (c) define the objectives of improvement measures and (d) the different components of this concept will be implemented. Planning is not a linear process and monitoring after the implementation helps to refine and design and improve the project further. Experiences during planning and from implementation and operation should always be considered and plans be revised if necessary. Figure 12 visualizes the different planning stages. The feedback loops illustrate that amendments to the plans are to be done based on the experiences. More precise information about adequacy of proposed solutions and about formerly unidentified problems helps in developing better solutions.

Figure 12: Stages of the planning process



Source: Faecal Sludge Management in Developing Countries A planning manual, EAWAG

Establish the need to plan

The key stakeholders of the FSSM project should have consensus on need to plan. All the stakeholder responsible for implementation should be convinced with need to plan. Engagement with all the other stakeholders is necessary through proper channel to communicate the need of plan and benefits of FSSM. The main initiative for improvements in faecal sludge and septage management is more likely to come from the authorities, than from the individual citizens. Therefore, the support from authorities and decision makers will be decisive for the success of better FSSM.

Explore the situation

The thorough understanding of the existing situation is essential to tackle the right problems and to consider the right constraints while developing solutions. The first approach should be to gather a broad understanding of the situation and to know about all relevant issues and the relations between them. Beside the basic goal of understanding the situation, one should always seek to identify the main problems with FS management and their causes.

Develop solutions

The first step of developing solutions is to define the direction in which the project needs to go. One needs to define the main planning objectives, and specify them, to set the targets for the various measures to be developed. In most cases, one overall objective will be “to improve public health”, the protection of the population from health risks through the transmission of pathogenic organisms contained in human faeces. After developing the specific objectives, one can identify the tasks to be done to achieve those objectives. The proposed solutions can then be evaluated on their adequacy to achieve the set objectives by the help of those criteria. Clearly measurable indicators are helpful to evaluate the fulfilling of criteria.

Implement the concept

The implementation should not be seen as the final stage of the planning process. The stakeholders will learn a lot from the process of implementation and one should use the learned lessons for future initiatives. This principle should be institutionalized through fixed procedures for monitoring and evaluation of the implemented components and for the use of the gained information before implementing further components.

2.5 Notes for Trainer

This session talks about the approach and stages of FSSM planning and its implementation using various tools and concepts to achieve a sustainable FSSM model with safe solutions. The trainer needs to communicate to the audience clearly that the choice of approach and the tools for various stages of planning are to be selected based on the objectives of the project and the stakeholders involved.

2.6 Bibliography

- Blackett, I., Hawkins, P. (2019). City Service Delivery Assessment for Citywide Inclusive Sanitation - Tool and User Guide. Inclusive Sanitation in Practice, United Kingdom
- City Sanitation Plan for Kochi - Draft Report Volume 1, Main Report, Corporation of Cochin & GIZ-ASEM, August 2011
- City Service Delivery Assessment for Citywide Inclusive Sanitation User Guide, Inclusive Sanitation in Practice, April 2020
- Citywide Inclusive Sanitation, World Bank Group & Global Water Security & Sanitation Partnership.
- CWIS City Snapshot- ASCI, Online ADB Sanitation Dialogue 2021
- Faecal Sludge Management Toolbox, Supported by World Bank, EAWAG and IWMI.
- Ganesh S Kumar, Sitanshu Sekhar Kar, and Animesh Jain (2011), Health and environmental sanitation in India: Issues for prioritizing control strategies, Indian Journal of Occupational and Environmental Medicine.
- Peter Hawkins, Isabel Blackett, and Chris Heymans (2013), Poor-Inclusive Urban Sanitation: An Overview, Water and Sanitation Program.
- Sanitation Safety Planning, Manual for safe use and disposal of wastewater, greywater and excreta, WHO, 2016
- SANIPLAN A City Sanitation Planning Model, www.pas.org.in
- SSP For Peri-Urban Town Devanahalli (2014), India Case Study, World Health Organization
- Raj et. al., The SaniPath Exposure Assessment Tool: A quantitative approach for assessing exposure to Faecal contamination through multiple pathways in low resource urban settlements, PLoS ONE, June 2020.
- The SFD Approach Article, Sustainable Sanitation Alliance, 2018.

2.7 Further Reading

Faecal Sludge Management in Developing Countries A planning manual (2002), Eawag

Comparison of tools & approaches for urban sanitation, WASH matters, WaterAid September 2016

Guidelines for Citywide Inclusive Sanitation (CWIS) Planning, Eastern and Southern Africa Water and Sanitation Regulators Association (ESAWAS), March 2020

Roland Schertenleib et. al. (2021), A Sanitation Journey: Principles, Approaches and Tools for Urban Sanitation.

Session

03

State level Approaches for FSSM planning

3. State Level Approach for FSSM Planning

3.1 Learning Objectives

- To understand the approaches for state-wide scale-up for FSSM
- To understand the steps involved in implementation of FSSM across all ULBs

3.2 Session Plan

Duration - 30 minutes

Topics	Time	Material/Method
State level implementation of planning approaches for FSSM	15 min	Powerpoint presentation
Case studies	10 min	Powerpoint presentation
Q&A	5 min	Discussion

3.3 Key facts

- Each state needs to identify its strengths, weakness, opportunities, and threats while preparing a state investment plan to scale FSSM.
- The plan shall focus on utilizing the existing infrastructure as much as possible before deploying new infrastructure.
- For smaller ULBs, a safe disposal mechanism is a good sustainable option as O&M of collection, conveyance, and treatment facilities might not be affordable.
- Regional climatic conditions and understanding of demand and supply of the sanitation services should determine the capacity and technology in FSSM.

3.4 Learning notes

3.4.1 State level planning of FSSM

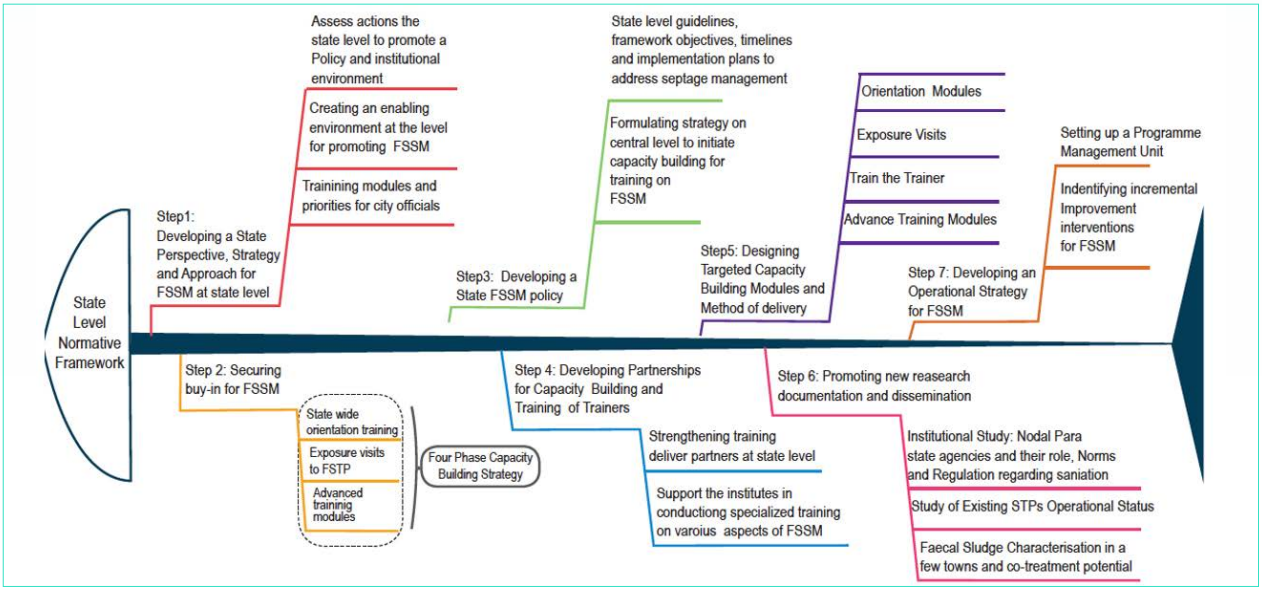
Normative framework

The framework for operationalizing FSSM at state level is divided into seven steps. The seven steps are shown in the Figure 13. It starts with creating an enabling environment by developing state perspective for operationalizing FSSM across the state and ends with developing a operational strategy for FSSM culminating into a state scale up plan for FSSM.

Developing a State Perspective, Strategy and Approach

This step starts with assessing the institutional environment and the actions taken by each institution to promote a policy or regulation. The main objective of the step is to create enabling environment in the following six aspects – government support, legal and regulatory framework, institutional arrangements, skills and capacities, financial arrangements and socio-cultural acceptance. All these aspects are touched upon in detail in the following steps.

Figure 13: Normative framework for operationalizing FSSM at State Level



Securing buy in for FSSM

At the state level it is important to sensitize the key institutions and their officials regarding FSSM. This helps to have clear distinction between the roles and responsibilities and also helps to get a buy in for FSSM.

The state government and/or the urban development department of the state is responsible for bringing in policies, regulations, protocols etc. They are also responsible for developing overall plan for the state and invest in sensitization and building capacities of the stakeholders.

Figure 14: Institutional framework for Sanitation in states of India.

	Funding	Design and Planning	Implementation	Operations and Maintenance	Monitoring
National Government	UD Department	CPHEOO, Project Guidelines			Pollution Control Board,
State Governments	Relevant State Departments	State Departments, Parastatals/ Boards	State Departments, Parastatals/ Boards	State Departments, Parastatals/ Boards	State PCBs
ULBs, Parastatals/ Boards	Only O & M costs	Parastatals/ Boards, sometimes ULBs	ULBs, Parastatals/ Boards	Mostly ULB, sometimes, Parastatals/ Boards	

Source: Municipal Strengthening, IIHS

The parastatal bodies and/or ULB who are involved in solid liquid waste management are responsible for creation and O&M of the infrastructure. They play a key role in planning process and sustainability of the project. It is very important that these agencies understand their role and carry out the necessary work in time.

The pollution control board is a regulatory authority which needs to records the effect and monitor the impact before and after the project is completed. The board is also responsible to monitor the characteristics of the discharges from the treatment facilities and fine the operator if necessary.

Developing State Policy/Protocol

- State can prepare three kinds of documents;
- A state policy as a guidance document for FSSM with a vision statement and objectives.
- Advisory and strategy documents supporting the scale up of FSSM across state
- Guidelines and technical manuals/advisories for assisting the implementation.

Capacity Building Plan and Content

A capacity building plan needs to be created for improving the taxonomy levels. To begin with, the officials need to undergo orientation training. An orientation training is a one day (6-8 hours) with an objective of introducing to the officials what FSSM is and how it helps to improve environmental sanitation. It also helps to make them realize the policies, regulation and guidelines/manual available for work to be further carried out by them. The second level of training is workshop with an exposure visit. This is a two-day module (12- 15 hours) with an objective to showcase best practices in FSSM. The exposure visit is to the state, site where FSSM has been operationalized in a systematic and inclusive manner. The third level of training is advanced training which is targeted towards engineers, planners and practitioners. These are 3-4 days (20-24 hours) of extensive training which also includes exercise based on case method. The main objective of such training is to take the participants to the higher taxonomy level of application of concepts and theories on the field.

Research, Documentation and Dissemination

Research and its documentation are required for overcoming challenges and issues faced (or will face) during operationalizing and implementation of FSSM plan. The documentation in the form of research reports, assessment studies, recommendation etc. While conducting research and documentation it should be kept in mind to involve the key stakeholders. This improves the engagement with the stakeholder and keeps in them informed about the plans. This later helps in also creating enabling environment for FSSM.

Dissemination helps in peer learning and extend a helping hand to other states having similar challenges. During dissemination, focus should also be in highlighting the mistakes and learnings from them as these points are more helpful to avoid same mistakes by the other states.

Operational Strategy

Developing an operational strategy for FSSM, the last step the framework. This includes identifying the gaps in the sanitation service chain and finding solutions to fill in the gaps. These solutions act as incremental improvement interventions for FSSM. The strategy document should also lead to preparation of the state wide scale up plan and an investment plan.

3.4.2 Developing a State Investment Plan

State level FSSM Plan should contain the following points

Introduction and Objectives

- Current sanitation status in the State - information on toilet coverage, percentages of Sewered and on-site sanitation, challenges faced
- Definition of faecal sludge, septage and is Faecal Sludge and Septage Management (FSSM)
- Sources of faecal sludge and septage also quantity generated, collected, transported, treated at present, untreated and disposed of scientifically, ensuing environmental pollution and public nuisance
- Importance of FSSM alignment with overall sanitation vision of the State; arising health, social, economic and environmental benefit
- Vision - high level purpose of sanitation and FSSM such as clean cities, healthy living, high standards of living, become a preferred state for tourism /business destination, etc
- Objectives and Scope - why is the State issuing the FSSM Policy to meet what challenges and what is covered by this Policy (geographically, institutionally, issues)
- Expected outcomes - benefits for whom State hopes to achieve from effective FSSM

Legislative and Regulatory Context

- Central Laws, Rules and Regulations
  - Environment (Protection) Act, 1986 and the Water (Prevention and Control of Pollution) Act, 1974 provide a framework for control of effluent, wastewater and septage discharge.

  - Municipal Solid Waste (MSW) Rules, 2016 under the Environment (Protection) Act apply to the final and safe disposal of post processed residual faecal sludge and septage to prevent contamination of groundwater, surface water and ambient air. Further, the MSW Rules 2016 will apply to the final and safe disposal of post-processed residual faecal sludge and septage.

  - Employment of Manual Scavengers and Construction of Dry Latrines (Prohibition) Act, 1993 put a ban on dry latrines, i.e., latrines with no water-seal or flushing mechanism, and the employment of persons for manually carrying human excreta. This was supplemented in 2013 with the Prohibition of Employment as Manual Scavengers and their Rehabilitation Act, 2013 by which “hazardous cleaning” in relation to sewers and septic tanks was also banned. The law now provides that manual cleaning of sewers and septic tanks, if necessary, may be carried out only in very controlled situations, with adequate safety precautions, and in accordance with specific rules and protocols for the purpose. All public and private sector staff should adhere to safety norms as provided in the Manual on Sewerage and Sewage Treatment published by the Ministry of Housing and Urban Affairs and such other safeguards under the Prohibition of Employment as Manual Scavengers and their Rehabilitation Act, 2013.

- State Laws, Rules and Regulations and Municipal Byelaws - list them out along with their relevance to FSSM.

State scale-up strategy

- Roles and Responsibilities of the State Government, ULB, Private sector, Research organizations, NGOs, external funding agencies, households, service providers

- Implementation Approach - outline of how the State Government plans to operationalize the FSSM Policy

    - State FSSM Implementation Strategy and Guidelines - the State Government plans to develop the Implementation Strategy and Guidelines and then operationalize them

    - ULB-level Implementation Plan - the key constituents of such an Implementation Plan by each ULB; details of such a ULB level framework

- Monitoring and Evaluation - plans for development of a robust M&E framework to measure and monitor expected outcomes at State and ULB level; such a framework will form part of the State FSSM Implementation Strategy and Guidelines

- Community Engagement and Stakeholder Involvement - plans for developing a robust community engagement platform for continuous involvement of ULB citizens and support to FSSM activities being initiated by the state.

- Capacity Building and Training - the approach, potential or identified institutional partners, possible sources of funding, key audiences for capacity building and training, what skills need to be built upon for successful implementation of FSSM.

Investment plans and funding requirements

- Funding options for State and ULBs- Central Government Schemes, 14th Finance Commission funds, State Government schemes.

- Other funding models - private sector participation and funding, levying of fees and user charges, CSR funds, funding from external agencies.

3.4.3 Case Studies

Many states in India have scaled up FSSM over the period of years in different ways. Case study of state of Tamil Nadu, Maharashtra and Uttarakhand has been discussed below. NIUA along has conducted feasibility assessment for the state of Uttarakhand and similar such study reports have also published Rajasthan and Tamil Nadu.

Case of Tamil Nadu

Tamil Nadu is the first State to issue the Operative Guidelines for Septage Management in a comprehensive manner. Tamil Nadu is one of the most urbanized states in India with around 48.45% (Census 2011) of the population living in urban areas. In terms of Septage Management, Tamil Nadu has accorded highest priority (Vision 2023) to implement Underground Sewerage scheme and STPs across local bodies to provide better sanitation facilities. Septage Management for the local bodies includes both residential and non-residential/commercial waste (excluding industrial waste). These Operative Guidelines for septage management seek to empower the local bodies with knowledge, procedures and facilities.

The key elements of Septage Management in Tamil Nadu are:

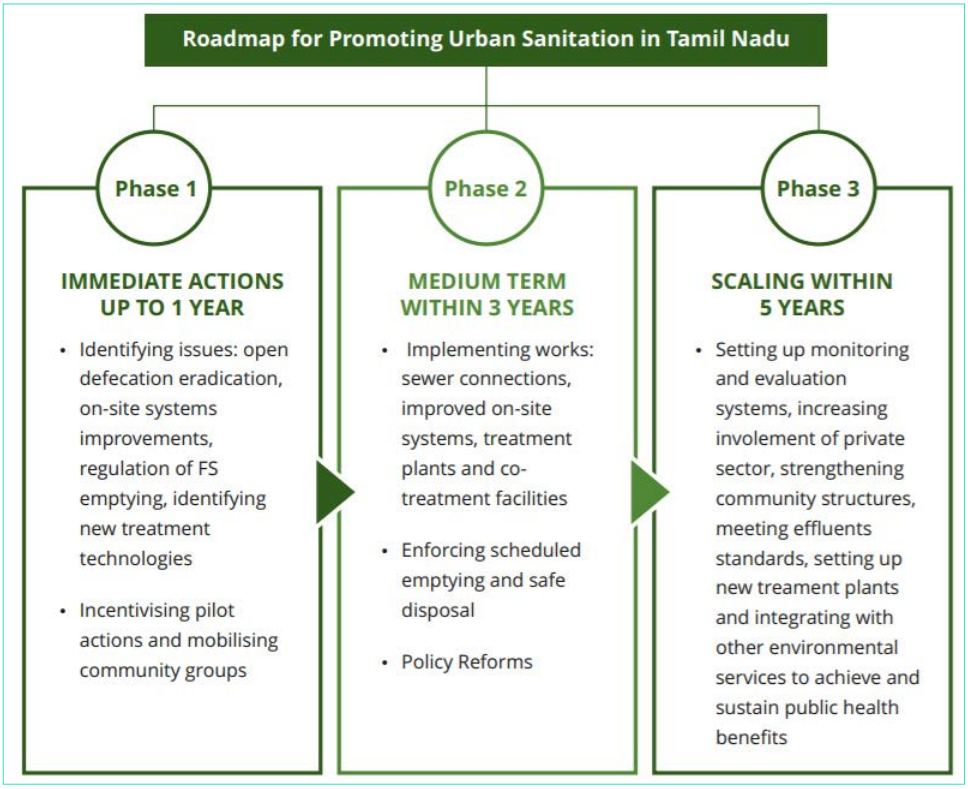
- Design and Construction of Septic Tanks
- Septic Tank Pumping & De-Sludging
- Septage Transportation
- Treatment & Septage Disposal
- Fees/Charges for Collection, Transportation and Treatment
- Information, Education and Communication
- Record-keeping and Reporting (MIS)

21 clusters of Local Bodies were identified based on the existing location of STPs. The local bodies have been grouped in such a way that all collection points are situated at around 18-20 kms of radius of the chosen STP. These clusters can be revised as new STPs are made under the ongoing Underground Sewerage Schemes.

Scaling up FSSM

The institutional arrangements that govern various aspects of sanitation in Tamil Nadu include several implementation and financial agencies at the State and ULB level. In Tamil Nadu, the Municipal Administration and Water Supply Department (MAWS) is the principal department responsible for planning, designing, and executing urban sanitation initiatives. On the basis of the sanitation policies and programs enacted in the State, the statement of intent and political commitment of the state government to prioritise and address urban sanitation are commendable. However, there are some drawbacks along the full cycle of sanitation that prevent successful implementation. In order to achieve 100% sanitation and improve public health outcomes in urban Tamil Nadu, legal, regulatory and institutional reforms across the sanitation value chain are needed.

Figure 15: Roadmap for Promoting Urban Sanitation in Tamil Nadu



Source: TNUSSP

Tamil Nadu's legal and policy framework

The onus of ensuring safe sanitation, and thereby achieving public health goals falls within the purview of the State and its institutions. Sanitation is a state subject and is recognised in the 74th Constitutional Amendment, 1992, which devolved 18 functions to the state and ULBs. Of these, the ULBs bearing influence on sanitation are:

- Water supply for domestic, industrial & commercial purposes
- Public health, sanitation conservancy and solid waste management
- Slum improvement and upgradation
- Public amenities including street lighting, parking lots, bus-stops & public conveniences

Apart from the Operative Guidelines for Septage Management issued in 2014, current state legislations, do not adequately address issues across the full cycle of sanitation. The lack of a comprehensive law, and dedicated institutions oriented towards public health and promoting safe sanitation, add to challenges in governance.

The acts and rules governing sanitation in Tamil Nadu are as below:

- Tamil Nadu District Municipalities Act, 1920 Municipal Corporation Acts, & Public Health Act, 1939 - Governs containment, emptying and transport of faecal sludge; prescribes rules and bye-laws for the construction, operation and maintenance of toilets, sewer systems and septic tanks
- Tamil Nadu Town & Country Planning Act, 1971 - Governs master planning for existing and new regional areas; provision of water supply, drainage, sewerage and sewage disposal facilities
- Tamil Nadu District Municipalities Building Rules, 1972 - Prescribes standard number of sanitary facilities required for residential and commercial buildings
- Environment (Protection) Act, 1986 & Water (Prevention & Control of Pollution) Act, 1974 - Enforces treatment and safe disposal/ re-use of sewage/ septage.

Case of Maharashtra

Maharashtra is the second-most urbanized state in India with its residents accounting for nearly 10% of India's population. The state of Maharashtra is having about 60 million urban population residing in 394 Urban Local Bodies. After the state became ODF, the government of Maharashtra (GoM) had issued a 7-point sustainability charter in 2017 that included focus on ODF-Sustainability and ensuring effective collection and treatment of human faecal waste in all cities. Urban Development Department (UDD), GoM adopted a systematic approach to move towards ODF+ & ODF++ in October 2017 in time bound manner through state wide faecal sludge and septage management (FSSM) plan. The state setup a technical support unit (TSU) housed under UDD to support for these activities.

The Government of Maharashtra (GoM) has adopted systematic approach to implement city wide FSSM plans across the full sanitation service chain in the ULBs. The UDD, Government of Maharashtra has a Memorandum of Understanding (MoU) with Bill & Melinda Gates Foundation (BMGF) for support to Swachh Maharashtra Mission. Under this MoU, the state has established a technical support unit (TSU) in partnership with CWAS, CEPT University to deliver effective sanitation services across urban areas in Maharashtra with a focus on FSSM solutions. The TSU provides guidance and support in implementation of FSSM plans in the cities of Maharashtra. Post declaration of ODF sustainability charter in 2017, Government of Maharashtra initiated developing state-wide strategy on faecal waste management and treatment i.e., moving towards ODF++ cities.

Two-pronged approach for state wide FSSM strategy

1. The state took two-pronged approach towards state wide FSSM strategy:
   - Co-treatment of faecal sludge at own or nearby STPs and
   - Setting up independent FSTP at city level for faecal sludge treatment.

2. All ULBs were classified into 3 categories:
   - ULBs with functional sewerage treatment plant (STP),
   - ULBs that can do FS co-treatment to nearby ULB's STPs
   - Remaining ULBs with independent faecal sludge treatment plant (FSTP).

A set of guidelines on FSTP Operation and Maintenance, standard operating procedures for desludging operations and model service level agreements have been developed to ensure sustained and safe sanitation service delivery in ULBs. State wide training workshops were conducted on implementation of FSSM plan. Also, a state level monitoring system and quality assurance framework has been established for monitoring FSSM implementation in the state. Most of the operational FSTPs are being operated by ULBs by assigning dedicated sanitation staffs. Most of the FSTPs are using treated water for gardening on FSTP site. The dried sludge is used either as manure in the gardening or mixed with compost from solid waste. Efforts are made to engage self-help groups (SHGs) for the operation and maintenance of FSTP.

The Urban Development Department, GoM developed various guidelines for septage management, and conducted regular capacity building programmes for all ULBs to implement city wide FSSM plan. UDD conducts regular review meetings to track the progress at city, district, division and state levels. A state wide monitoring system and dashboard is developed to track the implementation of FSSM plan. A series of field visits and on-call assistance is being provided by technical experts to guide the ULB officials during the implementation and operation of FSTPs. Maharashtra is also developing a strategy on convergence of NULM and SBM for improved sanitation service delivery with participation of SHGs in operation and maintenance activities.

Uttarakhand legal and policy framework

The State of Uttarakhand is a mountainous state in the north of India. It occupies a total land area of 53,484 sq km, which is 1.73 per cent of India's total land area. According to Census 2011, the total population of Uttarakhand is 10,116,752, with a majority of the population (69.45 per cent) living in rural areas. Administratively, the State is divided into 13 districts, 78 sub-districts, 74 statutory towns, 41 Census towns and 16,793 villages. There are 92 Urban Local Bodies (ULBs), which include six Nagar Nigam, 42 Nagar Palika Parishads, and 44 Nagar Panchayats. Piped sewerage system connects only 31.7 per cent of the total urban households with individual household latrines. More than half of the urban population in the State relies on On-Site Sanitation systems such as septic tanks (53.1 per cent) for the collection of faecal sludge and wastewater. Further, some individual households in the State discharge the waste from their toilets directly into open drains.

The sewage treatment capacity of the State is 152.9 MLD in contrast to sewage generation of 495 MLD. In other words, different sources discharge 342.1 MLD untreated sewage to water bodies, and this is responsible for deterioration of water quality. Given the limited availability of the piped sewer system, the absence of sewage treatment facilities in most urban areas, and reliance on-site sanitation as the primary sanitation system in urban areas, FSSM ought to form an important component of sanitation interventions in the State of Uttarakhand. Observations from the field regarding the status of FSSM in the selected towns and the issues that a ULB might face in FSSM implementation also highlight the need for urgent action in these and other parts of the State Uttarakhand.

Septage Management Cell

There is a link between laws relating to ULBs, to water supply and sewage, and to water more generally on the one hand, and FSSM on the other hand.

Uttaranchal Municipalities Act, 1916 and Uttaranchal Municipal Corporation Act, 1959 these two laws governing ULBs may fail to regulate FSSM effectively for several reasons: (a) the sanitation-related provisions do not include any explicit reference to septage and/or sludge, (b) the penalties for violation of the provisions of these two laws by 'any person' or the owner of the premises are meagre and they may not have the desired deterrent effect, (c) the ULB tends to prioritize certain statutory duties over others or there are resource constraints, the relevant provisions may not even be enforced, (d) there are no consequences in case the authorities fail to comply with their statutory mandate and (e) there is no regulation and licensing of private service providers (Koonan S. et. Al.; 2019).

More recently, the Urban Development Department has prepared a specific Protocol for Septage Management, 2017. It governs the ULB, the households and the operators (ULB or private) where facilities for treatment of septage and sludge are available. It includes the following provisions:

- Payment of a septage collection fee by households
- Addition of penalty amount to house tax
- Registration of private operators with the ULB and payment of fee (in addition to vehicle license)
- GPS tracking of vehicles
- Inspection of private operators to check spillage
- Use of treated septage (for agriculture) and treated sludge (for compost)
- Establishment of a Septage Monitoring Committee with the District Magistrate as the Chairperson by 31 July 2018
- Establishment of a Septage Management Cell at the district level.

Table 5: Overview of key state institutions and their roles

Institution	Key Roles
Uttarakhand Housing & Urban Development Authority	Development authority in relation to the whole of the State Area
Uttarakhand Pey Jal Nigam (UJN)	• Planning, designing and execution of sewage and water supply services in urban areas • Ganga Pollution Control unit
Uttarakhand Jal Sansthan (UJS)	Operation and maintenance of sewage and water supply services in urban areas
Uttarakhand Environment Protection and Pollution Control Board (UEPPCB)	• Monitoring and enforcement of environmental laws enacted by the central and state governments • Regulatory role for environmental protection, most importantly prevention and control of environmental pollution during the FSSM process such as desludging, treatment and disposal
Uttarakhand State Commission for Safai Karamcharis	Protection of the rights of sanitation workers in the state
Urban local bodies (Nagar Nigam, Nagar Parishad or Nagar Panchayat)	• Implementation of SBM (Urban) and AMRUT • Provisioning of desludging services, operation and maintenance of sewage treatment plants, and ensuring the safety of sanitation workers employed by the local government

In the State of Uttarakhand, the UDD is the nodal department for the development of the regulatory and institutional frameworks for FSSM in the State, and it has prepared the Protocol on Septage Management in 2018. Ultimately, however, the ULBs must adopt the Protocol through a Council resolution in order for it to become binding and enforceable within its jurisdiction, and implement it by monitoring compliance and punishing violations. The effectiveness of the FSSM framework depends on a clear division of powers, functions and duties among these institutions. The government must also address concerns relating to the institutional, financial and human resource capacity of ULBs to provide and monitor FSSM. Like sewage management, FSSM in the State of Uttarakhand is heavily dependent on financial resources from the Central Government.

3.1 Notes for Trainer

This session showcases details about state level implementation of planning approaches for FSSM. The stages to develop state investment plan for FSSM design and implementation. This session will help participants to understand the deferent strategy adopted by different states for developing and implementing FSSM strategy in the states.

3.2 Bibliography

Faecal sludge and septage management in Uttarakhand: a review of the law and policy framework, March 2019

Faecal Sludge and Septage Management in Maharashtra (September 2020), Center for Water and Sanitation (CWAS)

Faecal Sludge and Septage Management in Urban Areas, Service & Business Models, NITI Aayog, January 2021

Financing Faecal Sludge and Septage Management (FSSM) A landscape study of four Indian states, Centre for Water and Sanitation (C-WAS), Centre for Research and Development Foundation (CRDF), CEPT University, June 2019

Legal & Institutional Arrangements for Sanitation in Tamil Nadu, TNUSSP Practice Brief, IIHS

National Inventory of Sewage Treatment Plants, CPCB, March 2021

Sujith Koonan, Phillippe Cullet, Lovleen Bhullar (2019), Faecal Sludge and Septage Management in Uttarakhand: A Review Of The Law And Policy Framework, Centre For Policy Research SCFI-FI Sanitation, NIUA.

Swachh Bharat Mission (Urban) 2.0 Guidelines (2021), Ministry of Housing and Urban Affairs (MoHUA).

Session

04

City level Approaches for FSSM planning

4. City level Approaches for FSSM planning

4.1 Learning Objectives

- Understand the importance of an integrated approach for FSSM
- Learn stages of planning for FSSM on a city level, including a logical planning framework of necessary activities
- Understand how to select context specific options through case studies and know how different aspects are connected and influence each other

4.2 Session Plan

Duration - 60 minutes

Topics	Time	Material/Method
City level Planning approaches for FSSM	10 min	Powerpoint presentation
Integrated Municipal Information System	10 min	Powerpoint presentation
City Wide Inclusive Sanitation aspects	10 min	Powerpoint presentation
Case study – Journey to ODF++, Wai (Maharashtra)	5 min	Powerpoint presentation
Case study – Evidence based Planning, Nagda (MP)	5 min	Powerpoint presentation
City level Planning approaches for FSSM	10 min	Powerpoint presentation
Q&A	10 min	Discussion

4.3 Key facts

- There are five different stages of FSSM planning framework at city level from exploration to implementation.
- Integrated Municipal Information System is important as it links all the environmental services in the city and helps to optimize the management of the services.

4.4 Learning notes

4.4.1 City level Approaches for FSSM planning

Each city/ULB is expected to develop a detailed FSSM plan in conformity to the National FSSM policy and respective State guidelines on FSSM.

The five important stages of FSSM Project are:

- Exploratory study
- Preliminary (pre-feasibility) study
- Feasibility study
- Detailed Project Report (DPR) Development
- Implementation

Exploratory study

This stage can be considered as the ignition stage for the FSSM project. In this stage, identification of stakeholders in the project is done. A FSSM taskforce can be constituted of the key stakeholders and decision makers of the project. The taskforces need to develop the vision and draft objectives of the project.

Large portion of this stage comprise of data collection. It is advised that secondary data should be collected first and adequate desk research should be done before starting with primary data collection. For primary data collection, it is recommended to conduct a survey using spatial sampling methodology which yields data with higher accuracy and reliability. Digital tools such as mWater can be used for conducting the surveys. Following stakeholders should be surveyed:

- Households
- Institutions (hospitality, educational institutes, healthcare institutions)
- Sanitation infrastructure (community/public toilets)
- Desludging operators
- Civil contractors and masons

Preliminary study

The second stage of the project is undertaking prefeasibility study. Pre-feasibility (preliminary) study starts with characterization of the identified stakeholders in the first stage. The characterization of the stakeholders is based on their influence and interest in the project. Depending upon their influence and interest, the engagement tool and technique is decided. Chapter 6 of the module will provide more details on this.

It is recommended that various planning and technical documents such as City Sanitation Plan, City Development Plan, Detailed Project Reports etc. should be read through as part of desk research.

In this stage, the analysis of the primary data collected from the ground is done to draw inferences. This feeds into the next stage of feasibility study. Land identification for the treatment facility or for septage receiving station should also be carried out at this stage.

Feasibility study

In this stage the main objective is to identify the economically viable sanitation service model for the city under consideration. For identification of the model, certain key activities need to be carried out: (a) Quantification and characterization of the sludge- this helps to estimate the number of desludging vehicles required for providing the service and the selection of treatment processes to be installed at the treatment plant. (b) Detailed site investigation- this step is necessary to understand the site constraints. The investigation involves finding out the soil bearing capacity, ground water table, disposal point, topography of the site etc. (c) Selecting financial model through consultative process- this step involves structured discussion with the key stakeholders (i.e. having high influence and high interest). (d) Fixing the project implementation model- it is an important part of the project and can be sometimes time consuming if not done well. There are multiple types of models such as Engineering-Procurement-Commissioning (EPC), Build-Operate-Transfer (BOT), Hybrid Annuity Model (HAM) etc.

As part of the process, focus group discussions and key informant interviews can be carried out with the officials from different line departments such as urban planning department, parastatal bodies such as sewerage boards, ULB or special purpose vehicles in cases where applicable.

Feasibility report should lead into the next stage which is preparation of Detailed Project Report (DPR).

Detailed project report development

DPR is a document focussing on details of each part of the project. It should address the collection – conveyance, treatment and safe reuse/disposal of the faecal sludge and septage. For collection – conveyance the DPR should provide rationale on the estimated number of vehicles, their capital cost and operation maintenance cost. The cost of personal protection and safety equipment along with the human resources and consumables should also be considered. For treatment facility, the treatment processes (or the technology) is already chosen in the feasibility stage. In DPR, the details of the technology need to be presented. It contains engineering design, hydraulic drawing, construction drawings etc. DPR should also contain the recommendations for safe reuse and disposal of the treated end products. In case of reuse, if there is any purchase cost (i.e. revenue stream) for the treatment plant operator should also be mentioned and considered by doing cost analysis.

DPR shall also contain abstract sheet and detailed bill of quantities based on the latest state's schedule of rates. The total cost of the project shall also include centages. Along with the DPR, a tender document shall also be drafted at this stage based on the chosen project implementation model. It is recommended that a monitoring and evaluation (M&E) framework must also be created for the implementation and post implementation phase.

Implementation phase

Implementation phase consists of implementation of the DPR and M&E of the project. Once, the tender is advertised, bids are invited from the contractors. As the part of the bidding process, each contractor is requested to submit two bids – (a) technical bid and (b) financial bid. The technical bid consists of information of the organization, proposed team and their profiles, experience certificates from previous projects and company documents such as registration certificate and annual turnover. The contractor should qualify the first round of technical bid in order to move to the next stage of financial bids. In the financial bid, the contractor is expected to submit his financial bid in a certain format. The format might change from project to project. Usually when the bid is to be submitted physically, the two bids are sealed in two different envelopes and the two envelopes are sealed together in one large envelope.

After the recruitment of the contractor, consent to establish has to be taken from the State Pollution Control Board (SPCB) before construction process can start on the site. There is a particular format in which all the required information has to be submitted to the SPCB. Once the consent is obtained, the construction process will initiate. M&E of the construction process needs to be done for quality control. The process needs to be carried out as per the framework defined in the DPR stage. While the construction is in progress, IEC campaign and BCC can be undertaken. This ensures that when the treatment facility is operational, the desludging services can also begin smoothly.

After construction of the facility is finished, commissioning of the plant is done. There is a specific procedure which needs to be followed for commissioning of the plant. This has been discussed in detail in the Faecal Sludge and Septage Management- Design Module developed under SCBP. The results of the commissioning of the facility needs to be shared along with other documents to obtain the consent of operate. Once the consent is obtained, the facility can be made operational to receive faecal sludge and septage from the desludging vehicles and/or can be handed over

appropriate organization for further O&M.

4.4.2 Integrated Municipal Information System (IMIS) and Citywide Inclusive Sanitation (CWIS)

Data is a precious and strong asset for planning and improving sanitation services across the city. However, data collection is often time-consuming and resource-intensive and moreover, it needs to be updated regularly. When data is no longer up-to-date, the risk of inadequate or poor planning and decision-making increases significantly.

IMIS generates useful information like type of containment, access road, etc. - to ensure that the appropriate (logistical) arrangements are made to deliver service to the customers. Further, during service delivery, IMIS makes it possible for emptier to update IMIS information themselves, with real-time data, using mobile apps (e.g., status of sludge emptying or customer's feedback). Beyond these, working with IMIS opens up great possibilities to revolutionise data systems in municipalities.

IMIS enables authorities to carry out three key functions:

- Reporting for accountability using a customizable dashboard of indicators and information;
- Managing FSSM services, linked with a mobile app for service providers to record application, service delivery, and customer feedback on-site; and
- Planning and informing (long-term) investments through spatial-based analysis.

Use of IMIS requires GIS expertise to operate, besides remote IT support for maintenance. IMIS is a web-based application, which centralises all information in one platform. IMIS also helps to catalyse CWIS by making the service accessible, equitable and affordable to masses.

CWIS at Wai, Maharashtra

Small and medium towns in India (100,000 in population) have nearly 40% of India's urban population. While there are large gaps in sanitation across urban India, these gaps are more pronounced in the small and medium towns. This project supports one town in the Indian state of Maharashtra – Wai, to demonstrate a viable approach to provide citywide inclusive sanitation. Wai acts as a "laboratory" to test approaches that can be applied to other small and medium towns, as well as to underserved areas in larger towns in the state of Maharashtra and in other States in India. The City-Wide Inclusive Sanitation (CWIS) project for Wai monitors the quality of ODF+ service delivery, with special attention to urban poor and women, strengthen the city systems to ensure sustainability of these services beyond the project period and generate lessons that motivate and inform state actors to facilitate replication of Wai across the state.

Following are the activities that are being undertaken in this project:

Creating an enabling environment for FSSM in Wai Municipal council, under which CWAS provides support to Chief Officer, elected representatives and officials from the sanitation department who have the responsibility of planning and monitoring of FSSM services.

The support enables them to be accountable and ensure that the FSSM services are safe and inclusive. This includes activities related identifying measures to ensure financial sustainability for FSSM services.

Support is provided to Wai council to move towards ODF++, to take up interventions such as: increasing individual toilet coverage, monitoring FSSM activities, reuse of treated wastewater / septage and reviewing their plan for grey-water management.

Activities are taken up with Wai Municipal Corporation to ensure that planning and delivery of sanitation services are inclusive. This is achieved by ensuring that sanitation services reach all communities, including the low-income settlements. Also, interventions are taken up to ensure regular usage, replacement and monitoring of PPEs by sanitation workers. User centric and gender sensitive design of sanitation facilities and service/management approaches are being explored.

A city is classified as ODF+ when not a single person is found defecating or urinating in the open and all community toilets and urinals are functional and well maintained.

A city is classified as ODF++ when it has achieved ODF+ and its faecal sludge, septage and sewage is safely managed and treated with no discharging in open areas.

CWIS at Nagda City, Madhya Pradesh

The State of Madhya Pradesh has issued guidelines for State urban sanitation policy with a view that all cities & towns of Madhya Pradesh become sanitized, healthy and liveable so that all urban dwellers have access to and use safe and hygienic sanitation facilities. In order to achieve this goal, 100% human excreta and liquid wastes from all sanitation facilities, including toilets must be disposed of safely. Treated wastewater generated from existing wastewater treatment plants can be considered as an important component of water resources of Madhya Pradesh. Due to the terrain and the concentration of the urban population, the majority of treated wastewater is discharged into various rivers, nallas or on open land and only a part of it is used for irrigation.

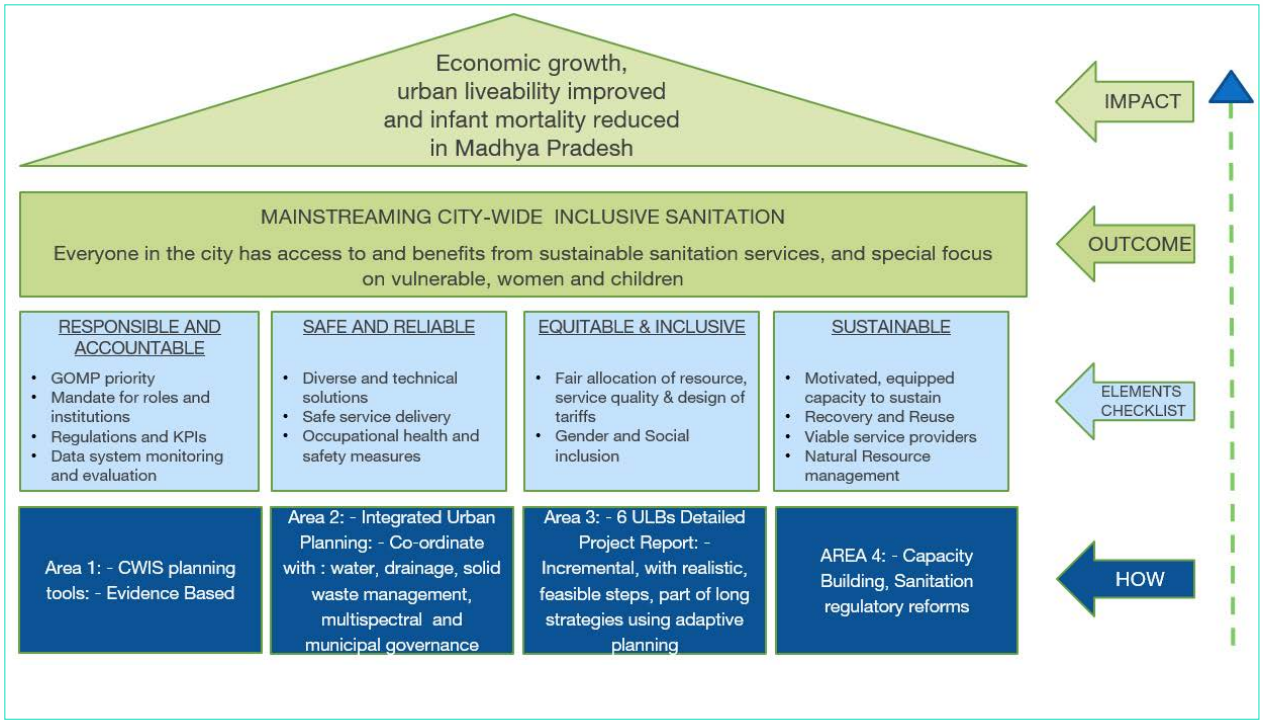
At present, the penetration of sewerage systems is low in Madhya Pradesh and more than 45% of urban MP households are dependent on On-Site Sanitation systems. Thus, until the Government's vision of 100% sewerage universalization is achieved, it is felt that faecal sludge output needs to be managed in an environmentally safe and sustainable manner using complementary and alternative treatment methods.

MP is the fifth most populated state of India with a total population of 72.6 million and eighth most urbanized state of India with 20.1 million of urban population. MP is a low-income state with high urban poverty rate of 21% and with total urban local bodies of 378. MP states had

limited technical, financial & institutional capacities having low water supply service coverage with intermittent operations, weak water pressures and wastewater infiltration risk. The cities are having untreated wastewater discharged into local environments, compromising the liveability of the towns and creating health and safety hazards.

In order to mainstream CWIS across the state, the state government of Madhya Pradesh identified four main pillars to drive the economic growth and improve urban liveability. The four aspects and their details are provided in the Figure 16.

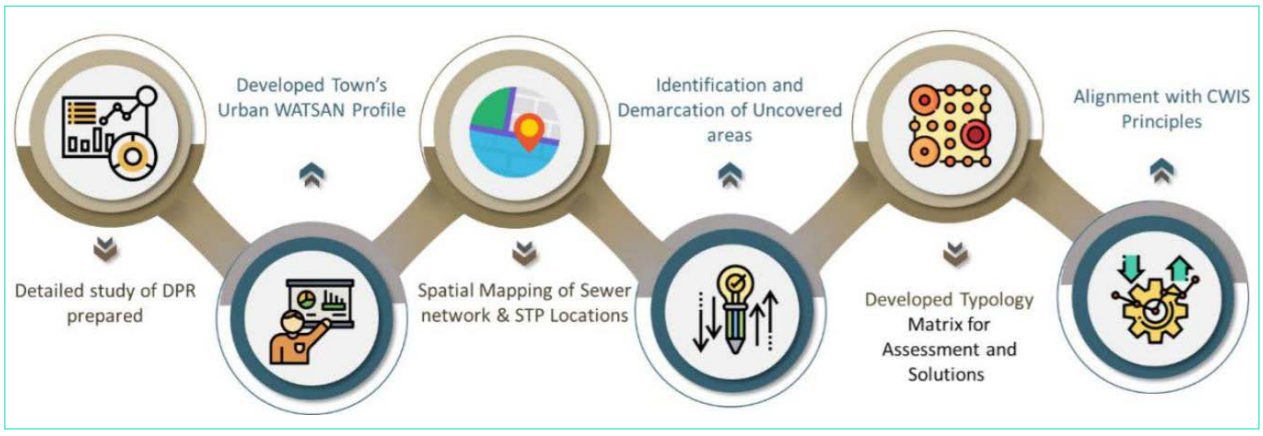
Figure 16: Step taken by Madhya Pradesh for mainstreaming CWIS



Source: Madhya Pradesh Urban Services Improvement Project, Asian Development Bank

The output of the projects are Improved Water Supply Infrastructure and Integrated stormwater and sewage infrastructure with Institutional strengthening and capacity development for sustainable services.

Figure 17 Steps of CWIS planning in Madhya Pradesh

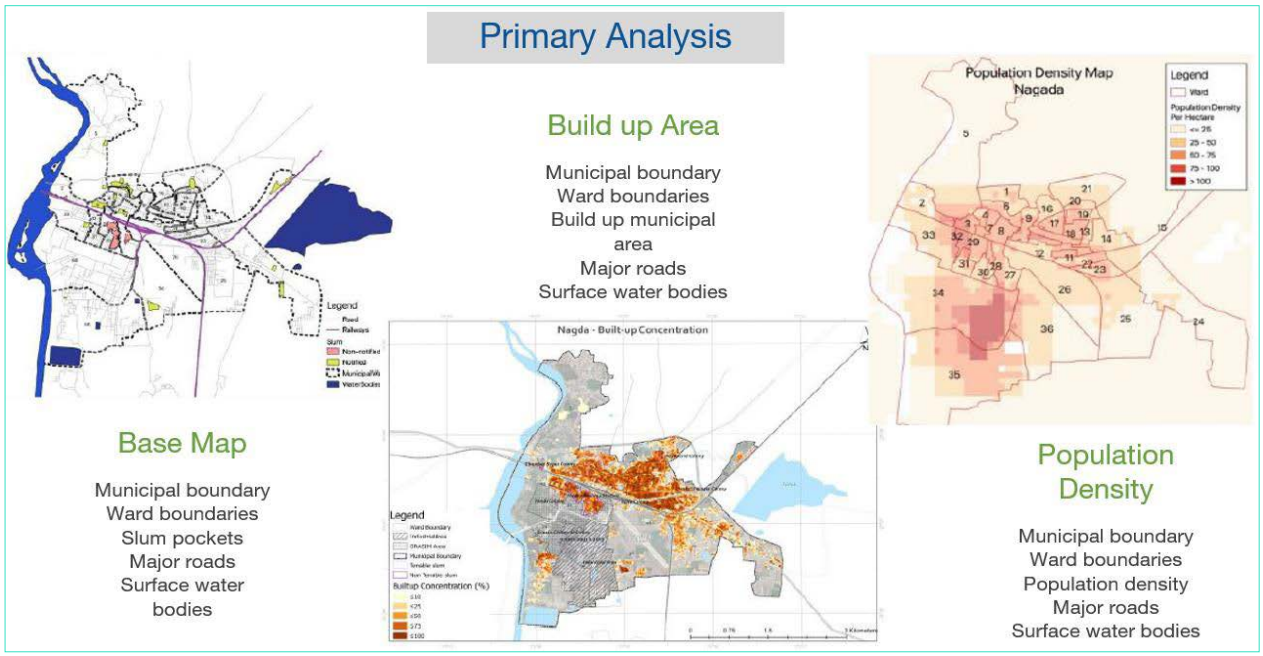


Source: Madhya Pradesh Urban Services Improvement Project, Asian Development Bank

A case study of Nagda City has been elaborated below:

Preparing a CWIS plan is a data driven process. Data is imported on a GIS platform for better visualisation of the information. A base map of the city is prepared showing key features important for the sanitation project. The build up areas and their attributes are marked on the base map and population density is analysed. The process and the its outputs are shown in the Figure 18.

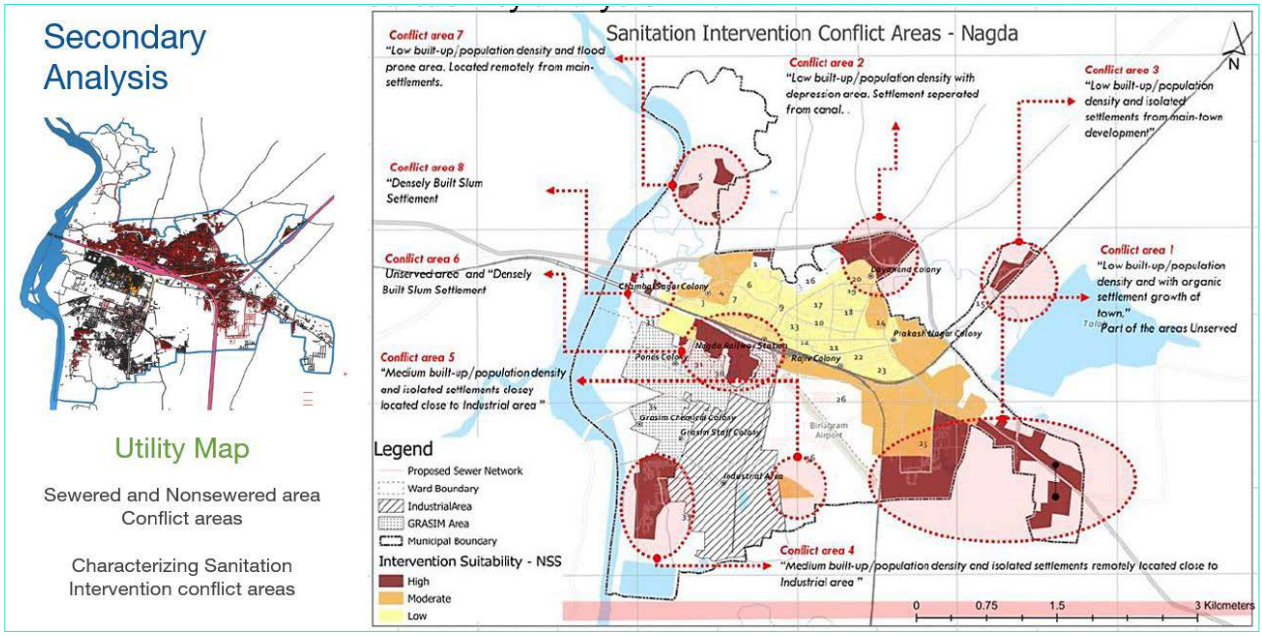
Figure 18: Evidence based planning of Nagda City, MP – Primary Analysis



Source: Madhya Pradesh Urban Services Improvement Project, Asian Development Bank

In the second stage of analysis, utility services are mapped on the city base map. This helps to identify the under served areas across the cities and related challenges. The challenges can be further analyzed by characterizing using certain parameters such as population density, terrain, socio economic level etc. Each case needs to be taken individually looked upon to understand the gaps and cause of gaps in the sanitation service chain.

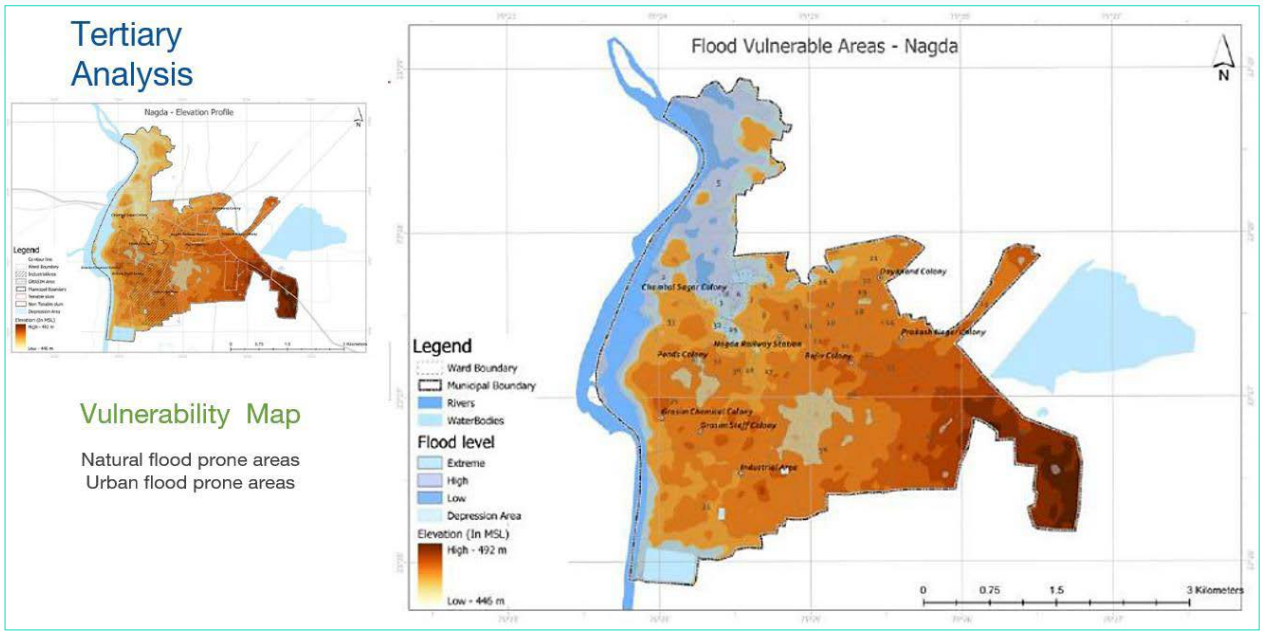
Figure 19: Evidence based planning of Nagda City, MP – Secondary Analysis



Source: Madhya Pradesh Urban Services Improvement Project, Asian Development Bank

In the third stage of analysis consist of vulnerability mapping. As shown in the Figure 20, few areas of the city are more vulnerable to natural flood and this will also affect the choice of sanitation solution. The risk associated with groundwater contamination in such areas due to soak pits and leaking containment units can be a major concern.

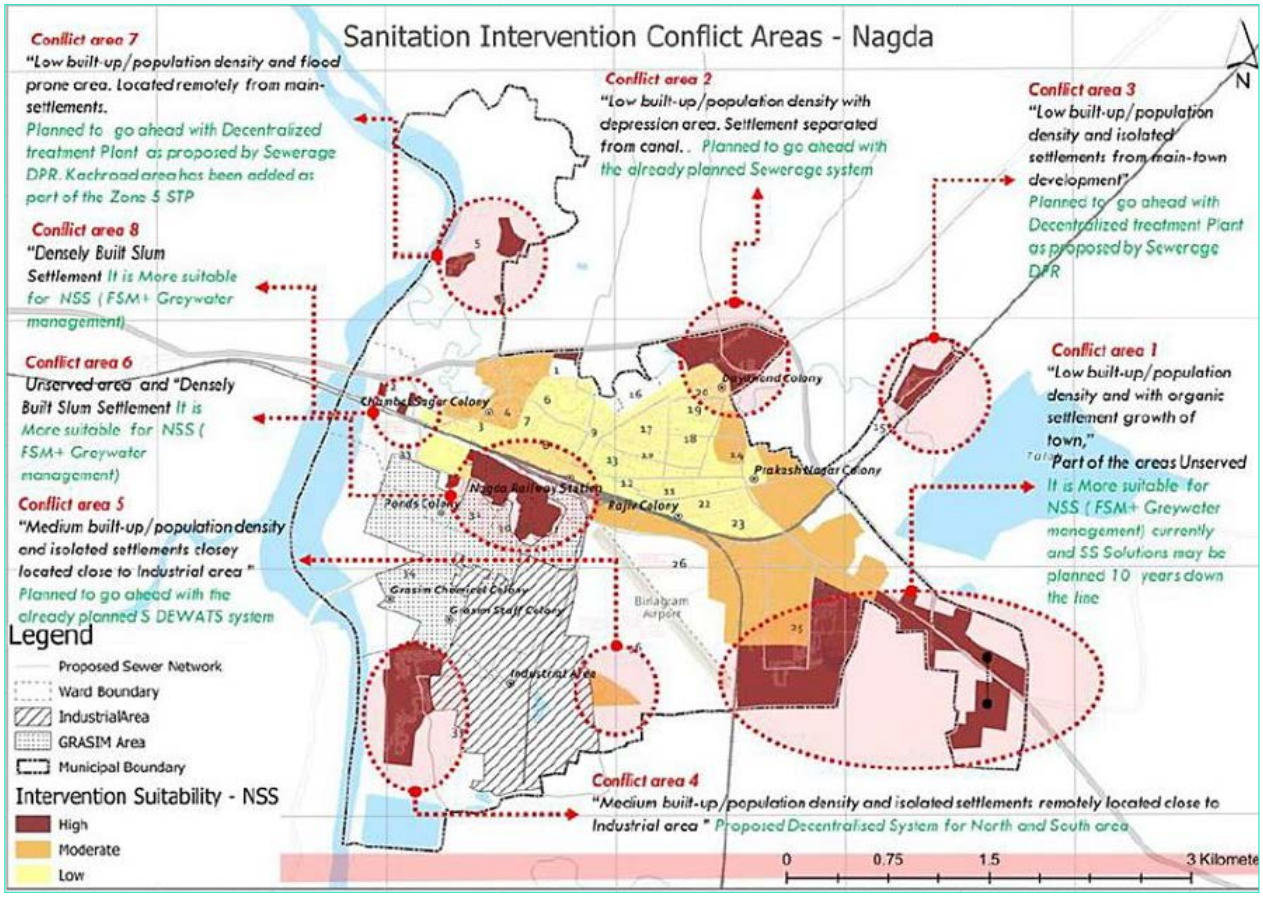
Figure 20: Evidence based planning of Nagda City, MP – Tertiary Analysis



Source: Madhya Pradesh Urban Services Improvement Project, Asian Development Bank

After completing the analysis, identifying appropriate sanitation solutions is done. For this, feasibility assessment is done for each area. Parameters used for characterizing the challenges are again used and given weightage here to identify the appropriate solution.

Figure 21: Evidence based planning of Nagda City, MP – Feasibility Assessment



Source: Madhya Pradesh Urban Services Improvement Project, Asian Development Bank

4.5 Notes for trainer

This session acts as a base for planning of city level FSSM planning with the cases studies of FSSM in India. Integrated Municipal Information System IMIS improves the sanitation system and the service delivery through improving the planning, management and monitoring – evaluation. IMIS also helps to catalyse CWIS by making the service accessible, equitable and affordable to masses.

4.6 Bibliography

Financing Faecal Sludge and Septage Management (FSSM) A landscape study of four Indian states, CWAS, CRDF, CEPT University, June 2019.

Integrated Municipal Information System by SNV Netherlands Development Organization, 2021

Madhya Pradesh Urban Services Improvement Project (April 2021) – Additional Financing Towards City-Wide Inclusive Sanitation Mainstreaming, Laxmi Sharma, Urban Development Specialist, Urban Development and Water Division, SARD (SAUW), Asian Development Bank.

4.7 Further Reading

Faecal Sludge and Septage Management in Maharashtra (September 2020), Center for Water and Sanitation (CWAS),

National Policy on Faecal Sludge and Septage Management (FSSM) by MoHUA, 2017

Primer on Faecal Sludge and Septage Management (2016), Ministry of Housing and Urban Affairs (MoHUA), Government of India.

Swachh Bharat Mission (Urban) 2.0 Guidelines (2021), Ministry of Housing and Urban Affairs (MoHUA)

Session

05

Faecal Sludge and Septage Management - An overview of key concepts

5. Faecal Sludge and Septage Management - An Overview of Key Concepts

5.1 Learning Objectives

- To understand the difference between wastewater, faecal sludge, and septage
- Understand types of sanitation systems, components of a sanitation system, and FSSM value chain
- Learn the different methods of quantifying faecal sludge and septage and types of desludging at a city level
- Gain knowledge about technical specifications to be followed in FSSM along the service chain

5.2 Session Plan

Duration – 45 minutes

Topics	Time	Material/Method
Difference between waste products	5 min	Powerpoint presentation
Sanitation systems	10 min	Powerpoint presentation
FSSM value chain	5 min	Powerpoint presentation
Quantification of FSS	5 min	Powerpoint presentation
Demand and scheduled desludging	5 min	Powerpoint presentation
Technical specifications for quality assurance in FSSM	10 min	Powerpoint presentation
Q&A	5 min	Discussion

5.3 Key facts

- Faecal sludge, septage and sewage are similar but not the same!
- Understanding ground challenges is key to planning FSSM.
- Quantification of faecal sludge and septage is tricky as the containment unit are not of standard dimensions and most of the cities follow demand desludging.
- Scheduled desludging helps in environmental sanitation however, is very challenging to operationalize in a city
- Maintaining quality assurance is key to improving sanitation service delivery such as desludging septic tanks.

5.4 Learning notes

5.4.1 Waste products and their characteristics

The urban water cycle is one of the key processes connecting human activity to natural systems. Therefore, the health and well-being of both human population and environment depends on the integration of urban water systems with the natural systems. The generation of liquid waste from human activities is unavoidable. However, not all humans produce the same amount of liquid waste. The type and amount of liquid waste generated in households are influenced by behaviour, lifestyle and standard of living of the population as well as by the governing technical and juridical framework.

The different sanitation systems generate the following products:

- Blackwater is the mixture of urine, feces and flushing water along with anal cleansing water (if anal cleansing is practiced) or dry-cleaning material (e.g., toilet paper)
- Greywater is used water generated through bathing, hand-washing, cooking or laundry. It is sometimes mixed or treated along with blackwater
- Urine is the liquid not mixed with any feces or water
- Brown water is blackwater without urine
- Excreta is the mixture of urine and feces not mixed with any flushing water (although small amounts of anal cleansing water may be included)
- Faecal sludge is the general term for the undigested or partially digested slurry or solid resulting from the storage or treatment of blackwater or excreta
- Septage is the term for the completely digested sludge collected from on-site sanitation systems such as septic tanks or ABR etc.
- Domestic wastewater comprises all sources of liquid household waste: Blackwater and greywater. However, it does not include stormwater
- Sewage sludge is the term for the sludge generated during aerobic treatment of domestic wastewater at the sewage treatment plant.
- Storm water in a community settlement is runoff from house roofs, paved areas and roads during rainfall events. It also includes water from the catchment of a stream or river upstream of a community settlement.

Characteristics of the waste are determined using following parameters:
The parameters used to characterize the FSS is same as that which are used for sewage and are stated below:

- Solid concentration (TS, TSS, TVS, VSS)
- Chemical Oxygen Demand (COD)
- Biological Oxygen Demand (BOD)
- Nutrients (TKN, NH3-N, Total P)
- Pathogens (Faecal coliform, Helminth eggs)
- Metals

Solids: All the contaminants of water, with the exception of dissolved gases, contribute to the solids load. In wastewater treatment, the solids can be classified according to: (a) their size and state, (b) their chemical characteristics and (c) their settleability.

The division of solids by size is above all, a practical division. The particles of smaller dimensions capable of passing through a filter paper of a specific size correspond to the dissolved solids, while those with larger dimensions and retained by the filter are considered suspended solids. If the solids are submitted to a high temperature (550^0C), the organic fraction is oxidised (volatilised), leaving after combustion only the inert fraction (unoxidized). The volatile solids represent an estimate of the organic matter in the solids, while the non-volatile solids (fixed) represent the inorganic or mineral matter.

Settleable solids are considered those that are able to settle in a period of one hour. The volume of solids accumulated in the bottom of a recipient called an Imhoff Cone is measured and expressed as mL/L. The fraction that does not settle represents the non-settleable solids.

Organic Constituents: The organic matter present in sewage is a characteristic of substantial importance, being the cause of one of the main water pollution problems: consumption of dissolved oxygen by the microorganisms in their metabolic processes of using and stabilising the organic matter. The organic substances present in sewage consist mainly of protein compounds, carbohydrates, oils and grease and urea, surfactants, phenols, pesticides etc.

BOD- The main ecological effect of organic pollution in a water body is the decrease in the level of dissolved oxygen. Similarly, in sewage treatment using aerobic processes, the adequate supply of oxygen is essential so that the metabolic processes of the microorganisms can lead to the stabilisation of the organic matter. The BOD represents the quantity of oxygen required to stabilise, through biochemical processes, the carbonaceous organic matter.

COD- The COD measures the consumption of oxygen occurring as a result of the chemical oxidation of the organic matter. The COD/BOD^5 ratio also varies as the wastewater passes along the various units of the treatment works.

Nutrients

Nitrogen- Nitrogen is an essential nutrient for algae growth, under certain conditions, to the phenomenon of eutrophication of lakes and reservoirs. It is an essential nutrient for the microorganisms responsible for sewage treatment. The determination of the prevailing form of nitrogen in a water body can provide indications about the stage of pollution caused by an upstream discharge of sewage. If the pollution is recent, nitrogen is basically in the form of organic nitrogen or ammonia and, if not recent, in the form of nitrate (nitrite concentrations are normally low).

- Total Kjeldahl Nitrogen = Ammonia + organic nitrogen (prevailing form in domestic sewage)

- TN = TKN + NO^2 - + NO^3 - (total nitrogen)

Phosphorus- Total phosphorus in domestic sewage is present in the form of phosphates. Phosphorus is an essential nutrient for the growth of the microorganisms responsible for the stabilisation of organic matter. Usually, domestic sewage has sufficient levels of phosphorus, but a lack may occur in some industrial wastewaters. It is an essential nutrient for the growth of algae, eventually leading, under certain conditions, to the eutrophication of lakes and reservoirs.

Pathogens

The biological quality of a water or wastewater is that related to the disease transmission by pathogenic organisms. The major groups of pathogenic organisms are bacteria, viruses, protozoans and helminths. The indicators of faecal contamination are total coliforms & faecal coliforms.

The group of total coliforms constitutes a large group of bacteria that have been isolated in water samples and in polluted and non-polluted soils and plants, as well as from feces from humans and other warm-blooded animals. The total coliforms could be understood in a simplified way as “environmental” coliforms, given their possible occurrence in non-contaminated water and soils, thus representing other free-living organisms, and not only the intestinal ones. For this reason, total coliforms should not be used as indicators of faecal contamination in surface waters. However, in the specific case of potable water supply, it is expected that treated water should not contain total coliforms. These, if found, could suggest inadequate treatment, post contamination or excess of nutrients in the treated water.

Faecal coliforms are a group of bacteria predominantly originated from the intestinal tract of humans and other animals. Escherichia coli is the main bacterium of the faecal coliform group, being present in large numbers in the feces from humans and animals. It is found in wastewater, treated effluents and natural waters and soils.

pH

The acidity or alkalinity of wastewater affects both treatment and the environment. Low pH indicates increasing acidity, while a high pH indicates increasing alkalinity (a pH of 7 is neutral). The pH of wastewater needs to remain between 6 and 9 to protect organisms. Acids and other substances that alter pH can inactivate treatment processes when they enter wastewater from industrial or commercial sources. Wastewater with an extreme concentration of hydrogen ions is difficult to treat biologically. If the concentration is not altered before discharge, the wastewater effluent may alter the concentration in natural waters, which could have negative effects on the ecosystem. Alkalinity in wastewater results from the presence of calcium, magnesium, sodium, potassium, carbonates and bicarbonates, and ammonia hydroxides. Alkalinity in wastewater buffers (controls) changes in pH caused by the addition of acids. Wastewater usually is alkaline due to the presence of groundwater (which has high concentrations of naturally occurring minerals) and domestic chemicals. The alkalinity of wastewater is essential where chemical and biological treatment is practiced, in biological nutrient removal and where ammonia is removed by air stripping.

Electric conductivity

The measured EC value is used as a surrogate measure of total dissolved solids (TDS) concentration. The salinity (i.e., saltiness) of treated wastewater used for irrigation is also determined by measuring its electric conductivity.

Temperature

The wastewater temperature is commonly higher than that of local water supplies. Temperature affects chemical reactions, reaction rates, aquatic life, and the suitability for beneficial uses. Furthermore, oxygen is less soluble in warm than in cold water.

Table 6: Comparison between septage and sewage

Parameter	Septage	Sewage	Ratio of Septage to Sewage
TS	40,000	720	55:1
TVS	25,000	365	68:1
TSS	15,000	220	68:1
VSS	10,000	165	61:1
BOD5	7,000	220	32:1
COD	15,000	500	30:1
TKN	700	40	17:1
NH3-N	150	25	6:1
Total P	250	8	31:1
Grease	8,000	100	80:1

Source: Handbook on Septage Treatment and Disposal, US EPA

FSS is highly concentrated in all parameters when compared to sewage. It has been reported that in some parameters, it is up to 68 times more concentrated than sewage. FSS is stronger than the sewage sludge formed at STP and its characteristics is still different. However, the treatment mechanisms used to manage sewage sludge can be tweaked and used for management of FSS.

Comparison of sludge characteristics and characterization ratios

The characterization ratios are important and convey a lot about the constituent of liquid waste and their interdependence. The following table represents characterization ratios for sludge obtained from containment units linked to public toilet, septic tank of household and medium strength wastewater.

Table 7: Characterization ratios of faecal sludge, septage and sewage

Ratio (gm/gm)	Public Toilets	Septage Tanks	Medium Strength Wastewater
VSS:TSS	0.65-0.68	0.50-0.73	0.60-0.80
COD:BOD5	5.0	1.43-3.0	2.0-2.5
COD:TKN	0.10	1.2-7.8	8-12
BOD5:TKN	2.2	0.84-2.6	4-6
COD:TP	109	8.0-52	35-45
BOD5 :TP	17	5.6-17.3	15-20

(Source: Strande L. et Al. (2014) Faecal Sludge Management).

The slowly biodegradable COD content in faecal sludge is much higher than septage. Hence in order to stabilise the faecal sludge, anaerobic digestion with more retention time is required. Septage has significantly higher amount of particulate non-biodegradable COD. This means septage does not need much stabilisation and COD reduction in septage can be achieved by simply removing the suspended solids from the liquid fraction.

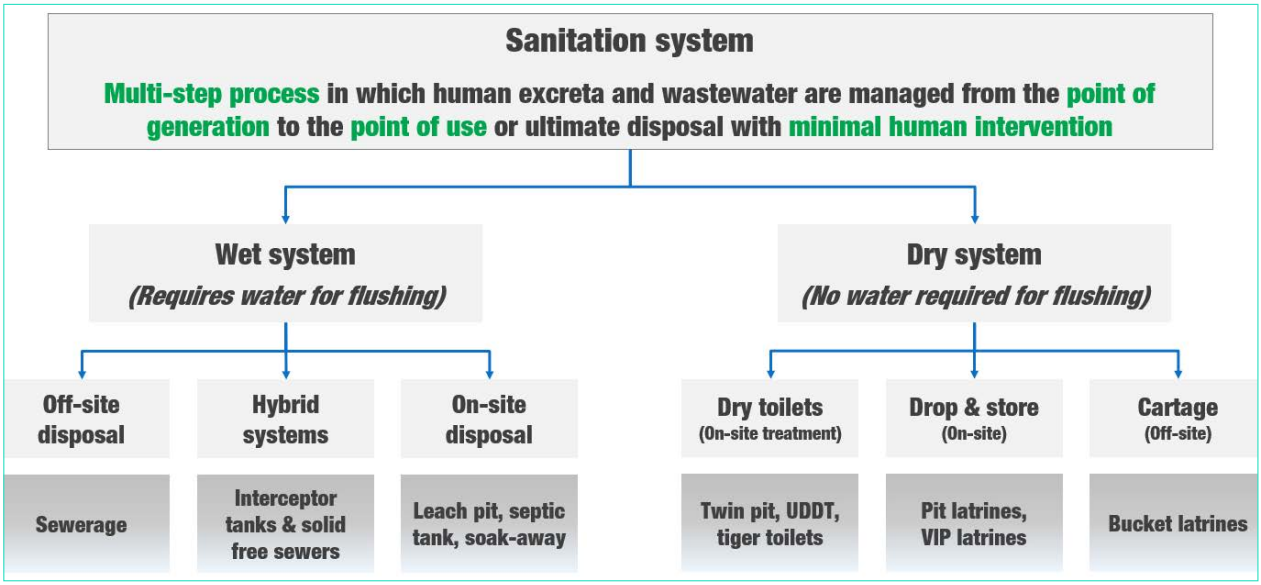
5.4.2 Sanitation System Approach and FSSM value chain

Sanitation system is a multi-step process in which human excreta and wastewater are managed from the point of generation to the point of use or ultimate disposal with minimal human intervention. It is important to understand that sanitation can act at different levels, protecting the household, the community and society. In the case of twin pit toilet, it is easy to see that this sanitation system acts at a household level. However, poor design or inappropriate location may lead to migration of waste matter and contamination of local water supplies putting the community at risk. Further down effects of waterborne sewage contamination affect the entire society by ill health and environmental damage.

Objectives of the sanitation systems

- Safe sanitation systems should keep disease-carrying waste and insects away from people, both at the site of the toilet, in nearby homes and in the neighboring environment.
- It should avoid air, soil, water pollution, return nutrients/resources to the soil, and conserve water and energy.
- The system must be operational with locally available resources (human and material). Where technical skills are limited, simple technologies should be favored.
- Total costs (including capital, operational, maintenance costs) must be within the users' ability to pay.
- It should be adapted to local customs, beliefs and desires.
- It should address the health needs of children, adults, men, and women.

Figure 22: Classification of sanitation system



Sanitation systems can be classified mainly as water-based (Wet) & water-less system (Dry) Depending on the use of water for practicing hygiene activities, sanitation systems can be classified as dry and wet sanitation systems. In developing countries such as India, wet sanitation systems are prevalent. These wet sanitation systems can be further classified into Sewered Sanitation and Non Sewered Sanitation as shown in the figure below. It is interesting to know that India is not practicing true non sewered sanitation in most of the cities.

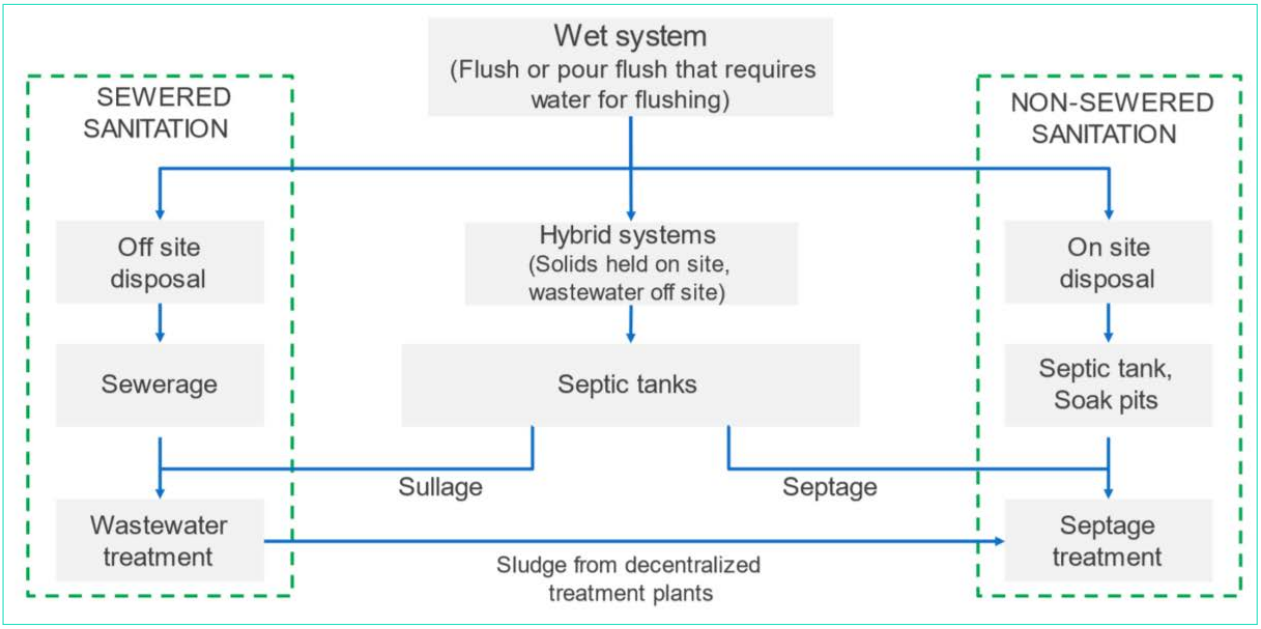
Wet Sanitation System

In the urban centres of developing countries, the use of flush toilets and water borne systems are used due to availability of the water. Water is used to transport the waste from one point to another. These systems are called wet systems. The wet systems can be classified into two types depending on where the treatment of waste is done. In case of “Off Site” disposal, the waste is carried away from the point of generation using water. The sewerage network brings the waste from all the households to a wastewater treatment plant. This type of system is called as sewered sanitation.

In the case of “On Site” disposal, the solids are stored in the containment unit and the liquid effluent is disposed into the ground using soak pits or soak away. After a duration of a few years, the contents of the containment unit are emptied and transported for further treatment. Since this conveyance of solids is done by mechanised equipment such as vacuum trucks and not by a pipe network, this type of sanitation system is called as non sewered sanitation. However, in India, we have developed a hybrid system where in the solids are contained in the septic tank at the household level and the sullage is disposed into the drains outside the houses.

The network of drains thus collects the sullage from all the households and by gravity brings it to the surface water body such as rivers, lakes and ponds. The septage from the septic tank is emptied after few years and transported by vacuum trucks for either treatment or direct disposal. This system cannot be classified as completely sewered or non sewered sanitation system and thus is referred to as hybrid sanitation system.

Figure 23: Wet sanitation system and its types



Sanitation System Components

A sanitation system should consider all the products generated and all the functional groups to which these products are subjected before being suitably disposed of. Domestic products mainly run through five different functional groups, which form together a system. Note: Depending on the system, not every functional group is required. A functional group is a grouping of technologies that have similar functions. There are five different functional groups from which technologies can be chosen to build a system.

A functional group is a grouping of technologies that have similar functions. There are five different functional groups from which technologies can be chosen to build a system.

A. User Interface

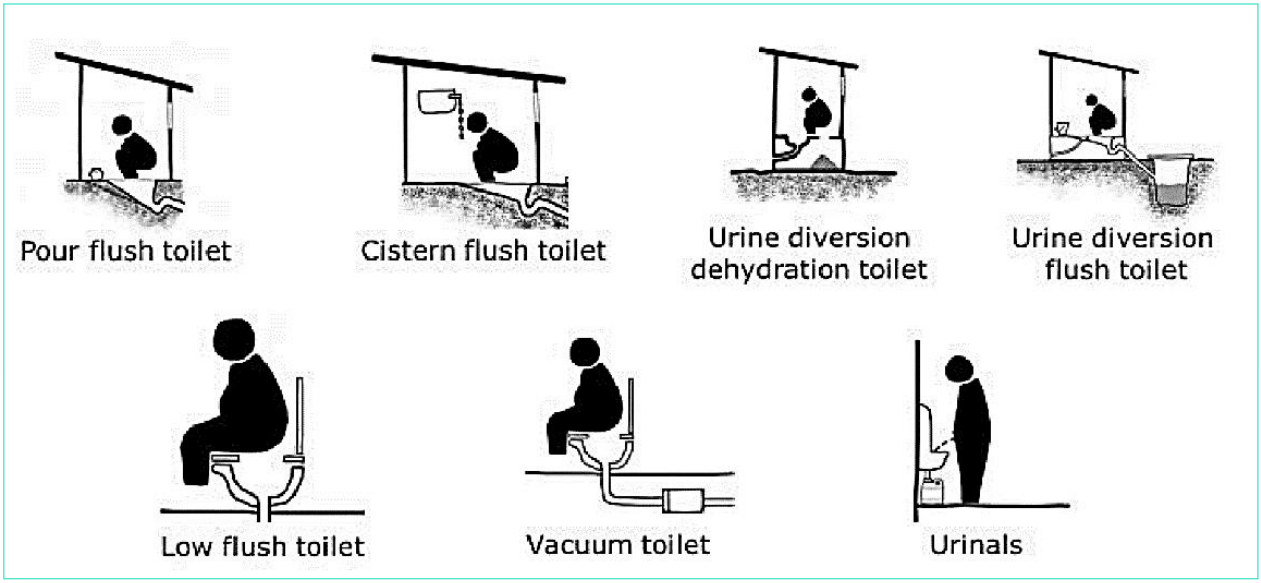
Describes the way the type of toilet, pedestal, pan, or urinal with which the user comes in contact; it is the way by which the user accesses the sanitation system. In many cases, the choice of user interface will depend on the availability of water. Note that Greywater and Storm water do not originate at the user interface but may be treated along with the products that originate from it.

The user interface must guarantee that human excreta is hygienically separated from human contact to prevent exposure to faecal contamination. The user interface is the way in which the sanitation system is accessed. Choice of the user interface significantly impacts the entire system design, as it defines the products or product mixtures fed into the system. Therefore, the user interface strongly influences the technological choices of subsequent processes.

Selection of user interface depends on the following five technical and physical criteria:

- Availability of space
- Ground condition
- Groundwater level and contamination
- Water availability
- Climate

Figure 24: User Interface Options



Source: SSWM toolbox

B. Collection and Storage/Treatment

Describes the ways of collecting, storing, and sometimes treating the products that are generated at the user interface. Treatment provided by these technologies is often a function of storage and usually passive (e.g., no energy inputs). Thus, products that are 'treated' by these technologies often require subsequent treatment before Use and/or Disposal.

This section explains how the output products of a user interface can be collected, stored, and treated on-site. The functional group Collection and Storage/Treatment describes the ways of receiving, storing, and sometimes treating the products generated at the user interface. The treatment provided by these technologies is often the function of storage, and is usually passive, without requiring energy input.

Products that emanate from these technologies often require subsequent treatment before use or disposal. There's quite a wide range of technologies which belong to this functional group. The technical and physical criteria for choosing appropriate collection, storage and treatment technology are as follows:

- Ground condition (Soil and strata (percolation and cost of construction)
- Groundwater level and contamination (cross contamination (pathogens))
- Climate-Temperature (degree of treatment) and rainfall (percolation rate)

C. Conveyance

Describes the transport of products from one functional group to another. Although products may need to be transferred in various ways between functional groups, the longest, and the most critical gap is between user interface or collection and storage/treatment and (semi-) centralized treatment. Therefore, for the sake of simplicity, conveyance only describes the technologies used to transport products between these functional groups.

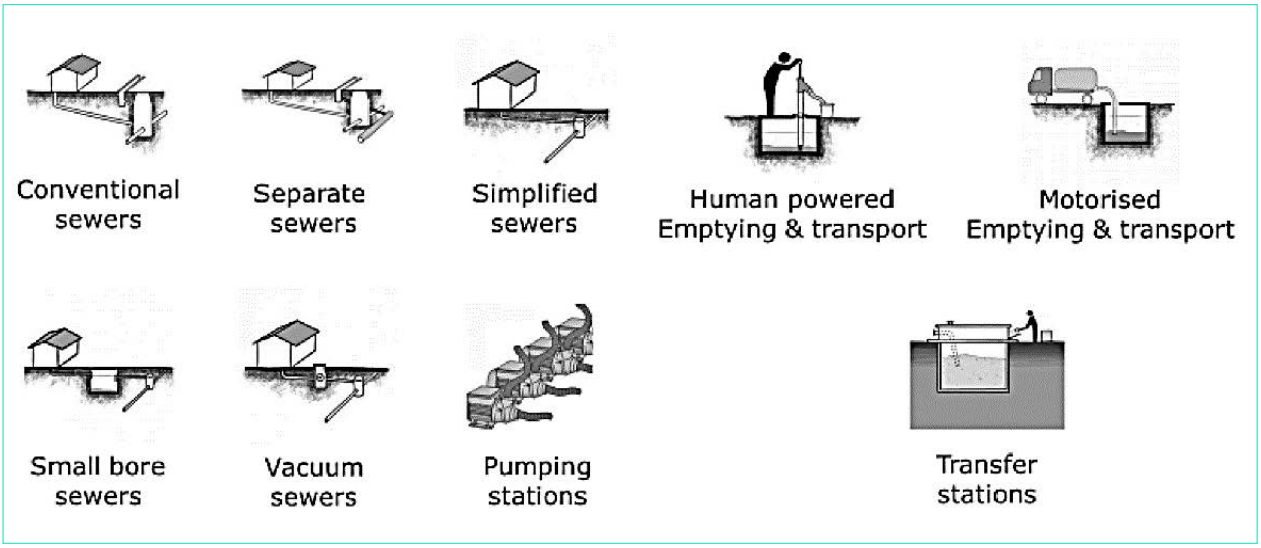
If waste products cannot be safely disposed of or even suitably reused on site, they have to be transported elsewhere. Conveyance describes how products are moved from one process to

another. Although products may need to be moved in various ways to reach the required process, the longest and most important gap lie between on-site storage and (semi-) centralised treatment.

The technical and physical criteria for choosing appropriate conveyance technology/system are as follows:

- Water availability,
- Ground condition,
- Ground water level and contamination.

Figure 25: Conveyance systems in sanitation



Source: SSWM tool box

D. Treatment

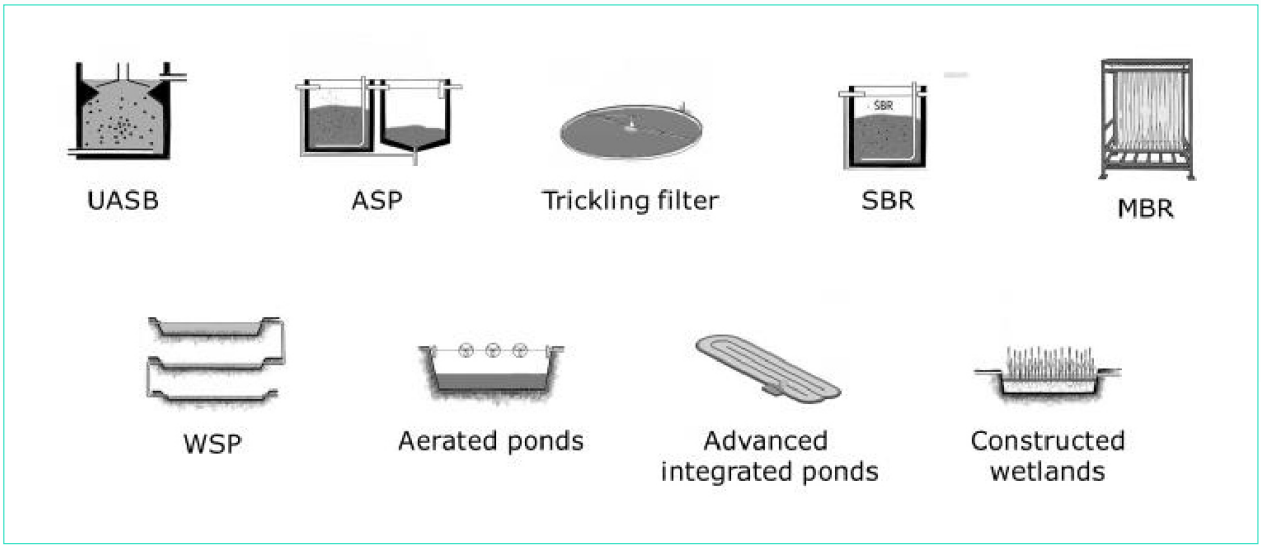
Treatment refers to treatment technologies appropriate for large user groups (i.e., neighbourhood to city level applications). The operation, maintenance, and energy requirements of technologies within this functional group are generally higher than for smaller- scale technologies. The technologies are divided into 2 groups: the first groups are primarily for the treatment of Blackwater, brown water, greywater or effluent (e.g., biogas settlers, ABRs, WSPs, constructed wetlands, whereas the second group (e.g., planted or unplanted drying beds, composting, anaerobic digestion) are mainly for the treatment of sludge.

Compared to household-centred storage technologies, the centralised treatment technologies are designed to accommodate increased volumes of flow and provide, in most cases, improved removal of nutrients, organics and pathogens. Centralised treatment refers to the treatment systems which, unlike those used on-site, are larger, require a greater inflow (that can usually not be met by just one family) and often more skilled operation.

The technical and physical criteria for choosing the appropriate technology for treatment are as follows:

- Availability of space and other resources (Choice of technology)
- Climate (Temperature affects rate of reactions)
- Ground condition (Flood-prone area)
- Groundwater level and contamination (Cross contamination from tanks underground)

Figure 26: Technologies for semi-centralized treatment



Source: SSWM tool box

E. Use and/or Disposal

Use and/or disposal refers to the ways in which products are ultimately returned to the soil, either as harmless substances or useful resources. Furthermore, products can also be reintroduced into the system as new products. A typical example is the use of partially treated greywater used for toilet flushing.

It can be done in following ways:

Agriculture: The dried faecal matter is used as soil conditioner in agriculture. The soil conditioner improves the soil's texture and helps increase the moisture retention capacity of the soil. The sterile urine after disinfection is used as fertilizer in the agriculture. Urine as a liquid fertilizer contains high number of nitrates and phosphates which can reduce the consumption of inorganic fertilizers.

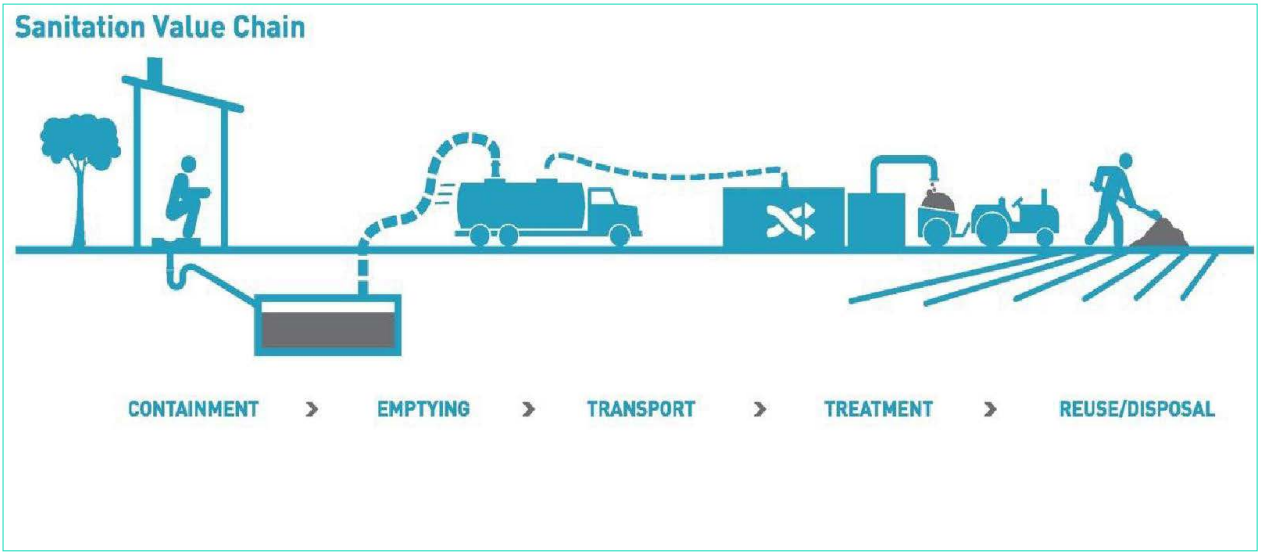
Aquaculture: The term aquaculture refers to the controlled cultivation of aquatic plants and animals by making use of various types of wastewaters as a source for nutrients and/or warm temperatures for plants and fish to grow. Fish can be grown in ponds that receive effluent or sludge where they can feed on algae and other organisms that grow in the nutrient-rich water. The fish, thereby, remove the nutrients from the wastewater and are eventually harvested for consumption. You can also read the description of plant aquacultures.

Recharge or disposal: This can be done is several ways. The most common way is to have a leach field or soak pit. However, there are ways like soil aquifer treatment and short crop rotation are popular in other countries and utilize the treated wastewater in the most sophisticated way.

Energy products from sludge: The sludge can be processed to make solid or liquid fuel depending on treatment process used. The biogas generated through anaerobic digestion can be directly used as liquid fuel or alternatively converted into electricity. Dried sludge can also be used as solid fuel in furnaces or brick kiln due to its high calorific value.

It is imperative to look at the sanitation market as a value chain where value can be added at each stage. It will, therefore, develop technologies, systems and services which accomplish this at each section of the chain, as shown in the picture below:

Figure 27: Sanitation Value Chain



Source: BMGF, 2017

All technologies, ideas and knowledge have been delineated with regard the sanitation value chain. The links in this chain are:

Containment: Any type of latrine or tank which is used to capture and store faecal sludge;

Emptying: Any type of device used to empty storage devices;

Transport: Physically moving the sludge from the storage device to the treatment plant;

Treatment: Treating sludge so that it is safe to dispose of or, ideally, reused;

Reuse: Regaining value from the sludge by making it's nutritional or calorific content available for agriculture, energy, etc.

The Sanitation value chain provides a useful method to divide different technologies into their useful functions and identify the type of partners that may be required. For instance, technology in the 'capture and storage' stage will require partners with construction expertise; whereas a technology in the 'treatment' phase will require partners with bio-chemical processing expertise.

5.4.3 Challenges in FSSM

FSSM is needed to manage the liquid waste originating from the human waste in a better and safe way so as to eliminate faecal oral transmission of diseases. Following are the reasons, why the ULBs need to focus on FSSM.

Figure 28: Need of FSSM

Insufficient infrastructure

There is a challenge with respect to sanitation infrastructure in India. Sanitation infrastructure does not pose a challenge only in the form of lack of sewerage network lines, but also in the case of emptying of septic tank and treatment of effluent let out by them. Achieving SBM objective, there is a need for conveyance facilities for emptying the septic tank, which currently be catered through illegal manual scavenging or the use of vacuum tankers. There is a need of treatment systems and proposal disposal management.

Regulations

The legislative framework in India has adequate provisions at the national-, state- and city-level to protect water and environment. Public health and sanitation are a part of the 'constitutional responsibility' of the municipalities under the 12th schedule of the Constitution (74th Amendment, 1992). Legislative and regulatory provisions for septage management. Municipal acts and regulations normally refer to management of solid and liquid waste, but do not provide detailed rules for septage management. Inadequacy in the implementation and enforcement of regulations worsens the problem. We need a better regulatory framework focused on septage management as well as more robust implementation. In February 2017, MoHUA issued the National FSSM Policy. The policy aims to set the context, priorities, and direction for, and to facilitate nationwide implementation of, FSSM services in all ULBs such that safe and sustainable sanitation becomes a reality for all in each and every household, street, town and city in India

Resource recovery

In India, faecal sludge is still considered a social taboo and practices of resource recovery are minimal. Resource recovery is an important aspect in septage management if we can look it as a wealth. It can be seen as a resource containing nutrients such as nitrogen and phosphorus and, in some cases, varying amounts of micro-nutrients such as boron, copper, iron, manganese, molybdenum and zinc. Urine contains 90% nitrogen, 50-60% phosphorus and 50-80% potassium, which are very valuable in agricultural applications. Septage can reduce reliance on chemical fertilizers and in combination with them, it can meet the requirements of nutrients for crop production. In some experiments, septage has also been used to generate energy through biogas systems and bio-methanization process. The methane thus produced can be used as fuel for cooking or for generation of electricity.

Health and environment implications

Septage contains elements that may produce bad odour, risk public health and create serious environmental hazards. Since septage is highly concentrated, discharging it into a water body may cause immediate depletion of dissolved oxygen and increase nutrients levels in the water, leading to eutrophication and increase in the number of pathogens, thus creating risk of health hazards. Knowledge of septage characteristics and variability are important in determining acceptable disposal methods. There is a direct discharge of collected septage by the private operators into drains, waterways, open land and agricultural fields, which in turn poses a larger threat to the environment and health.

Table 8: Challenges in FSSM

Components of value chain	Challenges
User Interface	• Availability of the space to construct sanitation facilities • Affordability of the construction cost • Non-availability or limited access of water, electricity • Less operation and maintenance of the sanitation facilities • Quality of the material used for the construction of the sanitation facilities
Collection	• Access for the on-site systems, congested locations for the movement of desludging trucks • No provisions for secondary effluent disposal units in the form of piped sewer network, leach pits or drain fields, thus directly discharging septic effluent into drains. • Most of the septic tanks present are not constructed as per the standard specifications, leading to varying sizes, partial lining, frequent failures, leakages/contamination of water bodies or soil etc
Conveyance	• Most households only call for septic tank cleaning services when the tank is overflowing or on the verge. The frequency of desludging typically varies from 5 - 10 years due to irregular sizes and usage pattern, which far exceeds the prescribed interval of 2-3 years as recommended by CPHEEO Manual, MoHUA's Advisory on Septage management (2013) • Unsafe handling of faecal sludge by the private operators • Desludging operators and Service providers are not properly trained and do not use safety equipment during operations
Treatment	• Requirement of scientific treatment facilities
Disposal	• Private operators practice the direct discharge of desludged faecal sludge/septage in the open drains, open land, SWM landfill sites etc.

5.4.4 Quantification of faecal sludge and septage

Why is quantification necessary?

Quantification is necessary for estimating the number of equipment required to provide the service of emptying septic tanks and transporting the sludge to a treatment facility. It is required to estimate the equipment required to co treat the septage at STP or to define the capacity of the independent treatment facility. Quantification becomes of utmost importance when financial viability of operationalizing FSSM in a town needs to be understood.

To start with quantification of FSS to be managed, the ULB needs to decide the type of desludging to be practiced. There are two types of desludging practices- (1) on demand desludging and (2) scheduled desludging.

Methods of quantification

Sludge production method

Sludge production method is useful in case of scheduled desludging. This method is based on the number of people and the standard sludge production rate. This is similar to estimating the wastewater production where 80% of the water utilized by the person is taken as quantity of wastewater produced. According to the IS 2470 Code of practice for Installation of Septic Tanks (part 1: Design criteria and construction) 1985, volume of digested sludge in the septic tank is given as 0.00021 m3/cap/d. The US EPA handbook on Technology Transfer for Septage Treatment and Disposal mentions the average per capita septage generation as 230 L/cap/d. It has also been mentioned that his number is highly variable and will change depending on a number of factors.

Sludge collection method

The sludge collection method needs to be adopted for quantification of FSS in case of demand desludging. In most of the cases of Indian cities, not all the waste which is generated at the household level is usually collected, be it solid of liquid. Hence, sludge collection method is much more reliable estimate of quantification of FSS in a city. In this method structured interviews need to be conducted with important stakeholders such as desludging operators, ULB official such as sanitary inspectors and households. Depending upon the responses and statistical analysis of the data collected, inferences are drawn to arrive at the quantity of FSS to be managed in a city.

Criteria and considerations for quantification

Seasonal and monthly variations need to be taken into account while quantification. Especially in cities that experience inflow of floating population (due to pilgrimage or tourism) on an annual basis need to consider the variation and peaking factor. Peaking factor is necessary to calculate the peak load which the treatment facility might have to handle in a month. The peaking factor in case of FSS can range from 1.5 to 4.

Challenges faced

The quantity of the septage collected also depends on availability of discharge locations or demand of septage among farmers. If there are multiple discharge points available, then operators will not have to turn down the request of the septic tank desludging. The collection might also change depending upon the desludging fees. A large informal sector exists in emptying of septic tanks which goes unmonitored. Not all the collected septage reaches at the designated discharge point for treatment. In absence of proper monitoring, the FSTP might still receive less septage because of indiscriminate disposal.

5.4.5 Demand and scheduled desludging

Demand based desludging

Demand based desludging refers to a model wherein the HHs calls the ULB or the private operator to desludge the septage once the septic tank is full and overflowing. This is essentially a complaint redressal system. Currently, demand-based desludging is prevalent in most of the cities in India. Since this is a market-driven model, the prices per trip for septic tank desludging is quite high. If the city wants to adopt/continue with demand-based desludging, it should be regulated heavily. HHs should be made aware to desludge their tanks periodically and regulations should be made and followed for the same.

Schedule based desludging

Schedule based desludging refers to scheduled/planned emptying of septic tanks or other containment systems at an interval of 2-3 years as recommended by CPHEEO Sewerage & Sewage Treatment Manual and the MoHUA Advisory on Septage Management (2013). In this, a septage conveyance plan or a schedule is drafted. For any plan to be effective, robust data on volumes and locations is required. The ULBs should collect baseline data on the type of sanitation systems connected to toilets, effluent disposal system, size and age of collection systems, when they were last cleaned and most importantly, their access, to plan for workable desludging schedules. It is advisable to divide the city into working zones for the same. Pilot desludging schedules can be implemented to learn operational issues and devise solutions, before scaling up to the whole ULB. While formulating zones, availability of septage disposal and treatment site/ existing STPs and their distance from the zone should be taken into consideration.

It is recommended that households in the demarcated septage management zone should be within 30 km travel distance from identified disposal sites for workability (Advisory Note on Septage Management in Urban India, 2013). Prior to this planning, the ULB shall first assess its role and capacity for implementation of the septage management plan. ULB should assess various aspects of septic tank emptying like how many septic tanks are required to be emptied annually as per CPHEEO norm versus how many are emptied in a year, how many vacuum emptying trucks/ capacity of trucks are required if number of septic tanks emptied as per CPHEEO norms versus how many trucks are available/working with capacities of emptier trucks, assessing the cost per emptying visit, method of maintaining the register for septic tank emptying services database etc. (Guidelines for Septage Management in Maharashtra, 2016).

Table 9: Scheduled and demand-based desludging

Scheduled Desludging	Demand Desludging
• Services at the predefined regular schedule (generally 3-5 years) as determined by the city. • City divided into zones for desludging. • Works as a public service model. • Service either by ULB or registered private sector. • Charges can either be taken through user charges or sanitation tax (can be levied if desludging provided as a service to the citizens).	• Services upon request i.e., demand based • Works as a complaint redressal model • Service by ULB (depending on capacity) or private sector depending (may or may not be licensed) and user charges are taken from households.
Pros: • Pro-active system wherein desludging is offered as a public service to the HHs. • Services are offered to all HHs in the city thereby comparatively more equitable. • More cost-effective due to efficiency gains and optimal business structure. • Comparatively more affordable to HHs since charges to be paid every year are low. • Positive implications on the health of the community and environment over a period of time.	Pros: • HHs decide when to avail to desludging services.

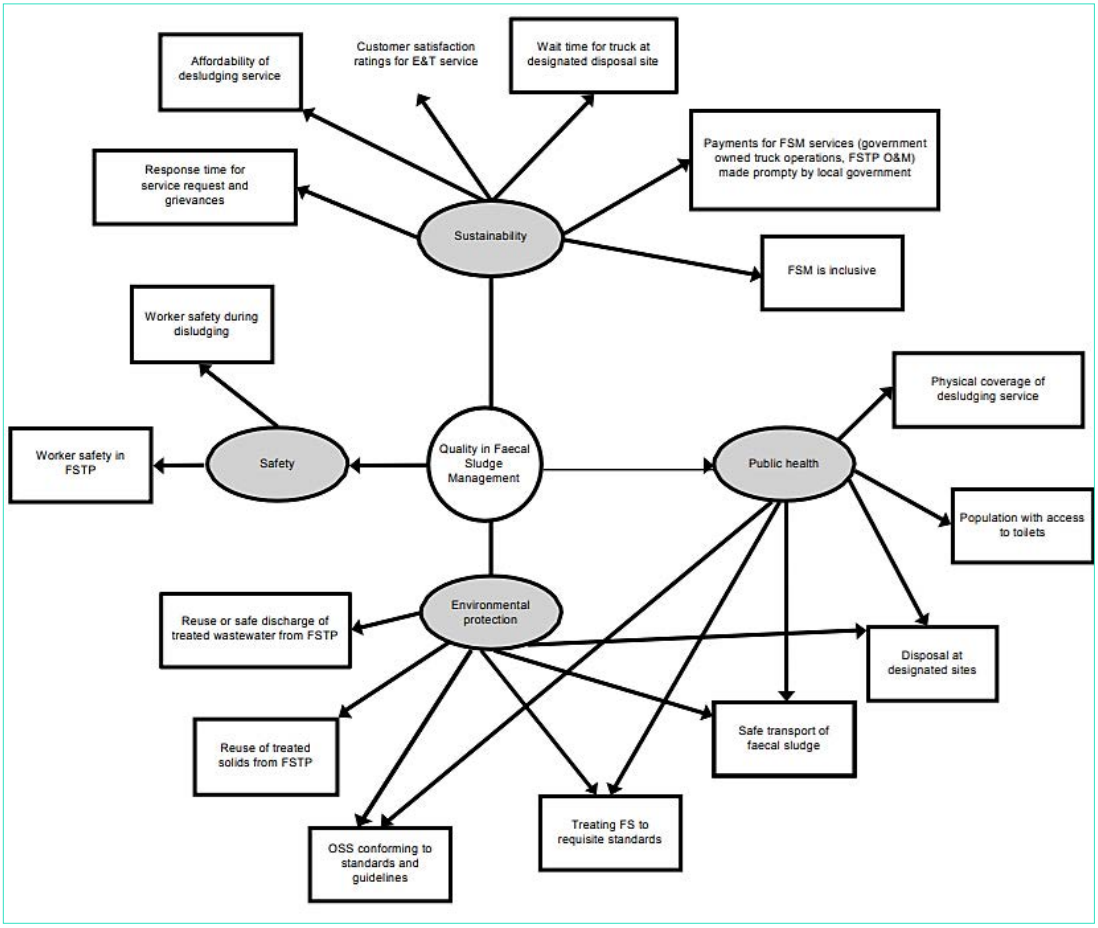
Cons: • Participation by HHs and their willingness to desludge every 3-5 years which may need extensive IEC activities. • Comparatively more infrastructure requirement.	Cons: • Very low desludging frequency by HHs. • No control over desludging charges. Can vary substantially with generally high prices per trip. • Need strict monitoring so that septage is disposed at the designated site and not in any other area in and around the city. • Low efficiencies of septic tanks with poor quality effluent overflow being released in rivers/water bodies causing negative environmental impact

5.4.6 Quality Assurance in FSSM

To ensure quality in scaling up of FSSM across India, indicators on quality and benchmarks for expected service levels need to be defined for all the components of the sanitation value chain. The quality of an FSSM system is defined (Figure 29) based on the following four objectives:

- Public health
- Environmental protection
- Safety
- Sustainability

Figure 29: FSSM Quality Indicators



Source - Background Note to Quality in Faecal Sludge Management, WASH Institute

A set of 16 indicators applicable at the city level and corresponding benchmarks are proposed in Chapter A of the Quality FSSM document. These indicators are intended to be operational level parameters (WHO Tool 7) that help the 'Sanitation Cell' of a ULB take FSSM related decisions. Therefore, these indicators are expected to seamlessly feed into existing reporting structures such as the Service Level Benchmarks indicators of the Ministry of Housing and Urban Affairs, India, to monitor sanitation progress achieved by the ULBs. The indicators help ULBs assess the performance of FSSM system and identify any gaps that needs to be addressed with a time-bound plan. The indicators also ensure transparency for private operators during procurement and for contract management. In the future, as the quality of FSSM services improve and as more ULBs meet the standards, these parameters are expected to evolve.

Faecal sludge contains pathogens which are detrimental to public health and environment. In defining treatment standards for faecal sludge, following issues play a vital role:

- Costs vs Public health benefits
- Existing capacity to monitor and test standards
- Data on treatment standards achieved by various technologies
- Standards should encourage reuse
- Multi-barrier approach to mitigate risks from reuse

Collection and Transportation Stage

The mode of sludge collection from onsite containment units such as septic tank, pit latrine, etc. is manual-mechanical or purely mechanical, it is critical to for all personnel involved to wear Personal Protective Equipment (PPE). The technical specifications for Collection, Emptying & Transport are most relevant when issuing licenses to private truck operators and when trucks are procured, or desludging services are outsourced by the state government or ULB. In India, E&T is dominated by informal private operators and only where the business viability is low due to low demand, ULBs are providing the service. Manufacturing of vacuum trucks is also dominated by informal players.

E&T technical specifications has two key components:

- Specification for Personal Protective Equipment (PPE)
- Specification for Emptying Vehicle

In India, E&T are integrated activities given the complementarity of services involved. Therefore, the technologies for emptying must be mobile and capable of being transported along with the desludging vehicle.

Thus, in defining the specification of the emptying vehicle, the objective should be following:

- Road worthiness of the vehicle
- Technical and economic performance of the vehicle
- Safety in emptying and transport

Road worthiness of a vehicle is under the sole purview of the road transport department which gives the required registration certificate and fitness approval to ply on the roads. On the functional parameters to perform technically and meeting the economic viability, the E&T vehicles must be designed to evacuate mechanically at least 95% of the contents from the OSS within a given time frame. To ensure safety, the functional parameters of the emptying vehicle should prevent spillage in and around the OSS during and after desludging and while transporting the contents to the designated disposal points.

Treatment Stage
Technology for treatment of faecal sludge is still evolving and as the sector continues to grow, the stakeholders' awareness of technologies will increase. However, given the sector is in a nascent phase, there are numerous issues prevalent in understanding the treatment process, which can impact the quality of FSTP infrastructure and its performance. FSTP should adhere to standards treatment protocols as described below:

Standards for biosolids
The standards for biosolids are classified under four components - pathogen reduction, vector attraction reduction (VAR), contaminant standards, and general criteria. It is expected that FSTPs adhere to requirements specified under all these components.

- Pathogen Reduction Standards
- Vector Attraction Reduction Standards
- Contaminant Standards

Standards for treated effluent
The standards of CPHEEO, CPCB, NGT and state pollution control boards are applicable for discharge of treated effluent to surface water bodies, land disposal, and ground water recharge.

Standards for emissions
Stack Emissions Standards - FSTPs implementing thermal processes are expected to meet standards for incineration of solid waste, as prescribed in the manual for Municipal Solid Waste Management (CPHEEO, 2016).

5.5 Notes for trainer
This session aims to introduce participants to types of waste products in sanitation with different types of sanitation systems. The session provides insights into FSSM as a subject and further gives the background of the first stage of planning i.e., quantification of FSS. Different types of desludging and technical specifications with standards going to introduce to participants.

5.6 Bibliography
STRANDE, L.; RONTELTAP, M.; BRDJANOVIC, D. (2014): Systems Approach for Implementation and Operation. London: IWA Publishing.

EAWAG/SANDEC (2008): (Sandec Training Tool 1.0, Module 5). Duebendorf: Swiss Federal

United States Environmental Protection Agency (USEPA). (1994). Guide to Septage Treatment and Disposal. Document EP/625/R-94/002. Washington D.C. 20460.

National Policy on Faecal Sludge and Septage Management (FSSM) (2017), Ministry of Housing and Urban Affairs, Government of India:

Background Note to Quality in Faecal Sludge Management, WASH Institute, September 2020

Faecal Sludge Treatment Systems: Design Module (Part B: Learning Notes), National Institute of Urban Affairs, Delhi, 2019

Session

06

Stakeholder Engagement Tools and Programs

6. Stakeholder Engagement Tools and Programs

6.1 Learning objectives

- To understand the process of identification and characterisation of stakeholders
- To learn about stakeholder engagement and different tools involved in it
- To understand the IEC and BCC activities focussing FSSM planning

6.2 Session plan

Duration - 60 minutes

Topics	Time	Material/Method
Stakeholders Analysis	15 min	Powerpoint presentation
Engagement with Stakeholders	15 min	Powerpoint presentation
IEC and BCC activities for FSSM	15 min	Powerpoint presentation
Q&A	15 min	Discussion

5.3 Key facts

- Stakeholder analysis is a vital tool for understanding social and institutional context of a project
- Identification and characterisation of stakeholder's essential information about who will be affected by and will influence the project
- Stakeholder engagement ensures mitigation of future risks
- Stakeholder engagement plays a vital role in sustainability of the project

5.4 Learning notes

5.4.1Stakeholder Analysis

Operationalizing FSSM at city level efficiently and sustainably require the involvement and support of all concerned key stakeholders. Stakeholders are any group, organization or individual that can influence or be influenced by the project. In order to understand and engage stakeholders, stakeholder analysis should be performed. Stakeholder analysis is the process of identifying and characterizing the stakeholders, investigating the relationships between them, and planning for their participation. It is vital tool for understanding the social and institutional context of the FSSM project. The findings of such analysis can provide early and essential information about who will be affected by the project and who could influence the project, which individuals, groups or agencies need to be involved in the project and whose capacity needs to be built to enable them to participate.

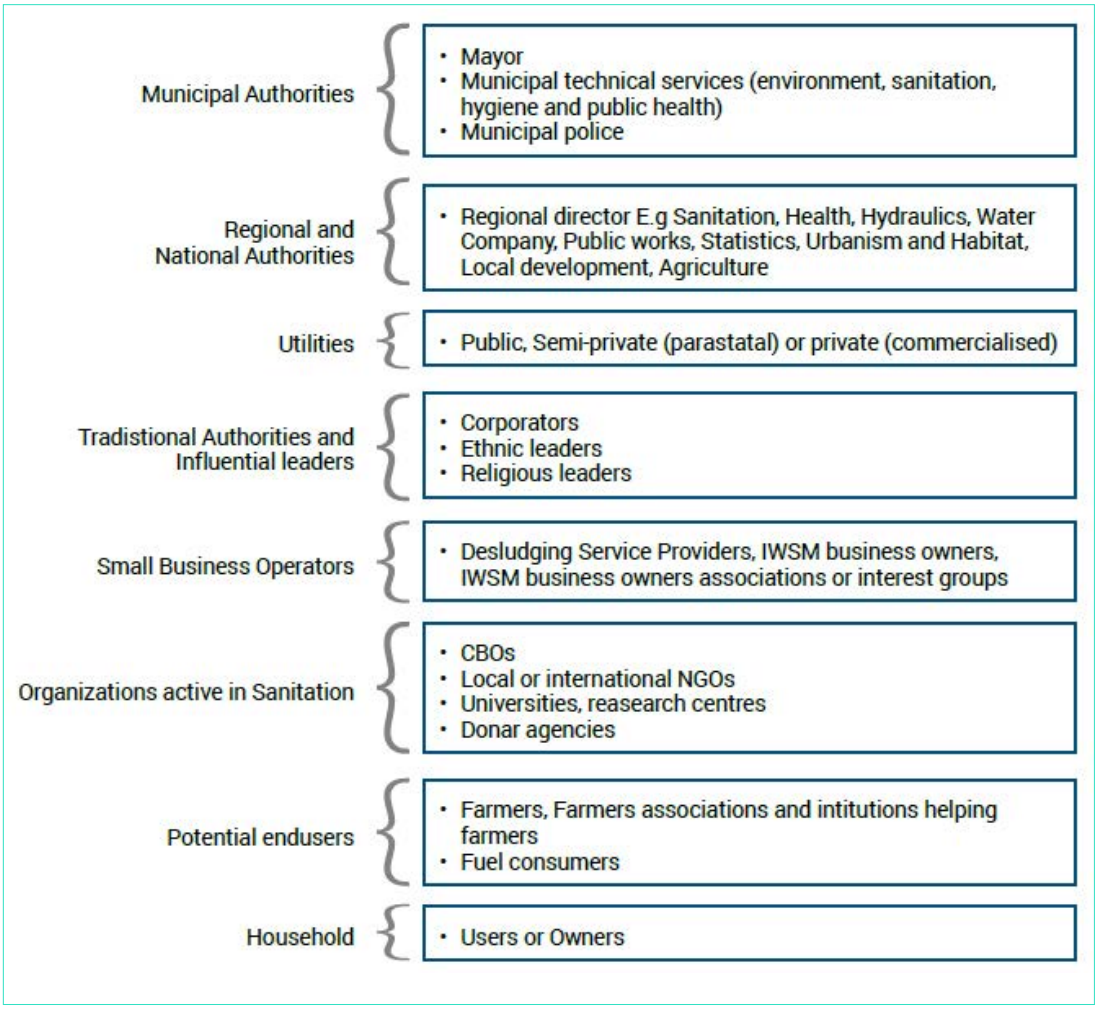
Stakeholder analysis process is important in order to:

- Identify who to involve and determine their level of participation at different stages of the planning and implementation process
- Understand who has what kind of interest and who is influential in supporting or in stalling/ delaying/rejecting the project
- Identify conflicts of interest between stakeholders
- Identify relations between stakeholders that should be improved and strengthened

- Structure the knowledge about the project stakeholders and share it with others
- Understand how to deal with the different people; for example, it should be clear who needs to be empowered, who needs to be informed and who should be dealt with in a particularly careful way (potential threats)
- In partnership with governments and implementing agencies, assess how best to harness the positive aspects of the informal sector, minimize the negative aspects, and look for genuinely effective ways of creating effective links between the formal and the informal.

Identification of Stakeholders

Figure 30: Key Stakeholders in FSSM



Source: Strande L. et Al. (2014) Faecal Sludge Management

Stakeholders' identification is one of the first tasks when starting a new project. Collaboration with local facilitators is essential to get the situation under control quickly. Identifying stakeholders is an iterative process, during which additional stakeholders are added as the analysis develops.

Characterization of Stakeholders

Characterization of stakeholders provides the necessary information on how to best involve each stakeholder and at the end process, how to best attribute roles and responsibilities.

Information to be collected

Main interest: Interest of the stakeholder in the future FSSM project needs to be determined through a consultative process.

Strength: Establish what the process leader can count on.

Weakness: Establish where information, empowerment and capacity building are needed.

Opportunities/threats: Characterise the potential positive (negative) perspective of the project.

Relationship between stakeholders: Hierarchy, friendship, competition or professional link. Good, bad can decide which working groups can be built.

Impacts: Type of impact of the project on the stakeholder determines the measure needed to maximise positive impact and mitigate negative impact. Involvement needs: The action required, results mainly from identified interest, weakness and potential.

Involvement needs (including training needs): the action required results mainly from identified interests, weakness and potentials

Table 10: Example of stakeholder's analysis

Stakeholder	Interest	Opportunities /Threats	Involvements Needs
Urban Local Bodies	Public health Sanitation work Sanitation fees	Power of enforcement through regulatory framework Management of treatment units	Sensitisation, need for capacity building, collaboration Institutional and regulatory framework, enforcement Involvement of financing schemes
Stakeholder B			
Stakeholder C			
.....			

Source: Strande L. et Al. (2014) Faecal Sludge Management

It is important to differentiate between two different types of opportunities and threat; the influence over the project and the interest in the project.

Influence: is the power that stakeholders have on the project i.e., to control which decisions are made facilitate their implementation or affect the project negatively.

Interest: characterise stakeholders whose needs constraints and problems are a priority in the strategy, e.g., sludge service providers, end users, households and sanitation authorities.

Table 11: Influence-Interest Matrix to Identify Involvement Needs and Participation Levels

	Low influence	High influence
Low interest	Not closely involved in the project and only require information sharing aimed at general public. **INFORMATION**	May oppose the intervention. Should be kept informed and acknowledged to avoid disruption or conflict. **CONSULTATION – INFORMATION**
High interest	Require special efforts to ensure that their needs are met and their participation is meaningful. **CONSULTATION - EMPOWERMENT**	Should be closely involved to ensure their support for the project. **CONSULTATION – COLLABORATION – EMPOWERMENT / DELEGATION**

Source: Strande L. et Al. (2014) Faecal Sludge Management

6.4.2 Engagement with Stakeholders

Stakeholder engagement or stakeholder involvement is key for the successful implementation of FSSM projects. It is the art of interacting with the stakeholders during the planning process to take into account their needs, priorities, and interests, achieve consensus, and remove opposition. Stakeholder engagement is largely about defining the participation level of people in the process and how to best answer their needs (e.g., through awareness raising or training and capacity building).

Stakeholders Participation Levels

The level of participation depends on what needs to be achieved with the targeted stakeholders e.g., households may be informed about the process or consulted to understand their collection needs. Collection and transportation operators may be consulted about their routes and to help define optimal disposal sites or collaborate on regulation definition.

Aspects should be considered when developing the involvement strategy:

- Perception of involvement: indicates how involved stakeholders feel about the project and sanitation services.
- Willingness to contribute to the project in planning, implementation or monitoring of the project.
- Expected benefit from the project
- Level of obligation which the stakeholder feels towards their responsibilities in the project
- People influencing the willingness of the stakeholder and extent of the peer pressure.

Stakeholders Participation Matrix

Information: Objective is to enable the stakeholders to understand the situation, the different options and their implications. This is one-way flow of communication.

Consultation: Objective is to have stakeholders' feedback on the situation options, scenarios and / or decisions.

Collaboration: Objective is to work as a partner with the stakeholder on various aspects such as creating scenarios and identification of preferred solution.

Empowerment / Delegation: Objective is to build capacities of the stakeholders so that they can make informed decision, take responsibility of final decision making, and assume their roles and responsibilities in the FSSM system.

Table 12: Stakeholders Participation Matrix

		Participation Level			
		Information	Consultation	Collaboration	Empowerment / Delegation
Planning	Launch of planning process	All stakeholders		Municipality, utilities	
	Detailed assessment of current situation		Key Stakeholders	Municipality, utilities	
	Identification of service options		Key Stakeholders	Municipality, utilities	
	Development of an Action plan	All Stakeholders	End users	Municipality, utilities, FS operators, NGOs	Empower weak and non-organised groups
Implement		Households, traditional authorities and opinion leaders	End users	Municipality, utilities, FS operators, NGOs	Empower and delegate to municipality, utilities, FS operators, NGOs
Monitoring and Evaluation		Key Stakeholders	Households, FS operators, end users	Municipality, utilities, selected NGOs	

Source: Strande L. et Al. (2014) Faecal Sludge Management

Involvement Tools

After the participation levels for each stakeholder have been defined, the involvement tools can be selected. There are many ways to involve people in the FSSM planning process and the decisions should be context driven. The selection of appropriate involvement tool varies from case to case. For example, the involvement needs may differ according to the complexity and boundaries of the project.

There are few following tools which can fit well in FSSM planning process:

- Individual meetings, informal or semi-structured interviews
- Focus groups discussions
- Workshops
- Site visits
- Participatory meetings
- Surveys
- Media campaigns
- Advocacy / lobbying
- Mediation

Selection of Appropriate Involvement Tools

The selection of involvement tools will vary from case-to-case basis as it depends on the goals, the personality and capacities of the local stakeholders. The best participatory approach is a combination of several techniques. The FSSM practitioner should consider the practical aspects of linked with the socio-economic conditions of the stakeholders and ensure, that the tool is adopted to the target audience. It is also important to clarify in advance the availability of resources required for conducting an adequate stakeholder's involvement program (time, budget, and know-how). Credibility of the FSSM practitioner, official legitimisation and transparency are indispensable for the planning process success.

Selection of appropriate involvement tool is dependent on following aspects:

Table 13: Aspects for selection of Involvement Tools

Political framework	Legal framework	Institutional framework	Social framework
• Involvement fit into existing political system • Need of involvement of political leaders	• Involvement conforms to the laws	• Involvement matches the institutional framework • Right authorities involved	• Involvement conforms to social customs

The engagement with the stakeholders is to be done in Consultation, Collaboration, Empowerment and Delegation. In order to perform this, different tools are utilized. Consultation can happen through personal meetings, focus group discussions and workshops. Collaboration can happen with all the four tools. Empowerment can happen mainly through focus group discussion and workshops. Delegation can happen mainly through advocacy and workshops.

6.4.3 IEC and BCC activities for FSSM

IEC is defined as the process of working with individuals, communities and societies to: develop communication strategies and promote positive behaviours which are appropriate to their settings for making the project successful. Providing information is the first and most crucial stage, where people are informed about the subject, FSSM and its components.

BCC is a process of working with individuals, communities and societies to develop communication strategies to promote positive behaviours which are appropriate to their settings and providing a supportive environment which will enable people to initiate and sustain positive behaviour

The subjects or key messages to be passed to the municipal staff shall include septic tank design standards, need for periodic desludging, tender details for engaging licensed transporters, and so

on. It has to be decided what mode of IEC would be most suitable for the said audience. These could be in the form of manuals, training sessions, etc. where the municipal staff is taught about appropriate methods of FSSM. For septage transporters, operators, and private vendors, the subject of interest can be safe disposal methods, vehicle design, the importance of using safety gears while desludging, correct and incorrect methods of desludging, etc.

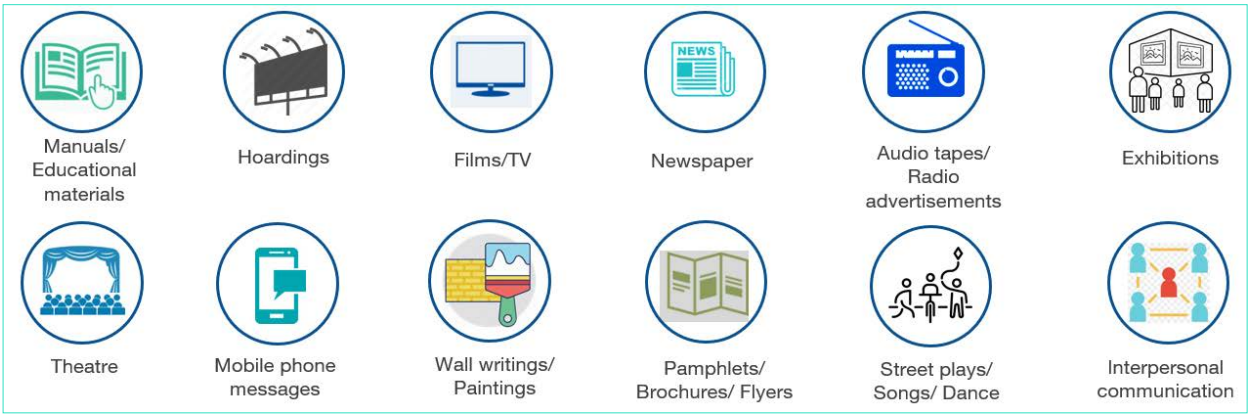
Figure 31: Example of targeted IEC campaign poster for sustaining ODF status

Source: Author

IEC for residents can be done in various ways. The sub-groups among residents include citizens, self-help groups, community-built organizations, and society members.

Following is the list of activities and illustrations that States and districts can take up. The list is informative not exhaustive. States and Districts can also devise their own activities best suiting to their requirements.

Figure 32: List of tools which can be used in a IEC and BCC campaign



Source: Author

As the SBM ODF protocol was in place since 2016 and most of the cites had declared themselves as ODF, the SBM ODF++ protocol was introduced in 2018, by putting in place additional parameters to ensure the sustainability and long-term impact of the ODF status. The purpose of ODF++ protocol is to provide a readiness check and guidelines for cities and towns that have already achieved ODF status as per the ODF protocol prescribed by MoHUA and are working towards ensuring sustainability of the ODF status to ensure proper maintenance of toilet facilities, hereby referred to as SBM ODF+.

BBC Media Action developed a Social and Behaviour Change Communication (SBCC) campaign featuring MALASUR. The Malasur campaign aims to heighten the risk perception of faecal sludge by linking it to water. It is a mnemonic, a creative property. It is a visual representation of faecal sludge which is at the heart of the communication intervention. It is inspired by Indian mythology where stories of good overcoming evil have always been a considerable driving force. This led to personifying the symptoms of faecal sludge as a threat and a villain, that needs to be captured and slayed.

Figure 33: Pictures from the IEC campaign carried out in local languages on Malasur

Mal (meaning waste in Hindi) that overflows from septic tanks or flows directly into open drains is positioned as a demon building its kingdom of disease underground by contaminating water sources. The slayers are all those who take proactive actions ranging from proper containment, transportation and disposal of faecal sludge.

Three key messages are being promoted:

- Containment: Build the right containment structure for your toilet
- Emptying: Desludge once in 3 years through a licensed operator
- Disposal: Check with the desludging provider where the faecal sludge will be disposed and report indiscriminate dumping

If the above is not followed, then Malasur will raise its ugly, menacing and dangerous head to harm people above the ground and find its way into water.

6.4.4 IEC/BCC Strategy of Odisha State

In Odisha, the implementation of FSSM is picking up pace. In order to improve citizens' awareness on FSSM at the state and town-levels, communication strategies focused on identifying the need for IEC and BCC are being implemented. The state government not only prepared state and city specific FSSM campaigns however, they also identified convergence among the different programs to amplify the impact of the IEC and BCC campaign.

Figure 34: Two-fold approach by Odisha state for creating enabling environment.

State and city specific FSSM campaigns	Urban platforms and programs
• Interpersonal Communication (IPC) through • Women SHGS • Mahila Arogya Samiti (MAS) and Swachh Saathis	• Swachh Survekshan • PEETHA, UWE! • Local festivals (Rath Yatra, Parab) • Local events (Local Self Governance Day)
Engagement of Swachh Saathis for PC with households have been effective in disseminating key messages among citizens and communities.	Orientation of ULB personnel, CBOS and Swachh Saathis are being regularly undertaken to sensitise them and also to build local champions.

Source: EY led TSU at HUDD, Odisha

Based on the findings, a variety of communication outputs were developed covering interpersonal communication, mid media and mass media. A wide range of communication activities, adopting a 360-degree approach, have been undertaken at the city level to communicate the key messages on FSSM.

Figure 35: Use of tools and local language for ease of understanding by locals in remote places

Source: EY led TSU at HUDD, Odisha

The outcomes of such communication campaigns are evident from the increased awareness on FSSM in Odisha, which in turn has led to an increase in the demand for FSSM services.

6.5 Notes for Trainer

The main aim of the session is to highlight the importance of stakeholder management in FSSM to optimize the sanitation service chain and contribute to sustainability of the project. The session is very important especially when the audience is coming from technical field. Success of the FSSM project is significantly dependent on how the stakeholder engagement is done and IEC, BCC campaign are carried out.

To enhance the learning experience, a role play can also be hosted with few members of audience. In the role play, an individual or a group of individuals are given a role of a stakeholder. It is recommended to provide a script for each role; however, in some cases, impromptu acting is also possible. The role play brings forward how each stakeholder plays an important role in the planning process of FSSM project and contributes to its success.

6.6 Bibliography

EAWAG/SANDEC (2008): (Sandec Training Tool 1.0, Module 5). Duebendorf: Swiss Federal Institute of Aquatic Science (EAWAG), Department of Water and Sanitation in Developing Countries (SANDEC)

Faecal Sludge and Septage Management in Urban Areas, Service & Business Models, NITI Aayog, January 2021

STRANDE, L.; RONTELTAP, M.; BRDJANOVIC, D. (2014): Systems Approach for Implementation and Operation. London: IWA Publishing.

The Story of Malasur (The Demon of Defeca) - A Compendium of Creative Outputs for Malasur, A public awareness campaign on Faecal Sludge Management (FSM), Ministry of Housing and Urban Affairs, GoI And BMGF, 2020

6.7 Further Reading

Faecal Sludge Treatment Systems: Design Module (Part B: Learning Notes), National Institute of Urban Affairs, Delhi, 2019

Integrated Wastewater and Septage Management — A Planning Approach (Part: B Learning Notes), National Institute of Urban Affairs, Delhi, 2020

Sustainable Sanitation & Water Management (SSWM) Toolbox, Seecon International gmbh, 2010.

Session

07

Situation assessment - Introduction to feasibility assessment

7. Situation assessment - Introduction to Feasibility Assessment

7.1 Learning objectives

- Understand the importance of conducting an assessment of initial situation for planning of an FSSM project
- To know the different tools and methods for collecting relevant data and learn how to perform an initial situation assessment

7.2 Session plan

Duration - 60 minutes

Topics	Time	Material / Method
Assessment of initial situation	25 min	Powerpoint presentation
Tools and methods for data collection	25 min	Powerpoint presentation
Q&A	10 min	Discussion

7.3 Key facts

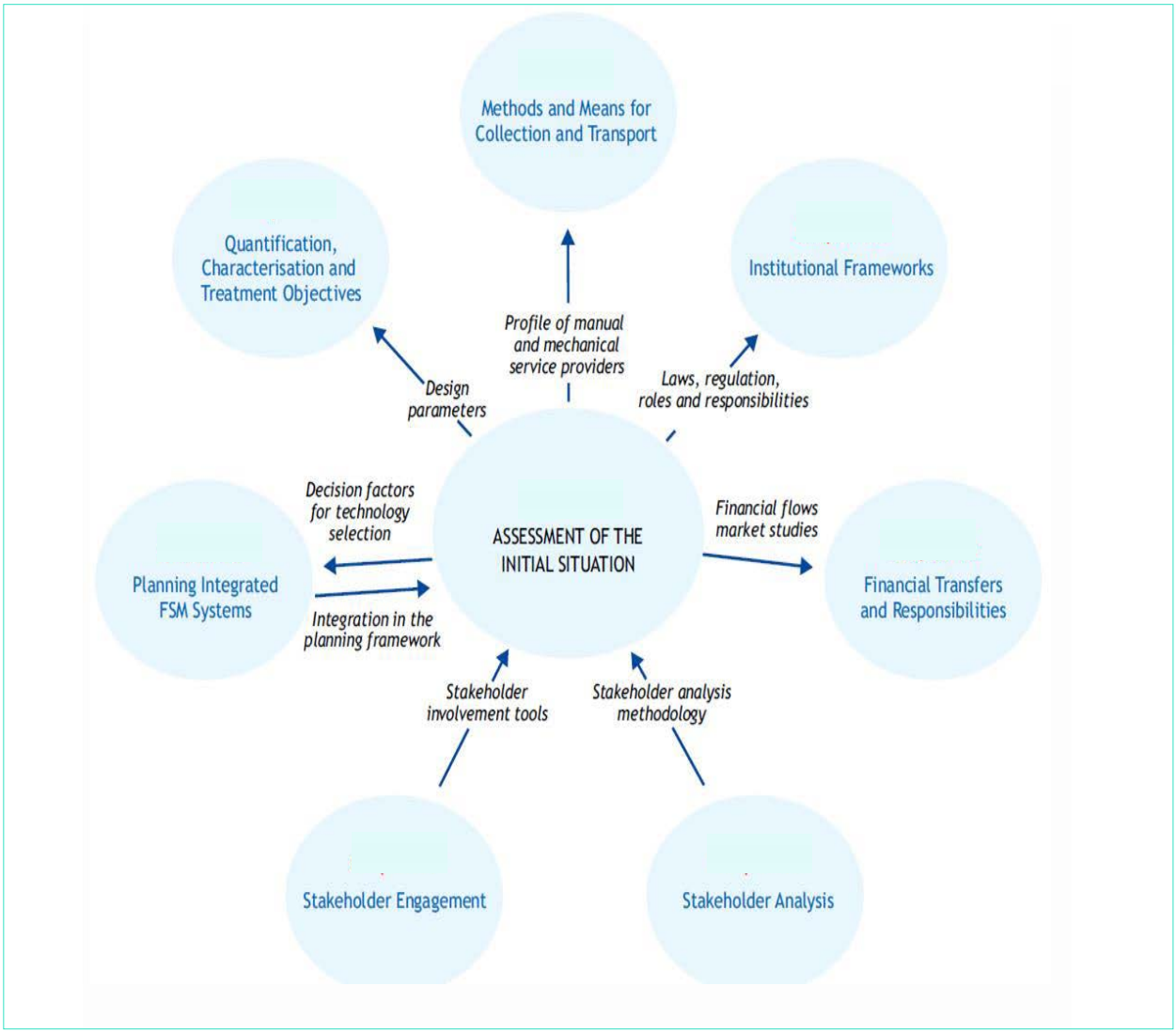
- Feasibility assessment - initial situation presents, defines the purpose of the project
- Primary data collection – household surveys, semi structured interviews, focus group discussions
- Secondary data collection – literature review, assessment reports, DPRs
- Data collection is an exhaustive process but helpful for mitigating risk of potential hurdles or failures in futures
- SWOT matrix provides inference from the analysis of the data collected

7.4 Learning notes

7.4.1 Assessment of initial situation

The first step in the planning process is collection of baseline data and assessment of initial situation. This assists in decision making. The main goals of assessment are : (a) to set the scene i.e., to create a good foundation for FSSM, (b) understand the context, (c) understand the stakeholders and (d) provide adequate information to start elaborating the FSSM scenarios. Data collection needs to be carried out step by step during the exploratory investigation, preliminary studies and feasibility study. This type of assessment gives a snapshot of the situation at the beginning of the project. It describes the existing service chain, starting with the types of toilets, the formal and informal sludge emptying sector, the organisation of the system and the links between the stakeholders. It also identifies the enabling environment, government support, the legal and regulatory framework, intuitional arrangement, skills and capacity, financial arrangement and socio-cultural acceptance.

Figure 36: Assessment of Initial Situation



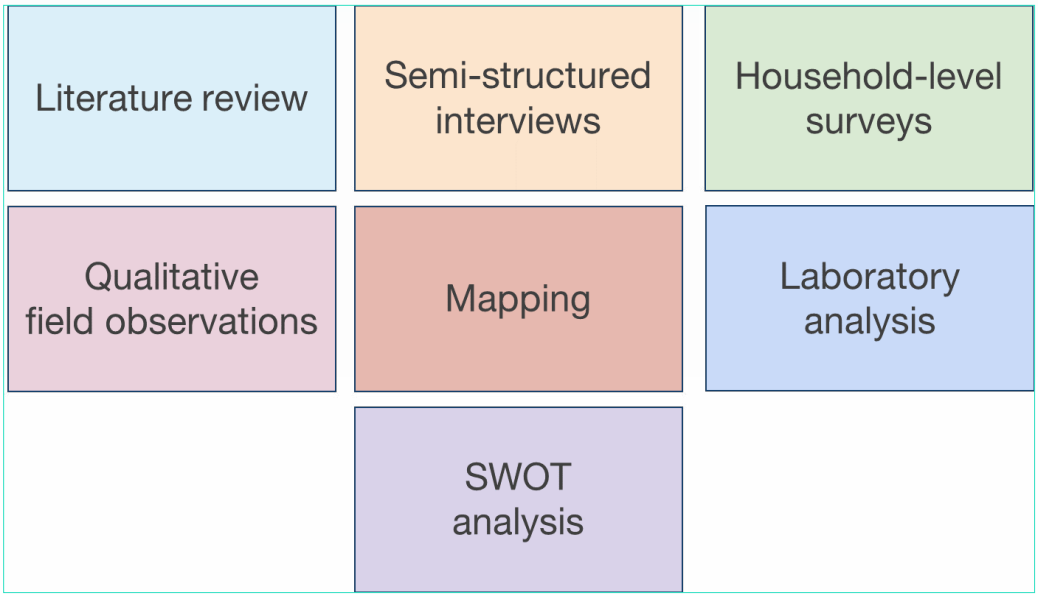
Source: Strande L. et Al. (2014) Faecal Sludge Management

In addition, the human dimension of this assessment should not be overlooked. This is when the first contacts take place and trust starts to build with the stakeholders. This is crucial for the rest of the project. It might happen that the data is not always readily available and that getting accurate information usually depends on the goodwill of local partners. Building trust relationships should be the first priority before rushing into data collection.

7.4.2 Tools and Methods for Data Collection

The collection of good quality data is not an easy process, especially when the data is scarce, not collected or analysed properly, or hidden or manipulated for political or personal reasons. Governmental agencies usually have the reports, statistics and maps that can serve as a preliminary introduction.

Figure 37: Tools and Method of Data Collection



Literature review

The literature review consists of searching data that already exists (grey literature i.e., reports, maps or white literature i.e., publications). Data quality (especially with statistics) is always questionable, and, in very dynamic contexts, may become quickly outdated. The main source of the information are always the different governmental agencies as well as non-governmental organizations (NGOs) and institutional organizations.

Household level surveys

Surveys or questionnaire are a way of collecting information systematically, so that data collected from different sources can be easily compared and analysed quantitatively e.g., using statistics. In FSSM, they are used to collect data at the household level in order to assess the practices, perceptions and sanitation status.

The following aspects need to be part of the household-level survey in an FSSM planning process:

Characterization of the interviewee: status, family, cultural background, household size

- Water supply: water sources, water quality, service quality, water consumption, costs
- Hygiene and sanitation
  - Type of on-site sanitation technology (or open defecation), numbers of users
  - Type of emptying services (what happens when the pit is full) – if no sewers: mechanical/ manual, public/private, frequency (winter/summer or dry/rainy season), cost, perception of cost and service, willingness to pay for improved services
  - If sewer network: type of sewers, problems encountered, discharge point
  - Greywater management
  - Solid waste management: disposal/endues practices
  - Stormwater management
  - In rural areas: animal manure management – disposal/enduse practices
- Institutional/organizational aspects: who is responsible for each service, positive/negative aspects
- Environmental awareness: perception of cleanliness and health impacts, willingness to improve
- Communications channels: main information sources, information on consumption habits

Semi-structured interviews

Semi-structured interviews are one way to structure discussions aimed at collecting information. The interviewers are the process leaders, usually with facilitators and the interviewees are the FSSM stakeholder. Semi structured interviews can be held with individuals or in focus groups. They require time and experienced interviewers but they help to build a solid basis for further work. Semi-structured interviews are conducted with a fairly open framework which allows for focused two-way communication. They can be used for both to give and collect information.

Qualitative field observations

While field visits are a powerful tool to expose all the stakeholders or reality, they are also a good way for the process leaders to better understand the reality, crosscheck the available information by observing and discussing with people, and build trust onsite with the main stakeholders. They provide an introduction to the existing sanitation services and an initial understanding of conditions from the perspective of local residents. Quantitative household level surveys are essential for good quantitative data, but freer observation is also important.

Mapping

Mapping is essential for a clear and extensive analysis of the existing situation, especially when it comes to understanding the city structure and identifying the treatment sites. Mapping is much easier in recent years with the democratization of satellite images (e.g., google earth) and Geographical Information Systems (GIS). A participatory mapping is also recommended, as it is good way to involve selected stakeholders. Particularly important is the identification of key elements, such as existing disposal sites or obstacles for emptying trucks (e.g., road segments prone to traffic jams and poor quality of roads).

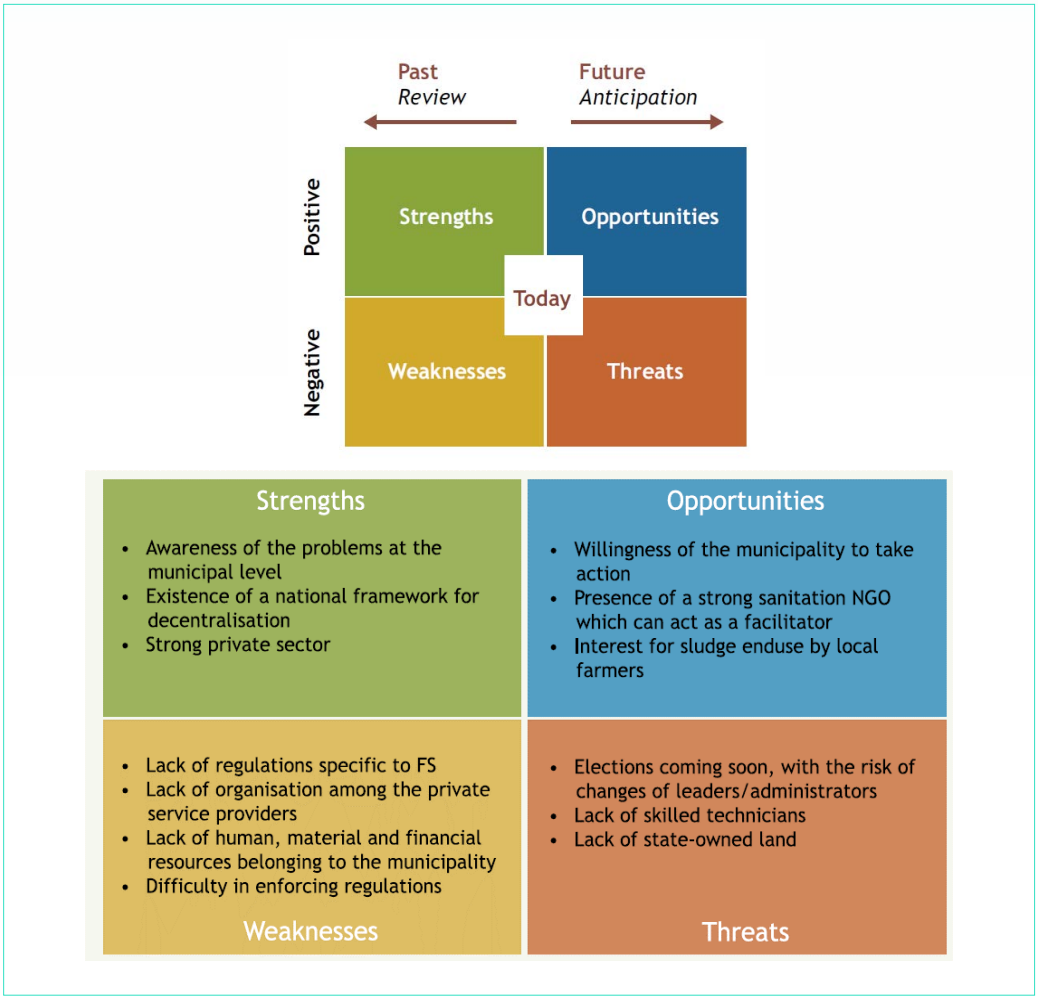
Laboratory Analysis

In FSSM, where a comprehensive database on characteristics does not yet exist, it is usually necessary to carry out the sapling campaigns and analyses in order to be able to characterize the sludge on a site-specific basis. Sludge characteristics vary significantly between and even within the cities, and it is important to obtain first hand data.

SWOT Analysis

When carrying out the initial assessment, it is important to determine what are the Strengths, Weakness, Opportunities and Threats (SWOT) of the environment in which the FSSM system has to be developed, especially the organizational and institutional framework, as well as the key stakeholders. The SWOT matrix shows the positive and negative factors that have to be dealt with, setting them out clearly in this way makes it possible to take action in order to maximize the potential of the strengths and opportunities while minimizing the impact of the weakness and threats.

Figure 38: SWOT Matrix and its example



Source: Strande L. et Al. (2014) Faecal Sludge Management

Data to be collected at city level

The most important data to be collected is:

- Population and demography: number of inhabitants, number of people per household, population density and growth rate, type of housing
- Water and hygiene: drinking water coverage and infrastructure, drinking water sources, types of supply (e.g., networks, taps in houses, fountains, trucks), operators (public/private), prevalence of diseases related to faecal matter
- Physical characteristics: geomorphology, hydrologic basins, areas prone to flooding, types of soil, ground water table
- Climatic data
- Stormwater management
- Main elements of the city structure
- Local economy: main economic activities in the city, main sources of household revenue, average income

Table 14: Information required of Existing Sanitation Services

Toilets and Onsite treatment systems	
Water availability	Information on existing water supply services (including daily consumption per household) can be used to estimate daily wastewater production
Sanitation facilities	Current levels of service (household and shared facilities) including approximate household coverage and number and location of communal or public toilets
Onsite treatment	Types of onsite sanitation system serving households with households connections
Waste collection and conveyance	
Existing sewage infrastructure	Coverage of sewerage and proportion of household with household connections
Faecal sludge and septage collection services	Coverage and frequency of servicing
Offsite wastewater treatment and reuse	
Wastewater treatment	Location and types of wastewater treatment infrastructure (if any exists)
Discharge or enduse	Location where wastewater and faecal sludge is disposed or end used

7.5 Notes for trainer

The session provides details about the situation assessment stage. The stage is very critical and involves collection of baseline data using different tools such as household surveys, semi structured interviews etc. Emphasis should be given on investing in planning of surveys and importance of collection of primary data to strengthen the FSSM plan. It is also important to perform quantification and characterization of the faecal sludge and septage. The analysis of the data is equally important and the tool of SWOT analysis helps to identify the potential threats and weaknesses, which should be addressed without fail in the FSSM plan.

7.6 Bibliography'

EAWAG/SANDEC (2008): (Sandec Training Tool 1.0, Module 5). Duebendorf: Swiss Federal Institute of Aquatic Science (EAWAG), Department of Water and Sanitation in Developing Countries (SANDEC)

Faecal Sludge Treatment Systems: Design Module (Part B: Learning Notes), National Institute of Urban Affairs, Delhi, 2019

Integrated Wastewater and Septage Management — A Planning Approach (Part: B Learning Notes), National Institute of Urban Affairs, Delhi, 2020

STRANDE, L.; RONTELTAP, M.; BRDJANOVIC, D. (2014): Systems Approach for Implementation and Operation. London: IWA Publishing

Session

08

Treatment approaches in FSSM

8. Treatment approaches in FSSM

8.1 Learning Objectives

- To know the factors that govern the design and selection of treatment technologies
- To understand the treatment objectives and their relation to the faecal sludge and septage treatment chain
- To learn the different approaches available in faecal sludge and septage treatment

8.2 Session Plan

Duration - 60 minutes

Topics	Time	Material/Method
Selection criteria for FSS treatment technologies	15 min	Powerpoint presentation
FSS treatment objectives and treatment chain	15 min	Powerpoint presentation
Approaches to FSS treatment	15 min	Powerpoint presentation
Q&A	15 min	Discussion

8.3 Key Facts

- Deciding the treatment technology for safe management of faecal sludge and septage requires a consideration of critical local factors
- Faecal sludge and septage treatment chain shall be finalized based on the treatment objectives
- Design of treatment system should be based upon the treatment objectives and the necessary compliance
- Selection of right approach is critical for affordability and sustainability of FSSM

8.4 Learning Notes

8.4.1 Selection Criteria Treatment Technologies

Setting up an FSSM system is not only about the selection of single technological options, but about finding a sustainable combination of services that guarantees the appropriate collection, conveyance, treatment and disposal or enduse of faecal sludge and septage, in a way that ensures household satisfaction, broad coverage and cost recovery. An FSSM system should be efficient and flexible, i.e., able to function normally and adapt to the frequency of sludge delivery and sludge quantities and characteristics, cope with climatic variations, produce end-products that are safe for use, be able to guarantee that the investment and O&M costs are acceptable and that are skilled employees for operation. Eleven criteria for the selection of a combination of technologies are proposed, divided into four categories: treatment performance, local context, O&M requirements and costs.

Table 15 Selection criteria for treatment mechanisms

Treatment performance	Local context	O&M requirements	Costs
Effluent and solids quality according to the discharge / reuse standards laid down by the pollution control board	• Characteristics of sludge (dewaterability, solids concentration, stabilization, spread ability) • Quality of the frequency of the sludge to be received at treatment facility • Climatic conditions – humidity and temperature • Land availability and its cost • Interest in the end use	• Availability of skilled persons for O&M and monitoring in case of mechanized treatment • Availability of spares locally in case of mechanical equipment	• Investment costs covered (land acquisition, infrastructure, human resources, capacity building and training) • O&M costs including cost of human resources, equipment and electricity • Affordability for households and ULB for paying for desludging services and treatment (i.e. sanitation service)

a. Treatment performance

The default criteria are that the treatment facility should be able to produce end products meeting the standards of discharge/ end use.

b. Local context

Most important criteria are the local context. The characteristic of the sludge and its characterisation ratios determine the degree of stabilisation and dewaterability etc. The frequency of desludging affects the quality of the sludge. Hence, if the frequency of the desludging is high, there is possibility of having faecal sludge. In that case, stabilisation of sludge becomes important. Climate play's important role in case of all-natural treatment mechanisms such as evaporation, evapotranspiration and stabilisation.

Land availability and it's cost of acquisition must also be considered before finalising the treatment mechanisms. In cases where the land is not available and acquisition of it is costly or time consuming, it is advisable to go for treatment mechanisms demanding less area. If there is interest in the use of end products of treatment, then treatment mechanisms suitable to produce those end products in demand should be chosen. For example, in cases where there is demand for biochar, pyrolysis will be suitable treatment mechanisms for pathogen reduction.

c. O&M requirement

Availability of the resources such as skilled persons, spares etc. at local level is very important. In absence of local availability of the resources, no treatment technology is going to economically viable in spite of it producing very high-quality end product.

d. Costs

The capital and operational expenditure (CAPEX and OPEX) of the technology is also one of the criteria and which is often thought to be the only criteria. Affordability of the complete project to the ULB or the end beneficiaries such as households should also be checked.

8.4.2 Treatment Objectives and Treatment Chain

A. Treatment Objectives

Dewatering or thickening of faecal sludge and septage is an important treatment objective, as faecal sludge and septage contains a high proportion of liquid, and the reduction in this volume reduces the cost of transporting water weight and simplify treatment steps. It also helps to reduce the size of reactors at the treatment plant as the volume for a specific HRT reduces.

Environmental and public health treatment objectives are achieved through pathogen reduction, stabilisation of organic matter and nutrients, and the safe end-use or disposal of treatment end-products.

Dewatering

The most important treatment objectives of the faecal sludge and septage is dewatering as it also supports directly or indirectly the other objectives. Dewatering helps to reduce the volume of sludge to be handled and treated using other treatment mechanisms, thereby reducing the capital expenditure significantly. Separating the solid and liquid stream simplifies the treatment of the faecal sludge and septage and helps to optimise the process. For example, in case of heat drying, dewatering will save significant amount of energy.

Faecal sludge has different dewatering characteristics compared to septage and wastewater sludge, in that it tends to foam upon agitation, and resist settling and dewatering. The duration of onsite storage, and the age of sludge also affects the ability to dewater the sludge. Empirical evidence shows that 'fresh' or 'raw' sludge (i.e. faecal sludge from pit latrines) is more difficult to dewater than older, more stabilised sludge. The dewatering, or thickening process can also include adding dry materials such as sawdust to increase the solids content. This is a common practice in processes such as composting where the sawdust also increases the carbon to nitrogen (C:N) ratio. This later helps in co-composting of biosolids with organic solid waste. The liquid stream that is produced during dewatering also requires further treatment, as it can be high in ammonia, salts, and pathogen.

Pathogen removal

The second most important objective is pathogen removal. Pathogen removal is important from the discharge and reuse point of view of the end products. Faecal sludge and septage contains large amounts of microorganisms, mainly originating from the faeces. These microorganisms can be pathogenic, and exposure to untreated faecal sludge and septage constitutes a significant health risk to humans, either through direct contact, or through indirect exposure. Any indiscriminate disposal of it results into cross-contamination of the water resources. Reduction of pathogen is achieved by various ways such as – starvation, predation, exclusions, desiccation, and altering temperature conditions.

- Starvation refers to starving the pathogen to death.
- Predation refers to introducing or allowing specific types of bacteria to eat (predate) the pathogens.
- Exclusion refers to physical exclusion of pathogens depending on their size using filters.
- Desiccation refers to reducing the moisture content to the level where the cell walls rupture due to dryness.
- Pathogens are believed to reduced significantly at temperature above 60^{0}C.

Nutrient recovery

Faecal sludge and septage contains significant concentrations of nutrients, which can be harnessed for beneficial resource recovery. If not managed properly, it can result in environmental contamination. Environmental impacts from nutrients include eutrophication and algal blooms in surface waters and contamination of drinking water (e.g., nitrates leading to methemoglobinemia).

Nutrient recovery is a specific treatment objective which is very important when the end products is to be used as soil supplements for improving its characteristic. Faecal sludge and septage contain good amount of nutrients. If managed properly, these nutrients can be used as supplement to synthetic fertilisers in agriculture.

Stabilization

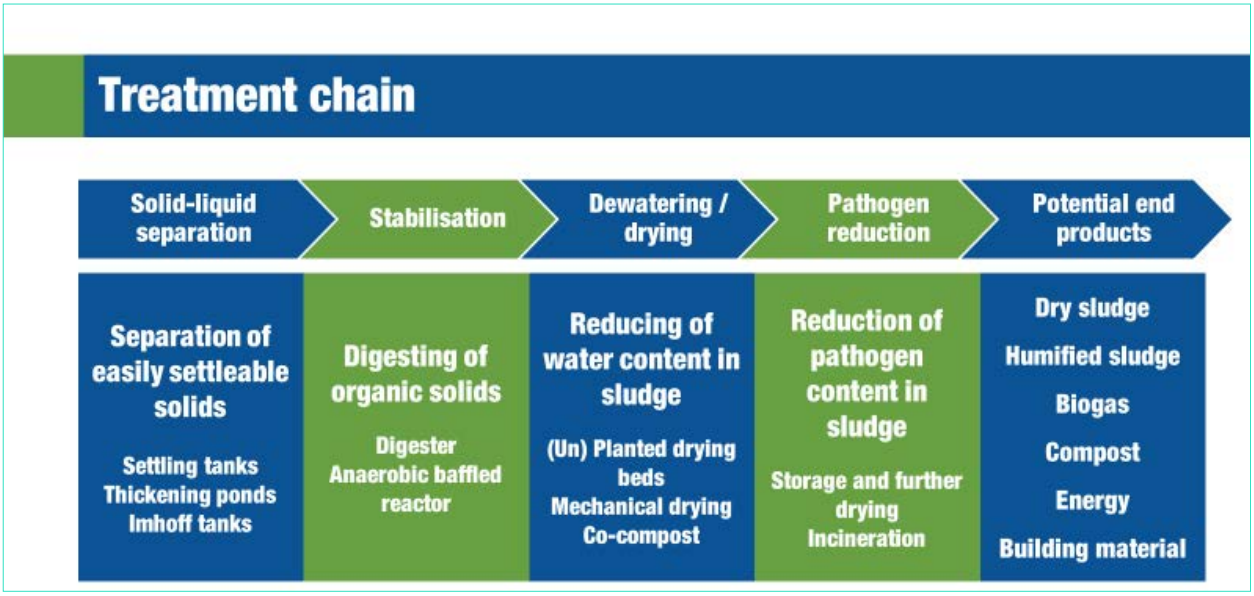
Untreated faecal sludge and septage has a high oxygen demand due to the presence of readily degradable organic matter that consumes significant amounts of oxygen during aerobic respiration. Disposal of faecal sludge and septage into the water body results in depletion of oxygen in surface waters. The process of stabilisation transforms organic, carbon-based molecules that are not readily degradable to more stable, complex molecules (e.g., cellulose and lignin).

Stabilization is achieved through the biodegradation of the more readily degradable molecules, resulting in faecal sludge with a lower oxygen demand. Common indicators of stabilisation include measurement of Volatile Suspended Solids (VSS) and organic matter (BOD and COD). In addition, stabilization ensures that organic forms of nutrients present in treatment end-products are stable, and can be more predictably and reliably used. Stabilization also reduces foaming of faecal sludge and septage, leading to better dewatering.

B. Treatment Chain

There are multiple stages of faecal sludge and septage treatment and each stage has a specific treatment objective. The figure below shows all the stages and treatment mechanisms under each stage and examples of treatment units for that stage.

Figure 39: Stages of treatment in faecal sludge and septage



Faecal sludge and septage contain more than 95% water; hence as the first step of treatment, the easily settleable solids are removed using sedimentation process. These solids are then treated biologically to digest and stabilize. In case of well digested septage, the solids can be directly sent to dewatering or drying stage, where the bound water and moisture is removed and the solids are completely dried. The pathogen reduction happens after that and is usually carried out by further sun drying the sludge or co combustion. The end product thus obtained can be numerous uses as in Figure 26.

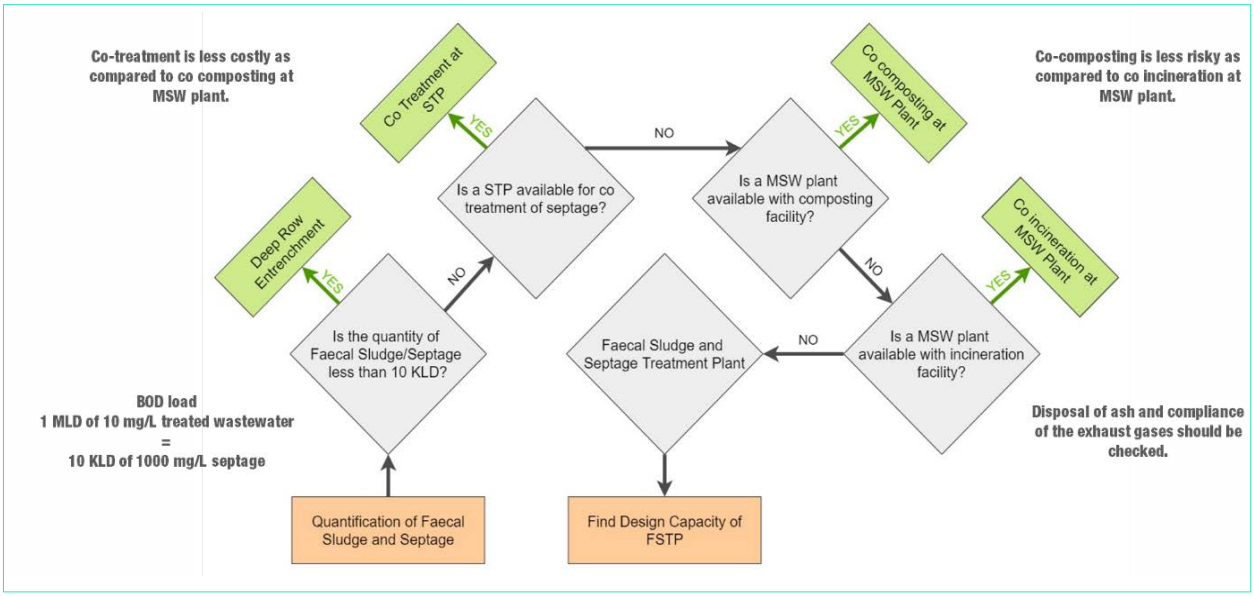
World Health Organization has published guidelines for safe use of wastewater, excreta and greywater. These guidelines can be referred and for preparing sanitation safety plan for the specific project.

Setting up a FSSM system is not only about the selection of single technological options, but about finding a sustainable combination of services that guarantees the appropriate collection, conveyance, treatment and disposal or endues, in a way that ensures household satisfaction, broad coverage and cost recovery.

FSSM system should be efficient and flexible, i.e., able to function normally and adapt to the frequency of sludge delivery and sludge quantities and characteristics, cope with climatic variations, produce end-products that are safe for use, be able to guarantee that the investment and O&M costs are acceptable and that are skilled employees for operation. Eleven criteria for the selection of a combination of technologies are proposed, divided into four categories: treatment performance, local context, O&M requirements and costs.

C. FSSM approaches

Figure 40: FSSM Approach based on existing assets within the ULB



It is important to realize that for the conversion of faecal sludge and septage into a safe product for enduse or disposal, it needs to be processed. Faecal sludge and septage typically contains large volumes of water and hence needs to be dewatered, which can be achieved on its own, or combined with solid-liquid separation. Depending on the end-goal, further treatment needs could include converting organic matter into a stabilized form and/or pathogen reduction. One of the key elements in designing any particular series of technologies is to keep the final goal in mind.

If the final goal is to make a dry product that can be reused in agriculture, then particular care has to be paid to dewatering and pathogen reduction. If the goal is to incinerate the sludge for energy production, then dryness is very important while pathogens do not play a role.

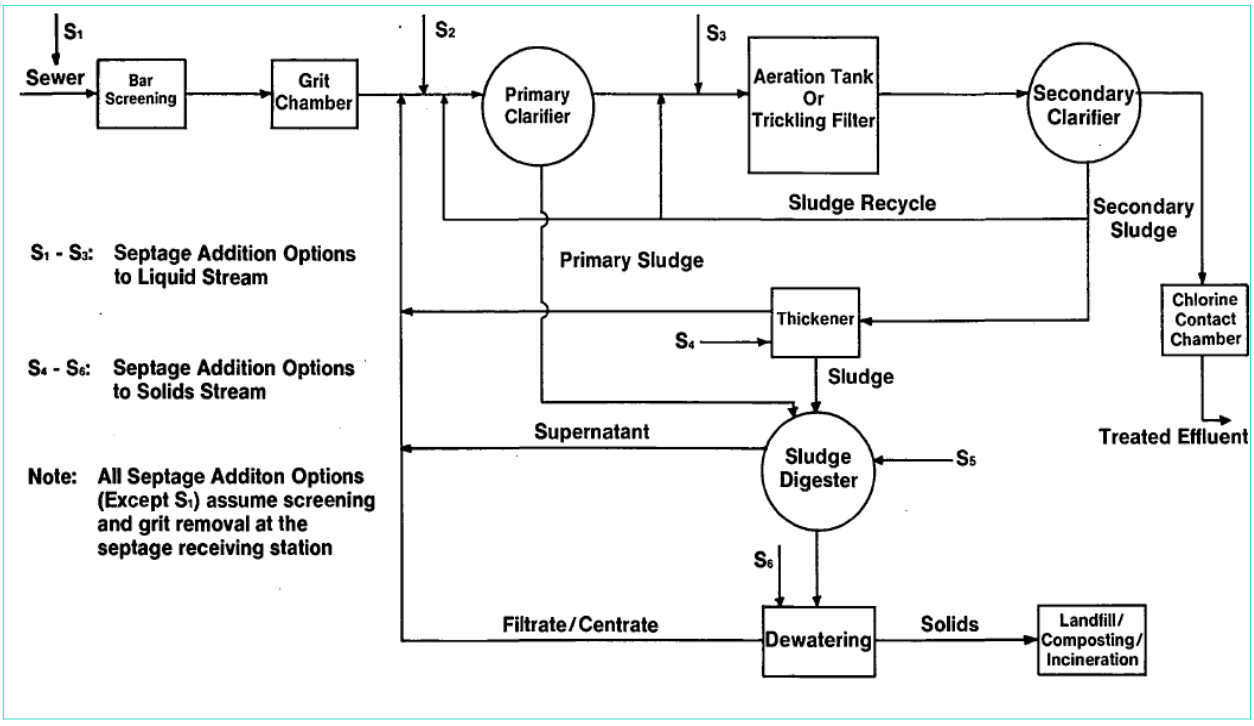
In cases where STP is located in vicinity, co-treatment of septage at STP can be practiced provided transportation of septage and cost of co-treatment is economically viable. In regions where co-treatment is not possible, population density and frequency of desludging of septic tanks should be checked. If setting up of treatment plant is economically not viable, then to avoid indiscriminate disposal of septage, it is recommended to practiced safe disposal practice as an interim measure.

- In ULBs where the population density is low and demand desludging is practiced, scientific land disposal (ex. Deep row entrenchment) can be practiced.
- ULBs where population density is medium and demand for desludging of septic tanks is low, solid liquid separation (Ex. Geotube) or scientific land disposal can be practiced. Liquid filtrate from the Geotube needs further treatment. The quantum of this liquid as compared to the septic tank effluent between two desludging is insignificant. If the ULB does not have a treatment plant for sullage then it is wise to check economic viability of liquid fraction treatment in such ULBs.
- In ULBs where population density is high and demand for desludging is moderate, it is recommended to have faecal sludge and septage treatment plant. In this case, not only the solids, but the liquid also will have to be treated as per the discharge norms.

1. Co-treatment at STP

One of the approaches for faecal sludge and septage treatment is co-treatment with sewer-based wastewater treatment technologies. However, appropriate treatment facilities are needed at sewage treatment plants to receive, pre-treat, and distribute the septage into the appropriate process units.

Figure 41: Addition points of faecal sludge and septage at the STP



Source: Handbook on Septage Treatment and Disposal, US EPA

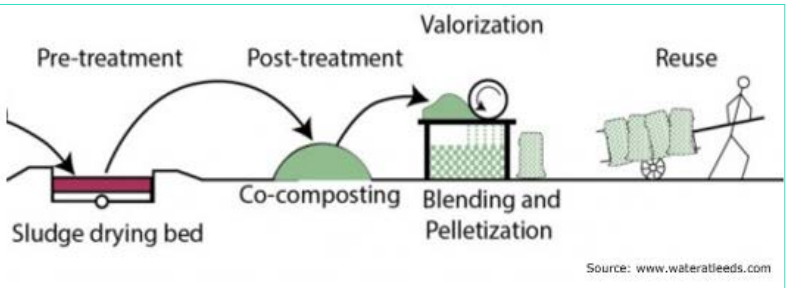
Septage which may be considered high strength wastewater can be either dumped into an upstream sewer or added directly into various unit processes in a sewage treatment plant. The considerably higher solids content of faecal sludge may lead to severe operational problems such as solids deposition and clogging of sewer pipes. This is mostly because the diameter and slope of sewers are designed for the transport of municipal wastewater typically containing 250 to 600 mg TSS/L rather than the 12,000 to 52,500 mgTSS/L present in faecal sludge and septage. Hence, the first step in designing a co-treatment system includes determining how the faecal sludge and septage will be transported to the treatment facility and discharged into the influent stream. Common problems with co-treatment of FS in STPs range from the deterioration of the treated effluent quality to overloading tanks and inadequate aeration.

2. Co-composting at MSW Plant

Co-composting is a biological process that involves microorganisms that decompose organic matter under controlled predominantly aerobic conditions. The resulting end product is stabilised organic matter that can be used as a soil conditioner. It also contains nutrients which can have a benefit as a long-term organic fertiliser. There are two types of composting systems, open and closed, of which open systems are lower in capital and operating costs but typically require more space. In an open composting system, raw organic matter is piled up into heaps (called windrows) and left for aerobic decomposition. To increase space efficiency, the heaps of waste can also put into walled enclosures which is called box composting. If untreated waste feedstock is placed in a closed container, then it is called in-vessel or closed drum composting and is considered in the category of closed systems.

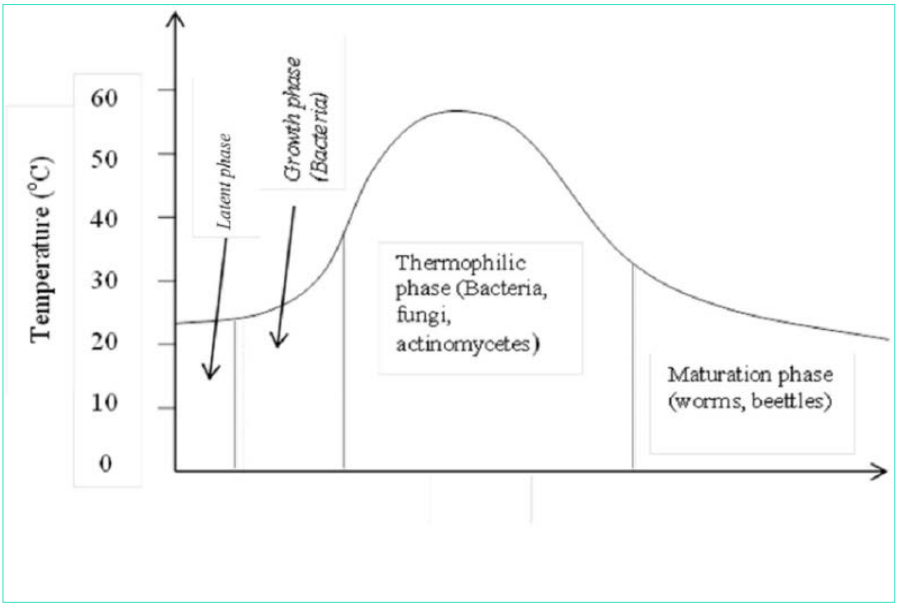
Figure 42: Co-composting of dewatered faecal sludge and septage with organic waste

Source: www.iwmi.cgiar.com



In a properly operated composting heap, the temperature rises rapidly to 60°C -70°C as heat is released when carbon bonds are broken down in an exothermic process. Pathogen die-off is highest during this time of high temperature.

Figure 43: Temperature profile during the composting process



Source: Vigneswaran S. et. Al.; 2016

After approximately 30 days, the temperature drops down to 50°C. During the maturation phase the temperature is around 40°C, and the process ends once ambient temperature is reached. The whole composting process (including maturation) takes a minimum of six to eight weeks.

3. Deep Row Entrenchment

Deep row entrenchment consists of digging deep trenches, filling them with sludge and covering them with soil. Trees are then planted on top, which benefits from the organic matter and nutrients that are slowly released from the faecal sludge and septage. In areas where there is adequate land available, deep row entrenchment can present a solution that is simple, low cost has limited O&M issues and produces no visible or olfactory nuisances. Benefits are also gained from afforestation. However, the availability of land is a major constraint with deep row entrenchment, as is the distance/depth to clean groundwater bodies. Deep row entrenchment is considered most feasible in areas where the water supply is not directly obtained from the groundwater source and where sufficient land is available, which means the sludge would have to be transportable to rural and peri-urban areas. In many countries such as India, legislation is still lacking for this option.

The main advantage of deep row entrenchment is that very little is needed for it- no expensive infrastructure or pumps that are very susceptible to poor maintenance. In addition, growing trees has many benefits such as extra CO_2 fixation, erosion protection, or potential economic benefits. Constraints are that sufficient land has to be available in an area with a low enough groundwater table and, moreover, the legislation still needs to catch up in many countries to allow for these low-cost techniques of managing faecal sludge and septage.

8.5 Notes for trainer

This session introduces criteria to select the treatment technologies for faecal sludge and septage management. Emphasis should be on defining the objectives of faecal sludge and septage treatment, followed by the selection for appropriate approach for treatment and choosing right treatment units. The trainer can use the Compendium of Faecal Sludge and Septage Treatment Plants in India published by NIUA under Sanitation Capacity Building Platform for citing examples while explaining the approach and choosing the right option.

8.6 Bibliography

STRANDE, L.; RONTELTAP, M.; BRDJANOVIC, D. (2014): Systems Approach for Implementation and Operation. London: IWA Publishing.

USEPA: Handbook on Septage Treatment and Disposal

Vigneswaran, S. & Kandasamy, Jeevetha & Johir, Md Abu Hasan. (2016). Sustainable Operation of Composting in Solid Waste Management. Procedia Environmental Sciences.

8.7 Further reading

EAWAG/SANDEC (2008): (Sandec Training Tool 1.0, Module 5). Duebendorf: Swiss Federal Institute of Aquatic Science (EAWAG), Department of Water and Sanitation in Developing Countries (SANDEC)

Faecal Sludge Treatment Systems: Design Module (Part B: Learning Notes), National Institute of Urban Affairs, Delhi, 2019

Integrated Wastewater and Septage Management — A Planning Approach (Part: B Learning Notes), National Institute of Urban Affairs, Delhi, 2020

Sludge Management: Biosolids and Faecal Sludge, Global Water Pathogen Project, August 2018

Session

09

Financing Aspects of FSSM

9. Financing Aspects of FSSM

9.1 Learning Objectives

- To evaluate the financing requirement for FSSM across the service chain.
- Understand how to prepare FSSM budget requirements for a city.
- To understand various business models of FSSM and understand what works for a city.

9.2 Session Plan

Duration - 45 minutes

Topics	Time	Material/Method
Financing FSSM	15 min	Powerpoint presentation
Financial flow models	20 min	Powerpoint presentation
Q&A	10 min	Discussion

9.3 Key Facts

- Various types of capital and operational expenditures are involved in operationalising FSSM in a city.
- Expenditure can be met through potential funding opportunities at the national and state level.
- It is important to explore various revenue stream at collection – transport and treatment stage of the service chain.
- Choice of financial model will depend on multiple parameters and stakeholder should be mutually agreed by all the key stakeholders.

9.4 Learning Notes

9.4.1 Financing FSSM

The ULB needs to assess the requirement of CAPEX and OPEX across the value chain for better planning of FSSM.

CAPEX of the project refers to all the expenditures which will happen once for setting up or implementation of the project. Following are few examples of capital expenditures:

- Cost of land and site preparation
- Civil structures, electrical and plumbing components, electromechanical components
- Establishment cost
- Site investigation
- Transport and overhead.

OPEX can be classified into (1) direct costs and (2) indirect costs.

Direct costs refers to the expenditure which may vary and depend on the degree or hours of operations. Ex: Cost of electrical energy, cost of polymers (coagulants).

Indirect cost refers to the expenditure which is fixed and does not depend on other factors such as load of FSS received etc. Ex: Lease of the land, human resource cost.

Income and revenue

Income and revenue refer to the incoming monetary streams. In case of FSTP, revenue can be generated through: (a) discharge fees, (b) purchase fees and (c) budget support.

Table 16: Assessment of CAPEX and OPEX across FSSM Value Chain

Service Chain	Capital Expenditure	Operational Expenditure	Stakeholder Responsible
Toilet Access & Containment	• New toilets • New Containment Systems • Refurbishment of toilets & containment system	Repair of toilets & containment systems	Household
Emptying and Conveyance	Procuring Desludging vehicles	• Fuel cost • Repair & Replacements • Salaries of employees • Establishment Cost	ULB/Private player
Treatment	• Cost of land preparation • Civil structure (life span of 30 years) • Plumbing and electrical component (life span of 15 years) • Electromechanical components (life span of 10 years) • Cost for site investigation & sampling • Transport and Overheads	Fixed Costs: • Expenditure to be borne in treating the FS and Septage received at the treatment plant • Cost of material for operation • Cost of power for operation • Cost of chemicals (if required any) • Human Resource cost • Preventive maintenance cost Variable Costs: • Expenditure to be borne even if FS and Septage received at the treatment plant	ULB/Parastatal agencies

Potential Sources of Financing for CAPEX and OPEX

Financial sustainability of FSSM is dependent on the capacity for financing both CAPEX and OPEX over the planned period. The assessment begins with estimating financial requirements for both CAPEX and OPEX, along with tariff restructuring, to make the system sustainable. The assessment provides guidance on potential sources of finance for meeting these expenditures including funding through external grants, private sector investments, user contributions, external debt or through local government internal resources.

The ULB needs to identify the potential financial sources available to avail fund for CAPEX across the value chain. (a) For construction of new septic tanks, possible sources for supporting CAPEX include HHs, government subsidy and CSR funds. (b) For refurbishment of septic tanks, which is a part of containment, the predominant source of CAPEX would be government subsidy or HHs have to borne the CAPEX. (c) For conveyance of septage, CAPEX can be sought from central or state grants, and under local government schemes. Private sector participation is also a potential source for CAPEX to procure vehicles. (d) Establishing the FSTP and the disposal site are major areas where more funds will be required if any private land needs to be procured. Possible sources from where CAPEX can be obtained would be grants from central and state governments, funds from local government and CSR funds. Private sector participation is also a potential source of finance but willingness of the private sector is to be assessed.

The government typically will support only for the CAPEX and not for OPEX; the ULBs have to explore possible ways to meet the OPEX. Potential sources for OPEX may include housing society fees, annual sanitation tax, and desludging fees taken from the property owners on the request of desludging their containment unit. Revenue generated by selling of product after the treatment of septage will also feed into OPEX revenues.

Identification of Revenue Sources

The ULB can decide to levy taxes/user charges or both, on the HHs for FSSM services. OPEX can be recovered by levying taxes and user charges from HHs. The ULBs could introduce a sanitation tax. Such a sanitation tax will be paid by the HHs to the ULB as part of annual property taxes. An exercise is designed on how to fix the amount of tariff for sanitation tax for the properties.

9.4.2 Financial transfers

Depending on what institutional structure is present currently, there may be one or more financial transfers in FSSM. The most common transaction which happens is between the household and the desludging operator. This transaction is known as Emptying Fees. It is a fee for emptying and disposal that is charged at the household level for providing the services. It may be charged by ULB or Private based on who is providing the service. The charges of emptying fees vary as per location, service provider, the market volume of sludge. In absence of any fee regulations, the private operators may charge higher fees. This type of model encourages households to opt for the services only in case of dire necessity and not regularly as per requirement.

In some cases, the desludging operators are regulated through contracting and licensing by the ULB. In such cases the fees paid by the operator to acquire the license to provide services to the household is known as Contracting Fees.

Sale of End Product is kind of revenue generated by sales of the end product is also a source of revenue. The selling price is dependent on supply, demand, and any subsidies that may be available in the location. Assessment of end user willingness to reuse and pay for treated products is important. Market at a city level and nearby area should be analysed in terms of acceptance of treated sludge for farming and willingness to pay for the same.

Sanitation Tax is a tax /fee for emptying and treatment of faecal sludge collected either once, or at regular intervals. It is a continuous income for the ULB and can be used for operations and maintenance of emptying services and treatment plant. For introducing a sanitation tax, various states have legal provisions in their tax structure for charging tax and are already charging fees in terms of sanitation tax/user charge, which is a major source of revenue. Gujarat, Maharashtra, Uttar Pradesh, Uttarakhand and Punjab have provisions for taxations in different heads like general sanitation tax for Gujarat, Special sanitary tax for Maharashtra etc. In the case of West Bengal, Punjab, Haryana, Rajasthan there are provisions for fees and user charges for drainage, scavenging etc.

Budget Support is the cash transfers within ULB from the general budget and other sources to support operations of FSSM activities. It may be long-term and non-conditional. Property tax can be used as a source to subsidize the cost of FSSM services to be provided.

There are various other transactions also involved in the FSSM process like discharge fees, discharge incentive, fines for illegal activities etc. Assessment of willingness to pay by the households is important before levying of such fees or taxes to decide the amount. Sanitation tax can be decided based on the willingness of HH to pay additional property tax to cover the O&M of the FSTP.

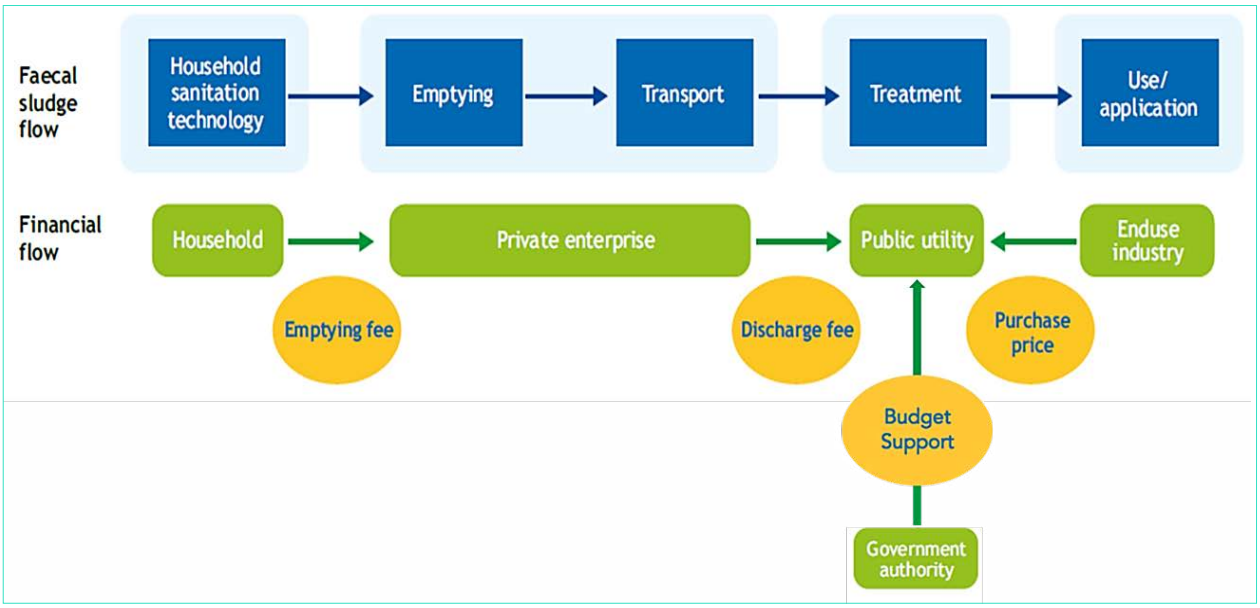
9.4.3 Financial flow models

There is no single FSSM model that has proven to be effective in all situations. The service delivery models are constantly modified and restructured depending on the economic, legal, and environmental conditions. Furthermore, the responsibilities within the system are constantly changing and as such, the financial transfers between stakeholders can take several forms.

A. Discrete collection and treatment model

In discrete collection and treatment model, each of the stakeholders is responsible for a single technology in the FSSM chain, and consequently, money is exchanged each time responsibility is handed over (emptying and transport are identified here as a single technology). The household-level toilet user pays a private enterprise (PE) an emptying fee to remove the sludge and the PE is responsible for the emptying and transportation of the sludge. The PE is then charged a discharge fee by the public utility for accepting and treating the sludge. An end-use industry also pays the utility a purchase price in exchange for treated FS or sludge-grown products (e.g., fodder). In this model, the utility operates independently from the government authority and must cover all costs by collecting sufficient discharge and purchase fees.

Figure 44: Discrete Collection and Treatment



Source: Strande L. et Al. (2014) Faecal Sludge Management

Dehradun, capital of Uttarakhand has surplus wastewater treatment capacity. The recently built STP under the Uttarakhand Integrated Urban Development Project at Kargi Chowk is used for co-treatment of faecal sludge and septage with sewage. The STP is currently, being operated and maintained by Jal Sansthan, Government of Uttarakhand. There are approximately 30 private desludging operators who provide service to the households for emptying septic tanks for a emptying fee of INR 1000 to 4000 per service. The fees is negotiated by the operator and household depending upon the accessibility to the tank, tiem taken for emptying and distance from the STP. The operators decant the septage at the STP and pay a discharge fee of INR 300 per trailer load. Jal Sansthan collects sewerage tax which is used to recover the cost of management of sewage and STP.

Figure 45: Use of Discrete Collection and Treatment Model in Dehradun, Uttarakhand.



- Kargi STP - 68 MLD utilized for co treatment by Jal Sansthan, GoU
- 30 Private desludging operators | Desludging fee INR 1000-4000 per trip | Tipping fee INR 300 per trip
- Septage Management Cell at the ULB regulates FSSM
- GoU provides budgetary support for O&M of STP
- Dewatered biosolids are provided to farmers for reuse

Source: Author

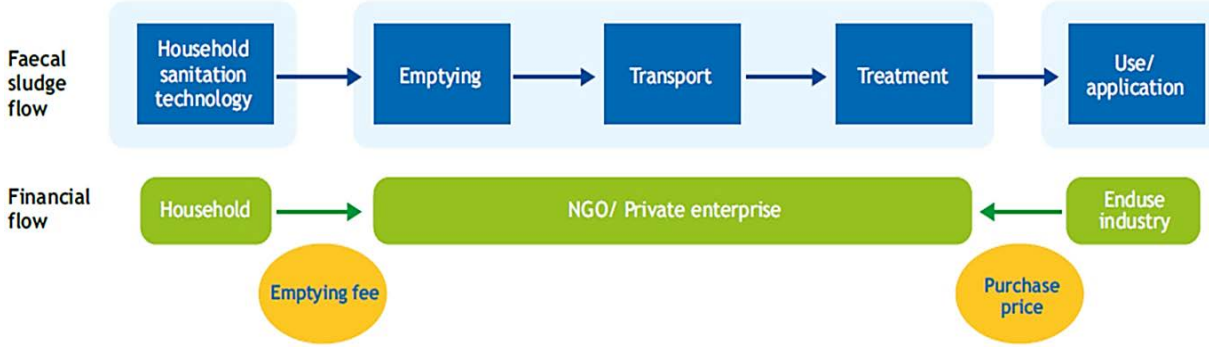
Table 17: Pros and Cons of Discrete Collection and Treatment

PROS	CONS
• Households are free to choose the most competitive price on offer for emptying • Timing of emptying is flexible and can be done when financially feasible • The household is not committed to a fixed sanitation tax	The utility's operating expenses must be covered by the discharge fee

B. Integrated collection, transport and treatment model

In integrated collection, transport and treatment model, the operator responsible for treatment is not subject to the sludge or payment irregularities of the PE responsible for emptying. The model 2 appears similar to model 1, but the financial implications are significantly different. In model 2, a PE or non-governmental organisation (NGO) is responsible for the emptying, transport and treatment, thus eliminating the need for a discharge fee between the stakeholder responsible for collection and transport and the stakeholder responsible for treatment.

Figure 46: Integrated collection, transport and treatment model



Source: Strande L. et Al. (2014) Faecal Sludge Management

Blue Water Company has been appointed by the local government in Leh to provide end to end sanitation services to the citizens of Leh. The company owns and operates the vacuum trucks and treatment plant. The source of revenue is emptying fees and purchase price obtained from selling the treated end product.

Figure 47: Integrated collection, transport and treatment model at Leh, India.



- Leh Municipal Council and Blue Water Company (BWC) has commissioned FSSM
- BWC is responsible for the collection and transportation of FS as well as the O&M of the FSTP
- BWC collects the desludging fees.

  Outcomes as of 2020
  - More than 2.6 Million liters FS collected and treated,
  - Trips increased from 6-8 trips/ month to 80-100 trips/ month.

Source: Blue water Company

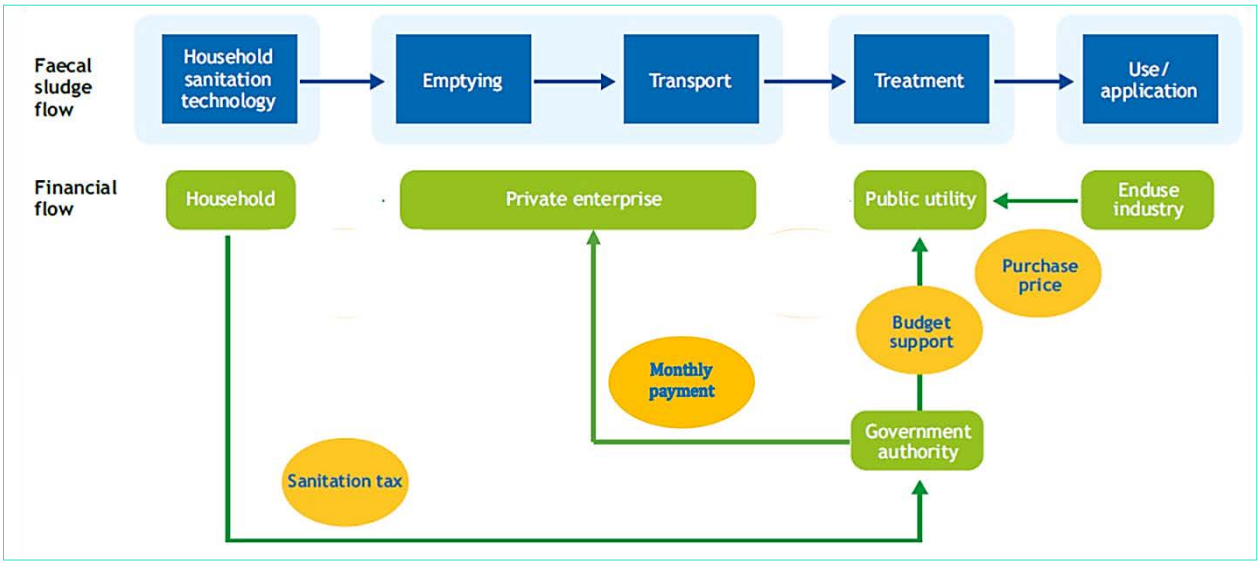
Table 18: Pros and Cons of Integrated collection, transport and treatment model

PROS	CONS
• A single operator is able to optimize the business model and improve efficiency; • Less potential for illegal discharge as the single entity will discharge at the self-run treatment works	High fees may be passed onto the household

C. Sanitation tax model

In sanitation tax model, a sanitation tax is paid directly to the government authority by the toilet user, either through water, sewer, or property taxes. The utility is given budget support from the government authority that collects the sanitation tax. The utility therefore does not need to rely entirely on the discharge fee and could lower it (in comparison to Model 1) thus reducing the total costs of the private enterprise. Therefore, the discharge fee must be high enough, such that operator can hold the PEs accountable for what they dump, but not so high that the toilet users are unable to afford the high emptying fees passed onto them by the C&T operators that the sludge is dumped illegally. This system is prone to corruption and under-servicing if the government authority is not competent or transparent in how it allocates it money. Furthermore, the financial balance is very much dependent on the consistent collection of the sanitation tax. Unstable land tenure, poor record keeping, corruption, transient populations and other features of fast-growing urban centres threaten the collection of a steady stream of user-based revenue. Fee collection is notoriously low in many government authorities and fluctuations in the sanitation fees can significantly affect the ability for the utility to make long term O&M decisions if there are not reserves available from the authority to buffer the variation.

Figure 48: Sanitation tax model



Source: Strande L. et Al. (2014) Faecal Sludge Management

This model is built on the theory that collection and transport stakeholders cannot afford the discharge fees charged by FSTP operators and so dump indiscriminately, causing damage to public and environmental health. Working under this scheme, the C&T operator would only have to recover a portion of the total operating costs from the emptying fee (the other portion would be made up by the discharge incentive). As a result, the collection service would be more affordable for poorer households, more sludge would be collected, less sludge would be discharged to the environment and the community as a whole would benefit.

The sanitation tax model is deployed by Wai Municipal Council in the city of Wai, Maharashtra. Wai. The municipal council collects the sanitation tax from properties and provides a service of scheduled desludging in an interval of three years. The desludging services has been outsourced to a private contractor who is paid on a monthly basis based on the pre-defined indicators in the contracts. Thermal treatment technology based on pyrolysis is implemented in Wai for treating faecal sludge and septage. The council also provides budgetary support for covering the O&M cost of the plant. Currently, the plant operator is not selling the treated end product and hence, the purchase price is eliminated from the revenue source.

Figure 49:Sanitation tax model at Wai (India) and Philippines

- In 2018, Wai started Scheduled Desludging service. Private desludging operator was contracted by ULB to provide the service.
- Performance linked payment to private desludging operator.
- In Philippines, the Metropolitan Waterworks and Sewerage System charge a Environment tax from the public and pays the private desludging operators who provides scheduled service under a concession agreement.

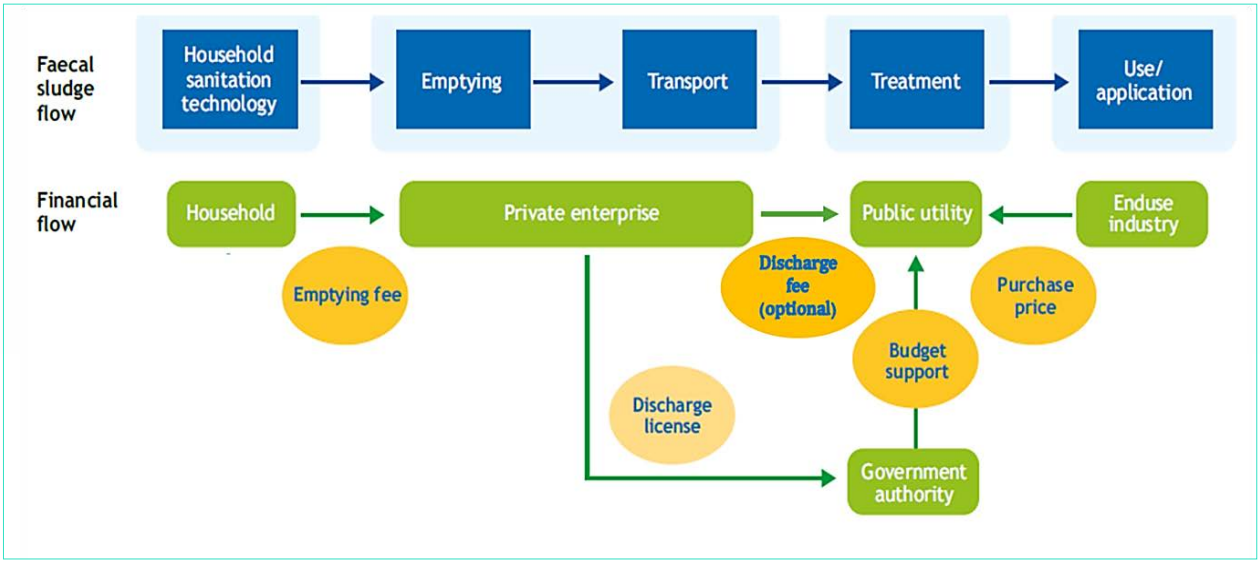
Table 19: Pros and Cons of sanitation tax model

PROS	CONS
• Emptying fees for households may be reduced; • Households that are difficult to access, or located far from the treatment plant, may become attractive to C&T operators because of incentives	• Incentives must be corruption proof (e.g., not given for diluted sludge etc.) • FSTP operator requires significant budget support to function budget support to function

D. Licensing Model

This model is similar to the commonly occurring private emptying and transportation model. The key difference lies in the issuing of license/permits to the private truck operators by relevant municipal authorities to operate emptying activity. Licensing helps in accounting for all emptying activity in the city, and can potentially track these operations to prevent illegal disposal of FSS. The license/permit could be either a one-time fee or fees paid annually by the truck operators. The municipal authority issuing the license provides basic “dos and don’ts” to the truck operators, and they need to monitor for regulatory compliance by tracking the operations of private truck operators. The license is revoked, if the truck operator is found to be violating any regulations, especially engaging in the illegal disposal of FSS in non-designated sites.

Figure 50: Licensing Model



Source: Strande L. et Al. (2014) Faecal Sludge Management

Licensing model has been adopted in India by the state of Tamil Nadu. The state through its Tamil Nadu Urban Sanitation Support Program has regulated the sanitation services associated with FSSM across the cities. As per the guidelines issued by the state, the ULBs are supposed to license all the operators and only licensed operators are allowed to provide the service to the properties across the city. The licensing fee is INR 1000 per year and discharge fee is INR 100 per trip. The treatment plant operator also receives budget support from the government authorities to recover the cost of liquid waste management.

Figure 51: Licensing model in ULBs across Tamil Nadu

- Tamil Nadu State Investment Plan in 2018 - Scale treatment across the state based on clustering of ULBs around STPs.
- Standard Licensing Agreement for private desludging operators.
- Host ULBs to license all the desludging operators serving within the cluster.
- ULBs to charge a License Fee of INR 1,000 per year and a tipping fee of INR 100 per load

Source: TNUSSP

Table 20: Pros and Cons of Licensing Model

PROS	CONS
• Industry regulation and legitimization through licensing • Improvement in health and safety conditions; • Unlimited discharges minimise risk of illegal dumping	• Not applicable in cities without existing private operators. • Requires stringent monitoring from the Authority to be effective.

9.4.4 Life Cycle Cost Analysis of FSTPs

Life Cycle Cost Analysis (LCCA) is widely accepted method that the total economic cost of a given system is best determined by assessing both the capital and operational costs together over the system's entire life cycle. This approach makes it possible to determine the most cost-effective solution amongst a range of alternatives by considering all cash flows over the lifetime of the system and allows practitioners to identify potential trade-offs between initial capital investment costs and long-term cost savings.

The application of LCCA to FSTPs is particularly appropriate because of the significant cost variability between different locations. Individual systems may have different CAPEX and OPEX profiles depending on location, and therefore, should be assessed on a case-by-case basis.

There are three types of temporal LCC variations that have to be considered in the analysis of FSTPs:

- Initial capital expenditure (CAPEX),
- Recurring costs i.e., Operation and maintenance expenditure (OPEX), and
- One-off replacement costs.

Figure 52: Life Cycle Cost

FSTPs	Capacity, KLD	CapEx, in Lakh INR	NPV - O&M in Lakh INR	NPV -LCC in Lakh INR	Total LCC in Lakh INR	LCC / year in Lakh INR	LCC / KLD in Lakh INR
Jabalpur	50	50.23	129.70	179.93	359.86	29.99	7.20
Devanahalli	6	70.90	118.69	189.59	346.67	28.89	57.78
Puri	50	73.90	193.01	266.91	533.83	44.49	10.68
Leh	12	52.20	119.63	171.83	343.66	28.64	28.64
Tenali	20	20.00	98.69	118.69	237.37	19.78	11.87
Phulera	20	239.45	163.39	402.84	805.68	67.14	40.28
Bhubaneshwar	75	167.90	209.52	377.42	754.84	62.90	10.06
Warangal	15	110.00	229.17	339.17	678.34	56.53	45.22

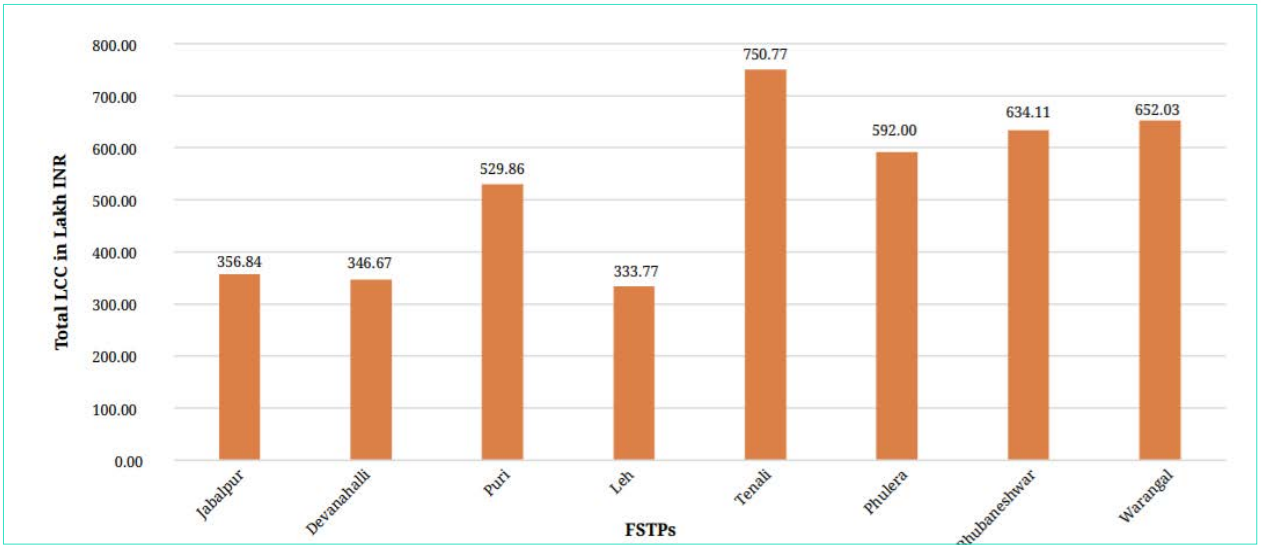
Source: Cost Analysis of Faecal Sludge Treatment Plants in India Life Cycle Costing & Contracting Models of FSTPs, NIUA

The results of the LCC analysis across the 8 FSTPs are presented in the table above.

- From the LCC analysis of the different technologies, it is evident that the technologies focusing primarily on liquid management are far lesser in the total LCC, when compared to technologies which focuses on both liquid as well as solids management.
- Phulera, Bhubaneswar and Warangal show total LCC, at about 3-4 times that of Jabalpur, Leh and Tenali.

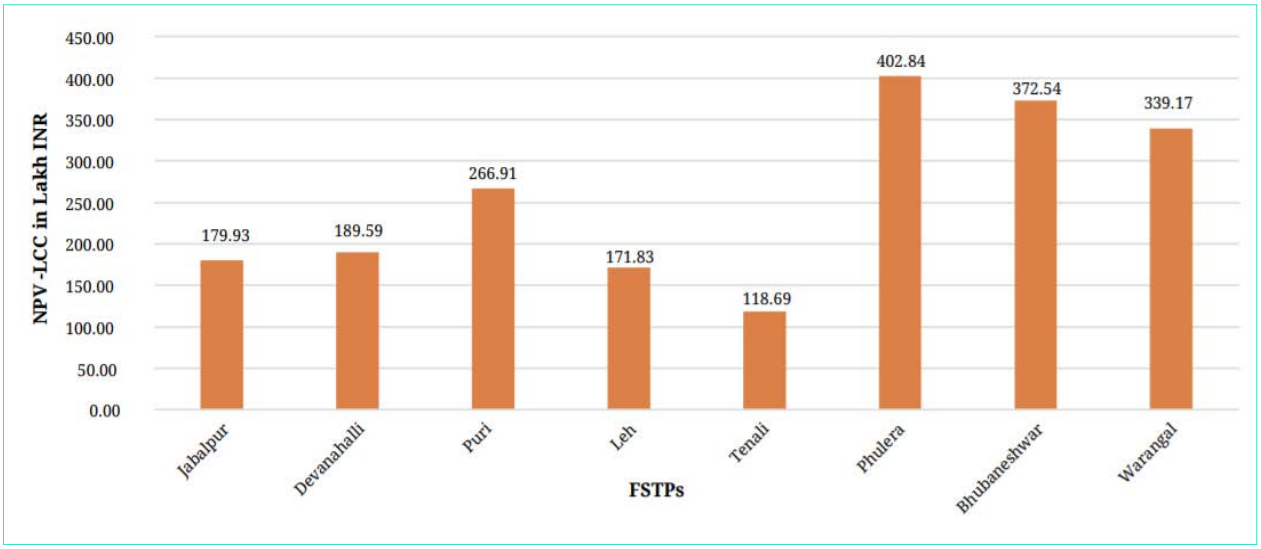
The total LCC cost across the technologies are represented in the graph below,

Figure 53: Total LCC Across FSTPs



The NPV of LCC for each of the FSTPs is almost 50% of the total LCC, which is represented in the graph below. This clearly denotes that the decision makers should consider the NPV of LCC for selecting the FSTPs for their towns and cities.

Figure 54: NPV of LCC Across FSTPs



9.5 Notes for trainer

This session aims to introduce to the participants to financial aspects of FSSM. Since, FSSM is dependent on a service chain, there are multiple financial transactions which might take place and need to be monitored in order to make the services affordable. For further understanding of the participants, examples of case study of Wai, Maharashtra can be presented and discussed. Case study of one or more FSTP can be elaborated and discussed further with participants from "The Cost Analysis of Faecal Sludge Treatment Plants in India" published by NIUA.

9.6 Bibliography

Cost Analysis of Faecal Sludge Treatment Plants in India Life Cycle Costing & Contracting Models of FSTPs, NIUA 2019

EAWAG/SANDEC (2008): (Sandec Training Tool 1.0, Module 5). Duebendorf: Swiss Federal Institute of Aquatic Science (EAWAG), Department of Water and Sanitation in Developing Countries (SANDEC)

Faecal Sludge and Septage Management in Urban Areas, Service & Business Models, NITI Aayog, January 2021

STRANDE, L.; RONTELTAP, M.; BRDJANOVIC, D. (2014): Systems Approach for Implementation and Operation. London: IWA Publishing

9.7 Further Reading

Faecal Sludge Treatment Systems: Design Module (Part B: Learning Notes), National Institute of Urban Affairs, Delhi, 2019

Integrated Wastewater and Septage Management — A Planning Approach (Part: B Learning Notes), National Institute of Urban Affairs, Delhi, 2020

Training module on preparation of detailed project report for Faecal sludge and septage management, National Institute of Urban Affairs, Delhi, 2018

Session

10

O&M Aspects of FSSM

10. Operation & Maintenance Aspects of FSSM

10.1 Learning objectives

- Learn the meaning of operation and maintenance (O&M) in FSSM
- Know the critical factors that govern the operation and maintenance aspects of an FSSM project
- Learn how to develop an effective O&M and monitoring plan to ensure the treatment performance of an FSTP

10.2 Session plan

Duration - 60 minutes

Topics	Time	Material/Method
O&M planning	10 min	Powerpoint presentation
Monitoring	10 min	Powerpoint presentation
Recordkeeping	10 min	Powerpoint presentation
Occupational Health and Safety	10 min	Powerpoint presentation
Case studies	10 min	Powerpoint presentation
Q&A	10 min	Discussion

10.3 Key facts

- Preventive maintenance is preferred over reactive maintenance and reduces risk of breakdown of system.
- Record keeping and asset management is essential for longevity of the project
- Occupational health and safety begin at the design project planning stage

10.4 Learning notes

10.4.1 Operation and Maintenance (O&M)

The O&M considerations which need to be taken into account while designing and planning of faecal sludge and septage treatment plant are given as follows:

Availability of local resources- Spares and tools pertaining to the natural treatment units are easily available. However, this might not be true in the case of mechanized treatment units. Consumables such as polymer or hypochlorite etc. needs to be bought quite frequently and hence the availability of the same needs to be checked. Skilled and trained manpower for mechanized treatment units might not be available at all places. Local NABL accredited laboratory should be identified for monthly checking of samples to maintain the records. Local contracting firms should be identified especially for preventive maintenance of various electromechanical components such as pumps and other equipment.

Degree of mechanization: Mechanization of the operations at the treatment facility reduced the human contact with the sludge and hence is required. However, higher degree of mechanization demands, uninterrupted power supply and trainer personnel for O&M of the plant. To optimize the operations at the treatment plant having higher and continuous load of sludge should think of certain degree of mechanization. Ex. Raking and transporting the dried sludge from the unplanted sludge drying bed can be performed using machines instead of manual labours.

A. Operation and Maintenance Plan

The O&M plan should contain the details mentioned below:

- The engineering drawings and specifications of all the treatment components installed at the treatment facility.
- In the case of electromechanical components, manufacturer's details along with the literature provided with the equipment and its operation guidelines should be attached.
- There are different types of people who will be working at the treatment facility such as environmental/civil engineer, head operator, operator, chemist, lab assistant, skilled labour etc.
- The list of tasks and person responsible for it should be clearly mentioned along with its frequency.
- Operation procedure and tools required to perform the task should be mentioned.
- Safety measure and use of appropriate PPE should be covered in the O&M plan.
- Information that needs to be monitored and logged into the operator's handbook should also be mentioned.
- Chemicals and consumables: O&M plan should consist of consumables such as chemicals their required quantities, name of the supplier and its specification. Storage details of these consumables should also be mentioned.
- In case of non-regular activities such as overhauling of dewatering equipment.
- The plan should also contain the steps that need to be taken in case of emergencies such as fire or medical emergency or natural calamity.

Maintenance Planning

Standard records are essential for maintenance planning, practices and methods. From an analysis of daily and monthly records, the work is scheduled. Plans are made to make necessary yearly repairs so as to take first things first in their importance of benefit to the whole. Emergency breakdowns and repairs will change a yearly preventive maintenance schedule. By the use of charts and diagrams showing accumulative performance and comparison of work, maintenance crews can be transferred from an operation where they are ahead of schedule, to the emergency work requiring immediate consideration. This gives flexibility to maintenance personnel. Every phase of maintenance operation needs to be considered from the collection of faecal sludge and septage from the containment units to the final discharge from the treatment plant.

Preventive or routine maintenance should be carried out to prevent any breakdown of the system and to avoid emergency operations to deal with clogged containment unit or over flowing tanks or backing up of wastewater into a house or structural failure of the system. Preventive maintenance is more economical and provides for reliability in operations of the collection and transport systems and treatment facilities. Emergency repairs, which would be very rare if proper maintenance is carried out well, also, have to be provided for. Proper inspection and preventive maintenance are necessary.

The above information showcases two main types of maintenance:

- Preventive Maintenance
- Breakdown Maintenance

The **preventive maintenance** program is essentially scheduled for inspection tasks designed to determine the effectiveness of the preventive maintenance program as well as the overall condition of the sanitary collection system. Inspections are to be done manually in most of the cases in collection-transport systems and treatment facilities.

The **breakdown maintenance** is also called as sudden maintenance and is designed to respond to a failure in the system, such as a blockage. Additionally, breakdown maintenance would provide for system rehabilitation, repair or replacement based upon the regular condition assessment of the collection system.

The maintenance procedure sheets should be prepared for each treatment unit and should consist of all the information mentioned below:

- The list of tasks which need to be performed for complete maintenance of the unit.
- The frequency of the action and certain activities such as oiling and greasing might have to be done weekly whereas checking of overhauling of the equipment needs to be done in each quarter.
- Tools required for performing the tasks needs to be mentioned clearly.
- A step-by-step procedure to do the task needs to be mentioned.
- What needs to be inspected and what the situation means should be checked and recorded into the log book.

Other regular activities

Other regular maintenance activities at the faecal sludge and septage treatment plant can be cleaning of spillages at the septage receiving station. This should be done immediately after the spillage before continuing for decanting another vehicle. Removal of scum layer at the settling thickening tank needs to be carried out on a weekly basis depending upon accumulation on the scum in the tank. Measurement of the depth of the sludge in settling thickening tank needs to be done on a daily basis or weekly basis depending on its operation cycle and incoming load of sludge. However, in the case of digesters, the measurement of the depth can be done on half yearly basis.

B. Asset Management

All the electromechanical components such as dewatering, drying equipment, etc can be considered assets for the treatment facility and need special attention to avoid breakdown. Asset management refers to the management of these electromechanical units. An asset management plan should contain all the information its cost and installation procedure. If any special specific spare parts which might require longer time to procure or costly should be known to the operator. The tools and supplies required to carry out the maintenance should be stored separately. Replacement cost of spares should also be indicated so that the operator can plan for the expenses in advance.

Preventive maintenance

It refers to the maintenance that needs to be carried out to reduce the likelihood of equipment failure. The regular preventive maintenance needs to be performed when the equipment is still functional so that it does not breakdown unexpectedly causing disruption of the operations. For example- inspecting the dewatering equipment such as a screw press for any wear and tear, cleaning of nozzles of the spray and greasing of the bearings regularly.

Regular sampling and analysis are required to understand the processes and performance of the treatment units. The records of it have to be maintained by the operator for any troubleshooting requirements.

Monitoring

The key objective of the monitoring at the sewerage system is to understand the process and performance of the sewerage units and components. Monitoring also serves as an early detection of any issue or failure. Monitoring plan with appropriate infrastructure, equipment in the laboratory, skilled personnel and finance. Different methods of monitoring are visual or sensory (odour) inputs, field (on-site) testing or elaborate analysis in the laboratory.

Chain of Custody

Chain of custody is a method which is used while performing sampling of influent and effluent for different treatment units. The custody forms contain all the necessary information regarding the samples. It also contains instructions for laboratory personnel, which might be useful for analysis of the samples. If the custody of the samples is given to another person, then this form becomes important as it ensures there is no loss of information between the person taking samples and the person analysing the samples in the laboratory.

To reflect the inspection and testing results in appropriate O&M of piping facilities, the test results should be recorded and stored in the proper format.

Figure 55: Chain of custody forms for sampling

Source: Inspector Lab

Analysis Manual

It is recommended that either a manual should be prepared specifically for the lab at the treatment facility or at least a manual prepared by experts should be followed. Such manuals contain information regarding sampling, its storage, preservation, transport and protocols to conduct tests. It should also contain information regarding the calibration and maintenance of the equipment used in the laboratory. Quality assurance and quality control plan should be available for sampling. Sampling is a very important stage in monitoring and a small mistake during this stage can significantly affect the analysis and thereby the inferences drawn from the results.

C. Record Keeping

Record keeping is a part of monitoring activity. Record keeping is in different forms and might have to be done by different persons. For example, the operator's logbook needs to be maintained by one or more operators appointed at the treatment facility. The reception log book should be maintained by the receptionist at the septage receiving station. Disaster or emergency response record helps to record the accidents happened at the facilities. These are required in case the facility goes for ISO certification. The preventive and corrective maintenance records are kept for electromechanical components to understand the right time to place orders for spares etc. Compliance's report is necessary and are to be produced in the case to pollution control board from time to time. Such record keeping helps to trace the issues, challenges and solutions for overcoming them. This documentation becomes of utmost importance, then the operators are changed during shifts or O&M contract is awarded to the new party.

Inspection Sheet

When inspections and examinations are implemented, an inspection sheet should be prepared and recorded. Figure 56 shows an inspection sheet for the machine hole. A similar inspection can be prepared for each treatment unit. The sheet needs to be filled in by the inspector and logged into the file.

Figure 56 Inspection Sheet

Inspection Sheet			No.
Location (Manhole No. etc)			
Inspection Date		Inspector	
Inspection items	Manhole cover	Abrasion, backlash, difference in level, invaded pavement, damaged, location unknown	
	Inside of manhole	Corrosion, damage to the floor, infiltration, metal steps corroded, inferior pipe end, rubbish, odour	
	Pipe	Corrosion, damage, coupling displacement, inadequate inclination, infiltration, roots of trees, earth, sand and mortar, road subsidence	
	House inlet	Cover (no damage), difference in level, corrosion, damage, damaged invert, earth and sand, location unknown, odour	
	Lateral	Damage, displacement, earth and sand, road subsidence	
Inspection Date		Inspector	
Inspection Result			
Follow up actions	□Necessary □Not necessary	□Contracted □ Self	
Date of order			
Date of schedule			
Date of completion			
Remarks			

Source: CPHEEO Manual, Part B – O&M, 2013

Logbook

Dedicated bound logbooks will be used for field data collection including but not limited to sampling, measurements and observations. Logbook entries should be objective, factual, and free of personal feelings or other terminology which might prove inappropriate. All pertinent field activity information will be recorded contemporaneously when observed or collected to prevent a loss of information. The logbook should be used to record daily work results, which can be used in the O&M of piping facilities. Then the daily record should be summarized in monthly reports.

Reception monitoring reports

Reception monitoring reports record the amount of sludge received at the plant each day, the discharge fees collected, and any issues reported by drivers or employees. Maintenance of accurate reception monitoring reports is critical as it minimises fraud and assists in guaranteeing that the collected FS was delivered to the FSTP and not discharged elsewhere.

Health and safety

There are many health and safety hazards associated with the typical tasks required to operate and maintain FSTPs. Health and Safety aspects should therefore form an integral part of the O&M plan but are quite often not given adequate attention.

The Health and Safety Plan specifies the procedures, practices and equipment that should be used by employees in order to conduct activities in a safe manner. Health and safety plans are prepared specific to each FSTP and contain aspects common to all FSTPs. Health and safety procedures are strictly enforced by management through the preparation of the safety plan, and also through posters and signs located in areas of risks (e.g., ponds and tanks, electrical device, confined spaces.

Based on experience, the following topics should be included in the health and safety plans:

- Personal Protective Equipment (PPE) and safety measures for o&m activities;
- Infection control and hygiene measures;
- Emergency contact procedures;
- Protection against falling and drowning hazards;
- Confined space entry protection; and
- Electrical safety and the use of the 'lock-out tag-out' procedure.

1.0.4.2 O&M case studies

1. O&M of Sanitation Facility, Tamil Nadu

In Tamil Nadu, Trichy city has adopted an approach to the management of its CT/PTs. Two decades ago, with support from Water Aid, Non-Governmental Organisation, Gramalaya, organised volunteers from SHGs as Sanitation, Hygiene, Education (SHE) teams to manage some toilets facilities. However, further support was needed towards efficient service provision along with sustainability and accountability. To address this, CT/PTs run by SHE team were strengthened through the Citywide Inclusive Sanitation (CWIS) programme. The objectives were to improve O&M and incurability of CT/PTs' financial sustainability to increase their usage and ensure reduction in the incidence of open defecation. Starting the initiative with support to 40 SHE teams, the programme has grown to bring new teams in other neighbourhoods. SHE teams are now responsible for the operation and maintenance of around 150 public conveniences in the city.

The initiative involved mobilising and capacitating women to operate CT/PTs along with broader outreach work. Towards this they were trained on various aspects including team building, record keeping and reporting, CT O&M and financial sustainability. SHE teams were federated as

Women's Action in Village Empowerment (WAVE) Federation with one member from each SHE team joining the WAVE Federation. The federated approach allows for cross-subsidisation, with toilets with higher footfall and higher revenue contributing to the upkeep of other toilets in lower footfall areas. Regular supervisory meetings and mechanisms have been instituted through the Federation. With 150 She teams, nearly 400 women have received training. In addition, vulnerable members of communities are provided employment, as those who are physically challenged, destitute, widowed or old are typically appointed as caretakers at the facilities. The teams simultaneously work to increase awareness on sanitation and hygiene within their communities, including ill-effects of open defecation, importance of well-maintained toilets and depute a person for solid waste management.

2. O&M of Sanitation Facility, Odisha State

Entrepreneurship has long been recognized as an important source of poverty alleviation, economic empowerment and a means to mitigate gender inequity. However, social norms and gender specific barriers have inhibited economically and socially marginalized groups, such as women and transgender, from making their mark in entrepreneurship. Micro entrepreneurship thus offers such vulnerable individuals with limited education and skills, a viable avenue to participate in economic activities, provided the same is accompanied by long term technical, financial and incubation support.

Figure 57: Engaging Women led SHGs through National Urban Livelihood Mission for O&M of the sanitation facility and treatment plants

Source: NITI Aayog and NFSSM Alliance, 2021

Cognizant of the same, the state of Odisha has been involving such marginalized members from the community in the state's sanitation endeavours through partnerships and associations with community organizations like Self Help Groups (SHGs). Accordingly, SHGs are involved in a number of sanitation initiatives from CT/PT construction to its O&M, composting, solid waste management, to mechanized desludging of toilet septic tanks/ cesspool operations, and more recently, a unique pilot in maintaining of septage treatment plants in 4 cities across the state.

10.5 Notes for trainer

This session talks about O&M of various FSSM components, it is recommended to have a discussion with the participants on integrating O&M with planning and design, asset management, monitoring and record keeping of wastewater management system components. It also talks various cases studies from all over India on successful management of sanitation in various cities.

10.6 Bibliography

STRANDE, L.; RONTELTAP, M.; BRDJANOVIC, D. (2014): Systems Approach for Implementation and Operation. London: IWA Publishing

Manual on Sewerage and Sewage Treatment Part B, Central Public Health and Environmental Engineering Organization.

10.7 Further Reading

Training module on preparation of detailed project report for Faecal sludge and septage management, National Institute of Urban Affairs, Delhi, 2018

Integrated Wastewater and Septage Management — Planning Module (Part: B Learning Notes), National Institute of Urban Affairs, Delhi, 2020

Faecal Sludge Treatment Systems: Design Module (Part B: Learning Notes), National Institute of Urban Affairs, Delhi, 2019

Notes

Notes

Download our latest reports, research briefs
and training modules at:

scbp.niua.org

About NIUA

NIUA is a premier national institute for research, capacity building and dissemination of knowledge in the urban sector, including sanitation. Established in 1976, it is the apex research body for the Ministry of Housing and Urban Affairs (MoHUA), Government of India. NIUA is also the strategic partner of the MoHUA in capacity building for providing single window services to the MoHUA/states/ULBs.

About SCBP

The Sanitation Capacity Building Platform (SCBP) is an initiative of the National Institute of Urban Affairs (NIUA) to address urban sanitation challenges in India. SCBP, supported by Bill & Melinda Gates Foundation (BMGF) is an organic and growing collaboration of credible national and international organisations, universities, training centres, resource centres, non-governmental organisations, academia, consultants and experts. SCBP supports national urban sanitation missions, states and ULBs, by developing and sourcing the best capacity building, policy guidance, technological, institutional, financial and behaviour change advise for FSSM. SCBP provides a unique opportunity for:

- Sharing and cross learning among the partner organisations, to pool in their knowledge resources on all aspects of urban sanitation capacity building;
- Developing training modules, learning and advocacy material including key messages and content, assessment reports and collating knowledge products on FSSM. Through its website (scbp.niua.org), SCBP is striving to create a resource centre on learning and advocacy materials, relevant government reports, policy documents and case studies;
- Dissemination of FSSM research, advocacy and outreach to State governments and ULBs.

Its strength is its ability to bring together partners to contribute towards developing state sanitation policy, training of trainers and training content development, technical and social assessments, training programme delivery, research and documentation.

National Institute of Urban Affairs

National Institute of Urban Affairs

1st Floor, Core 4B, India Habitat Centre, Lodhi Road, New Delhi - 110003
Phone: 011-24617517, 24617543, 24617595, Fax: 011-24617513
E-mail: niua@niua.org • Website: www.niua.org, scbp.niua.org

FAECAL SLUDGE AND SEPTAGE MANAGEMENT—PLANNING MODULE PART B: LEARNING NOTES