# FAECAL SLUDGE AND SEPTAGE MANAGEMENT

## AN ADVANCED TRAINING MODULE

## PART B - LEARNERS' NOTE

SCBP

Sanitation Capacity Building Platform

National Institute of Urban Affairs

Consortium for DEWATS Dissemination Society

Sanitation Capacity Building Platform

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**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

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This document is a compilation of various reference materials and additional reading materials to enhance the understanding of faecal sludge management. This compilation is provided along with the training on advanced faecal sludge management developed and delivered as part of Sanitation capacity building platform.

The platform provides due credit to CAWST, EAWAG, Ludwig Sasse, BORDA and UNESCO-IHE for having utilised their resource for the preparation of the compilation.

The materials in the document are to be read and understood alongside the other resources provided during the training.

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# ABOUT SANITATION CAPACITY BUILDING PLATFORM

National Institute of Urban Affairs (NIUA) is a national nodal institute that works closely with the Ministry of Housing and Urban Affairs (MoHUA), Government of India. The Sanitation Capacity Building Platform (SCBP) anchored by NIUA aims to build local capacity for planning, designing and implementing non-sewer decentralized sanitation solutions, with specific focus on Faecal sludge and septage management (FSSM) and waste water.

SCBP is a partnership of various research organizations and non-profit institutions (CPR, BORDA/CDD, CEPT, CSTEP, UMC, CSE, CPR, WASHi, iDECK, Dasara, Ecosan Services Foundation, AIILSG). The platform works in in partnership with national nodal training institutes working for Atal Mission for Rejuvenation and Urban Transformation (AMRUT) and Swachh Bharat Mission (SBM), with universities and research organizations and all stakeholders in the urban sanitation space. SCBP is supported by a grant from the Bill and Melinda Gates Foundation (BMGF).

# ABOUT THIS HANDBOOK

The Swachh Bharat Mission has aimed to make India open defecation free by October 2019. The wide prevalence of on-site sanitation system in India necessitates the need to explore safe management of septage along with improved access to toilets. Recognising this, the Government of India has also emphasised septage management in its flagship programme of AMRUT and has also issued policy guidelines on Faecal Sludge and Septage Management (FSSM).

This document is a part of the advanced training module on faecal sludge management for engineers. It provides engineers with a comprehensive understanding on various aspects of FSM such as planning, design of treatment systems, contracts for implementation and O&M, etc.

This document consists of details pertaining to the concept of the training, session plan, objectives and key take aways from each session and lesson plan. The purpose of this document is to faciliatate the resource person in conducting the training program.

# ABOUT THE TRAINING MODULE

| | |
|---|---|
| Day 1, Session 1<br>Introduction and need for FSM | This session introduces the importance and global need for faecal sludge management to realize public health, environmental, social, and economic benefits. |
| Day 1, Session 2<br>Feacal Sludge Management - Over view | This session facilitates understanding of the problems in FSM implementation and also have an idea about tentative solutions to overcome these problems |
| Day 1, Session 3<br>Case Studies | This session covers the FSM case studies from around the world and heps to understand the applicability and efficiency of FSM in various scenarios |
| Day 1, Session 4<br>Collection and Conveyance of FS | This session introduces the various options for collection and conveyance of faecal slude and enables the participant to calculate the number of trucks for their town/city |
| Day 1, Session 5<br>Approach to Feacal Sludge Treatment | This session heps to understand the difference between sewage and faecal sludge and to familiarize with treatment principles, objectives, and outcomes |
| Day 1, Session 6<br>Faecal Sludge Treatment Technologies | This session introduces at least five treatment technologies for faecal sludge and to understand the need for combination of treatment technologies |
| Day 1, Session 7<br>Planning for FSTP Implementation | This session introduces the process involved in implementing an FSTP different cities and explains various contract methods for implementing FST |
| Day 1, Session 8<br>Preparation for feasibility study | This session elaborates the different data collection points and methods for a feasibility study to implement FSM |
| Day 2<br>Feasibility Study | This session allows the participants to gain hands on experience in data collection for feasibility study to implement FSM |
| Day 3, Session 1<br>Presentation on feasibility study | This session is an activity where the participants prepare and presentation of the data collection during the feasibility sutdy and discuss the scenarios |
| Day 3, Session 2<br>Treatment conecpt - Sludge drying | This session hepls to understand the concept and characteristics of sludge drying using planted and unplanted drying beds |
| Day 3, Session 3<br>Design of drying beds | This session enanles the participants to carry out preliminary design of the treatment module - Sludge drying and planted sludge drying bed |
| Day 3, Session 4<br>Treatment concept - effluent | This session introduces the components of effluent treatment that is required in a faecal sludge treatment plant |
| Day 3, Session 5<br>Design of Treatment Systems | This session hepls the participants to put together modules for treatment of faecal sludge to achieve the desired objective |
| Day 3, Session 6<br>Operation and Maintenance | This session deals with the various O&M requirements of the technology options discussed during the training |
| Day 3, Session 7<br>Components and Review of a DPR | This session elaborates the various components that must be included in an FSTP DPR and proveids a framwork for assessing an FSTP DPR prepared by external consultants |

# Introduction

Non-sewered sanitation is a recent and novice topic in the field of sanitation planning and implementation in India. Though these systems have been existent for quite some time in the country, not much focus was laid on the proper and sustainable treatment of waste generated from such systems. The focus over the years has largely been towards networked or sewerage based sanitation with the focus to connect all household's wastewater sources to a network and provide an end of the pipe treatment. Though such an approach might be at the mainstream of planning, yet the dearth of funds and sustainable operation model has led to very few urban local bodies being sewered. As a result, most ULB still primarily rely on non-networked sanitation such as septic tanks, pits, community cess pits etc. There is not much that has been done or planned for treatment or conveyance of the waste from such systems and their treatment.

However, with the recent changes in the policy and emphasis by civil society, the focus is now also towards safe conveyance and treatment of wastewater generated from such on site sanitation systems. Urban local bodies have been provided mandate and direction by the central and state governments to promote FSM (a major part of non-sewered sanitation). However, the capacities within the ULB or other engineering departments are limited in this field. It is hence the need of the hour to equip the team of these engineers with knowledge and skill to implement effective solutions.

This document is a learning tool for the participants of the training program for government engineers working with the state or local bodies who would be intimately or partly involved in planning and implementing an FSTP.

# TRAINING AGENDA

## DAY 1

| Time | Session name | Session outcomes |
|---|---|---|
| 0930 -1000 | Registration and introduction | Participants introduction and training outcomes and expectations |
| 1000 – 1045 | Introduction and need for FSM | ▪ Participants understand the concept and need for FSM<br>▪ Participants remember shit flow diagram (SFD) as a tool for assessing sanitation<br>▪ Participants can list the stakeholders involved in FSM |
| 1045 – 1130 | Faecal sludge management – Overview | ▪ Participants will learn the components of FSM.<br>▪ Participants have an understanding of the problems in FSM implementation and also have an idea about tentative solutions to overcome these problems |
| 1130 – 1145 | Tea break | |
| 1145 – 1230 | Case studies | ▪ Participants are confident of FSM as a solution<br>▪ Participants can remember benefits accrued to the public and ULB due to FSM |
| 1230 – 1300 | Collection and conveyance of Faecal sludge | ▪ Participants are aware of various options for collection and transport of faecal sludge<br>▪ Particpants are able to estimate the number of vechicles required for desludging. |
| 1300 – 1400 | Lunch break | |
| 1400 - 1445 | Approach to Faecal sludge treatment | ▪ Participants understand the difference between sewage and faecal sludge<br>▪ Participants are familiar with treatment principles, objectives, and outcomes |
| 1445 – 1530 | Faecal sludge treatment technologies | ▪ Participants are aware and remember at least five treatment technologies<br>▪ Participants understand the need for combination of treatment technologies |
| 1530 – 1545 | Tea break | |
| 1545 – 1630 | Planning for FSTP implementation | ▪ Participants are aware of the process involved in implementing an FSTP for their cities<br>▪ Participants are aware of various contracting methods for FSTP implementation |
| 1630 - 1700 | Preparation for feasibility study | Participants are aware of data collection methods for a feasibility study |
| 1700 - 1715 | Debriefing on days learning | Participants reinforce their learnings |
| 1715 – 1730 | Feedback | Participants co-create the learning environment based on their needs. |

## DAY 2

| Time | Session name | Session outcomes |
|---|---|---|
| 0930 – 0950 | Briefing | Participants are aware of the day's agenda and remember critical data to be collected |
| 0950 – 1100 | Travel to site | |
| 1100 – 1300 | Data collection in groups | Participants have necessary data for feasibility study |
| 1300 – 1345 | Lunch at site | |
| 1345 – 1500 | Return travel | |
| 1500 – 1515 | Debriefing | Participants learn new perspectives from others/groups |
| 1515 – 1700 | Group work | Participants have information for preparing feasibility study |

# DAY 3

| Time | Session name | Session outcomes |
|---|---|---|
| 0930 -1000 | Preparation for Feasibility study | |
| 1000 – 1100 | Presentation on Feasibility study | Participants have experience of a feasibility study |
| 1100 – 1130 | Treatment concept – Sludge drying (Planted and unplanted drying beds) | Participants understand the concept and characteristics of sludge drying using planted and unplanted drying beds |
| 1130 – 1145 | Tea break | |
| 1145 – 1215 | Design of sludge drying bed | Participants carry out preliminary design of the treatment module – Sludge drying and planted sludge drying bed |
| 1215 – 1300 | Treatment concept – Effluent treatment | Participants can list and understand the components of effluent treatment |
| 1300 – 1400 | Lunch break | |
| 1400 – 1500 | Design of a treatment system | Participants can put together modules for treatment of faecal sludge to achieve the desired objective |
| 1500 – 1530 | O&M of Treatment technologies – sludge drying beds, planted drying beds and Effluent treatment | Participants are aware of th various O&M requirements of the technology options discussed during the training. |
| 1530 – 1545 | Tea break | |
| 1545 – 1630 | Components and review of DPR | ▪ Participants know the various components that must be included in an FSTP DPR<br>▪ Participants posses a framework for assessing an FSTP DPR prepared by external consultant |
| 1630 – 1700 | Debriefing | To assess the learning of the participants |
| 1700 – 1715 | Feedback | Participants can share their learning experience |

## Day 1 - Session 1

# Introduction and need for FSM

This Technical Brief introduces the importance and global need for faecal sludge management to realize public health, environmental, social, and economic benefits.

Great efforts are being made globally to reduce open defecation by building on-site sanitation technologies, like pit latrines and septic tanks. Yet, emptying full on-site sanitation technologies and safely managing the faecal sludge is an essential service that is often neglected. Households and institutions are lacking the knowledge, skills and services to manage the faecal sludge once the technology is full.

2.7 billion people around the world use on-site sanitation technologies that need faecal sludge management services (Strande, Ronteltap & Brdjanovic, 2014). Ideally, on-site sanitation technologies should be emptied in a safe and hygienic manner by well-equipped and protected workers who transport the sludge for treatment, use or disposal. However, in reality, most technologies are either abandoned or emptied using unsafe and unhygienic methods. Sludge is simply dumped by the home, in the street, or in nearby water sources.

Day 1

Session 1

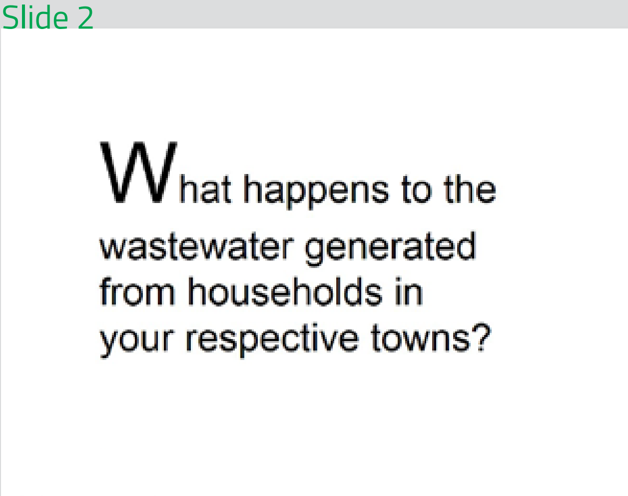
Outcomes

- Participants can list the stakeholders involved in FSM
- Participants understand the concept and need for FSM
- Participants remember shit flow diagram (SFD) as a tool for assessing sanitation

# Objectives of the session

- Goals of sanitation
- Sanitation value chain and the issues occurring across it
- Shit flow diagram
- Role of FSM within sanitation
- Financial estimates for centralised v/s FSM system
- Stakeholders in FSM

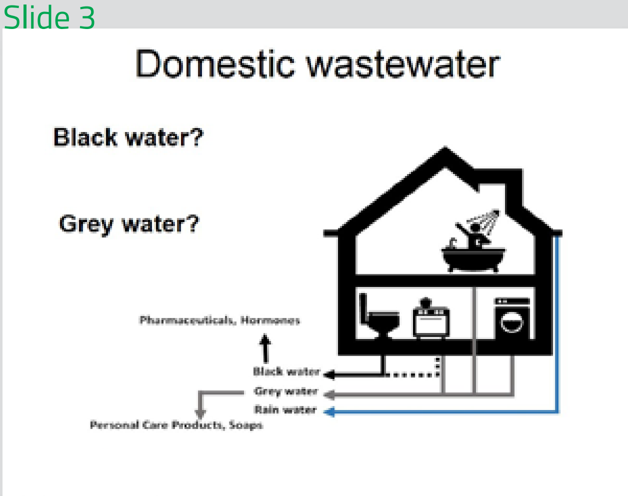
Slide 2




Wastewater is water that has been used for various human consumption (domestic, agricultural, commercial or industrial) purposes.

Wastewater generated from households is also called domestic wastewater. It should ideally go into a piped conveyance system or into a containment system

Slide 3

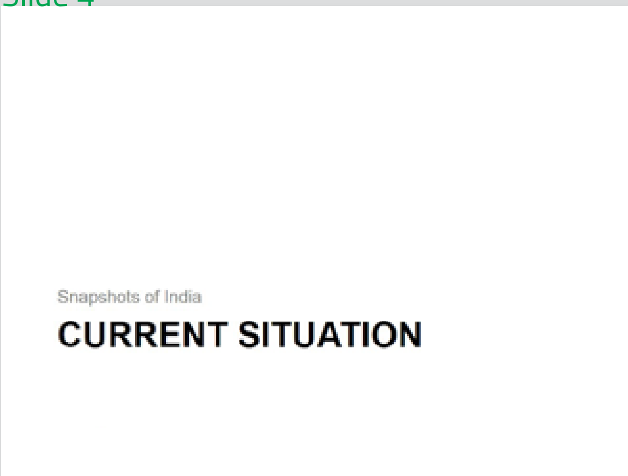



Domestic wastewater mainly constitutes of black water and grey water.

Black water comprises of source-separated wastewater from toilets, containing faeces, urine and flushing water (and eventually anal cleansing water in "washing" communities).

Grey water comprises of source-separated wastewater from the kitchen, bath and/or laundry, which generally does not contain significant concentrations of excreta

Slide 4




Slide 5

Open defecation is practiced by 49.8 percent of the population in India. This is a matter of great concern from environment, public health and safety.

Slide 6

Typically the sanitation situation in India is grim. The toilets are broken or in unusable condition. Lack of proper maintenance is the key reason for this situation.

Slide 7

Laying conventional sewer system over a larger area is expensive. These systems also require high maintenance. The high cost of maintenance and replacement makes unrepaired sewer pipes a common site in countries like India.

Slide 8

One of the manifestations of lack of solid and liquid waste management is in the form of polluted storm water drain channels. These drains were originally supposed to carry storm water (rain water). Most of them have transformed into gutters carrying domestic wastewater and solid waste resulting in choking of the drains and reduction of the overall carrying capacity of the drains. As a result when rain water pours into these drains, these drains overflow into the streets thereby posing a public health hazard.

Slide 9

Lack of liquid waste treatment facilities has resulted in indiscriminate disposal of sludge collected from on-site sanitation systems such as septic tanks and pits into open area. This in effect negates the environmental benefits coming from using toilets as the waste is still getting dumped directly into the environment.

Slide 10


Poor sanitation facilities results in human excreta directly disposed into the environment. This leads to contamination of water and soil which in turn takes a heavy toll on the health of people, especially children, who are more susceptible to diseases due to weak immune system.

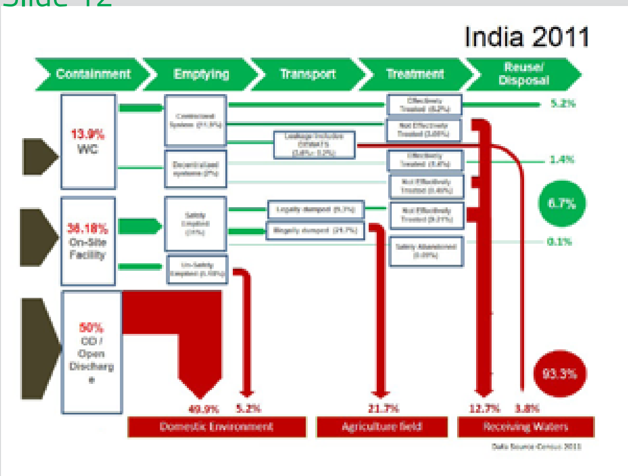
Slide 11


There are four major goals of sanitation:

- Public health: bringing down prevalence of diseases caused by lack of sanitation
- Environment: prevent or contain the contamination of water, soil and air
- Convenience: easy and convenient to use
- Safety: shouldn't expose the user to any caused by animals or humans

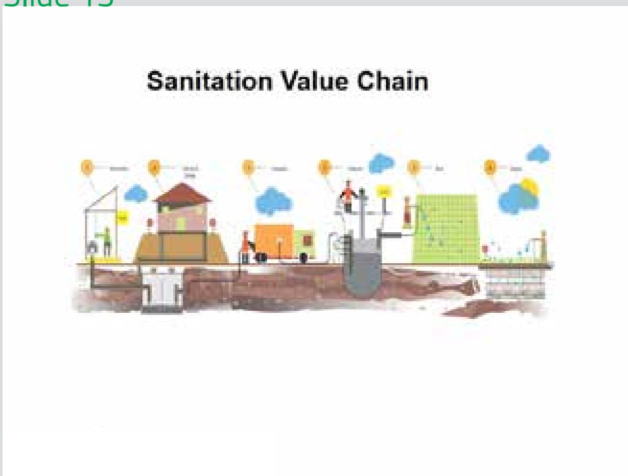
The toilets without adequate management of waste coming out of it address only the issues of convenience and safety leaving the first two unaddressed.

Slide 12




The 2011 Census suggests that 93.3% of the human excreta generated in India are ending into the environment. With the reduction in open defecation due to the government-led toilet building initiatives, the amount of excreta disposed into the environment right after defecation will reduce. However, due to inadequate facilities for treatment of the excreta, the excreta will continue to end up into the environment untreated.

Slide 13




The sanitation value chain is a diagrammatic representation of the movement of faeces from generation to disposal. It has six components:

- User interface
- Collection & storage
- Conveyance
- Treatment
- Reuse
- Disposal

In the first two stages where the mason could play an important role in the sanitation value chain.

Slide 14


User interface comprises of the toilet superstructure. There are 4 common types of user interfaces:

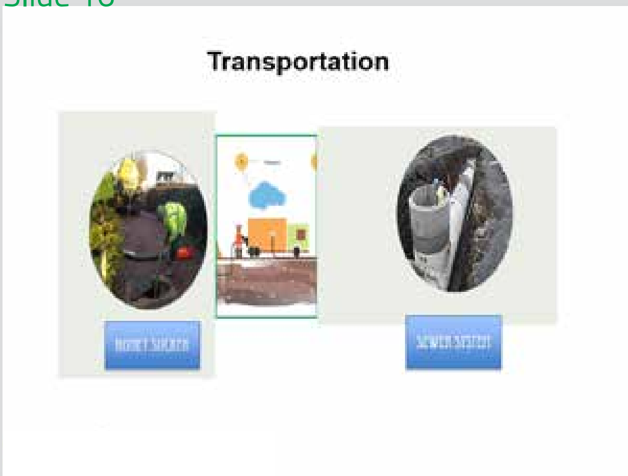
- Pour flush toilets: these are toilets in which the faeces and/ or urine is flushed by pouring down water manually, usually with a bucket
- Cistern flush toilets: these are toilets in which the faeces and/ or urine flush by pressing down a flush lever attached to a cistern to release water
- Pedestal type toilet: these toilets allows the user to sit and use the toilet
- Urine diversion toilets: these toilets have separate slots for urine, faeces and anal cleansing there by allowing the sterile urine to be separated at source from faeces. The separately collected urine can directly be used in agriculture after dilution in water in 1:20 urine: water ratio.

Slide 15


Containment or collection & storage comprises of the containment system. There are 4 common types of containment system:

- Soak pit: these are the simplest form of containment unit in which the solids of the faecal matter is contained in the pit and the liquid is allowed to be absorbed into the soil in a controlled manner through the gaps in the containment structure. It is ideal for areas with moderate to low water table; i.e. the bottom of the pit should be at least at 1.5 metres in all the seasons.
- Twin pits: these are containment units which also act as simple treatment units. Two soak pits are constructed and only one is used at a time. Once the first pit fills up, the pit is closed and the faecal matter is allowed to decompose. Meanwhile the second pit is used to contain the fresh faecal matter. The pits are constructed in adequate size so that by the time the second pit fills up; the matter in the first pit is completely decomposed and is safe to be applied in agriculture. The first pit can then be emptied and used, while the second pit remains closed for the faecal matter to decompose. This type of system can be used in areas where soak pits can be used.
- Septic tanks: these are 2 chamber water-tight containment units which are designed to both contain the solids and treat it to some extent due to the movement within the tank from one chamber to another. The effluent (liquid part) is ideally let out into a soak pit filled with a filter media allowing the water to get absorbed in a controlled manner. These are ideal for high water table conditions.
- Holding tank: these are single chambered water tight tanks which hold both the solid and liquid part, thereby requiring frequent cleaning (desludging).

Slide 16




Conveyance is usually done by vehicle mounted cesspool trucks (also called honey suckers) transporting the sludge from the containment unit for treatment or disposal.

In case of sewered system, the waste is directly collected from the user interface and conveyed to the treatment plant using sewer lines.

Slide 17

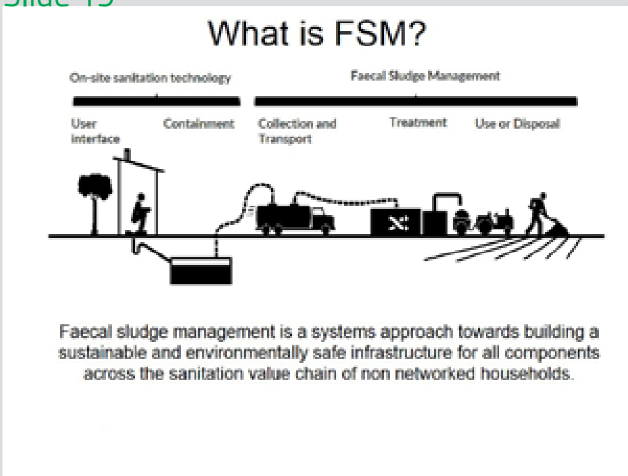

Faeces is treated in treatment plant which are centralized (catering to an entire town) and decentralized (catering to small pockets within the town, closer to the source of generation) in nature.

Slide 18


After treatment, the bio-solids can be used as soil conditioner while the effluent can be used for irrigation, landscaping or let into water bodies after meeting required discharge standards.

Reuse ensures resource recovery. It plays a great role in ensuring economic viability of the system by sale of the reuse products and environmental sustainability by ensuring that the resources are returned to the environment in the most beneficial way.

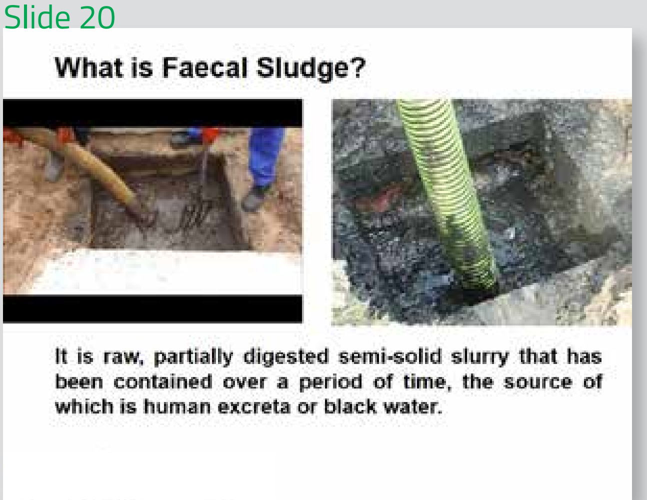
Slide 19




The above discussed process of managing the flow of faeces from the source of generation to reuse and/ or disposal is called faecal sludge management. It involves building infrastructure and coordinating with institutions and stakeholders involved in providing sustainable sanitation in non-sewered areas.

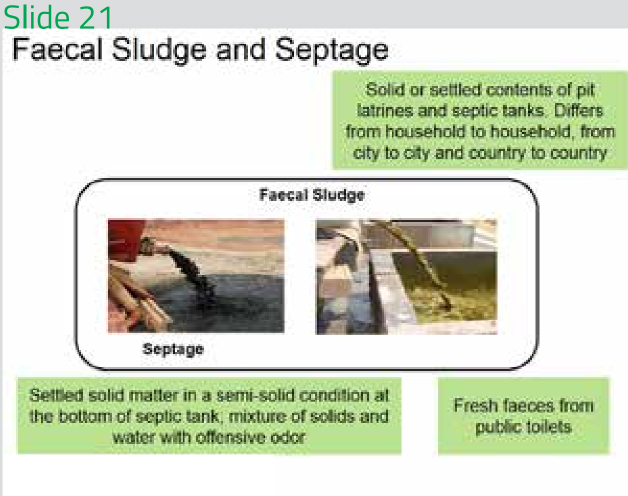
For more information refer to (Technical Brief: Introduction to Faecal Sludge Management)

Slide 20




It is the sludge (raw or partially digested semi solid slurry) formed from faecal matter after being contained in a containment unit over a period of time. For more information refer to (Technical Brief: What is faecal sludge?)

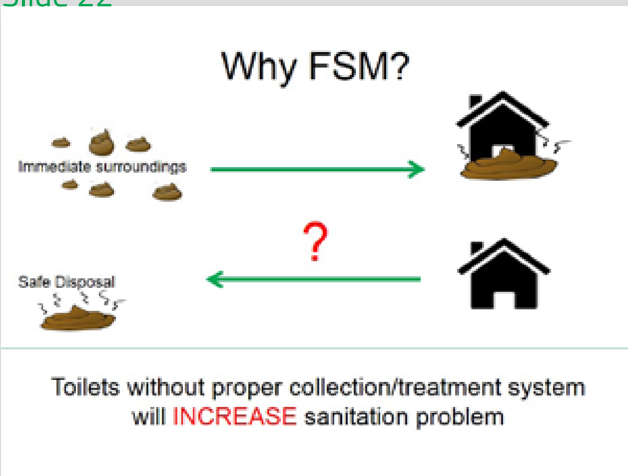
Slide 21




Faecal sludge is any faeces generated sludge contained in a containment unit over a period of time. It is a broad term referring to the sludge generated in any kind of containment unit.

Septage is a subset within faecal sludge specifically referring to the sludge generated from a septic.

Slide 22




As discussed earlier, building toilet alone without the adequate FSM still leads to environmental and public health issues.

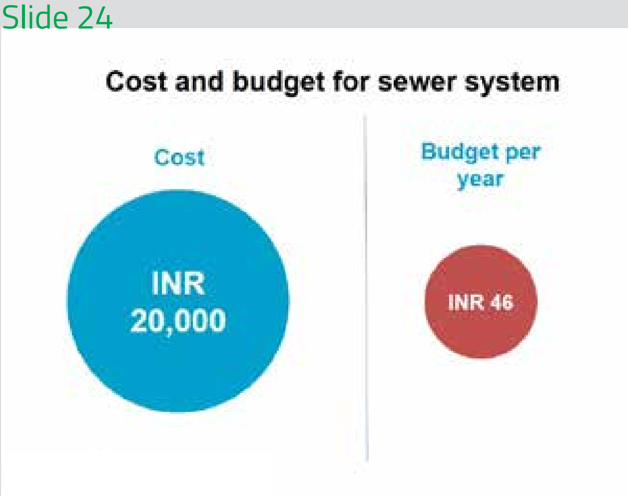
Slide 23

**Budget for wastewater**

| Description | Total Budget | | Wastewater | |
|---|---|---|---|---|
| | USD | INR | % | INR/capita |
| AMRUT | 0.63 B | 41 B | 31% | 10 |
| State and City | 0.20 B | 13 B | 100% | 10 |
| Smart City | 0.50 B | 32 B | 25% | 6 |
| National River Conser | 0.06 B | 4 B | 50% | 1 |
| SPM Rurban Mission | 0.04 B | 3 B | 30% | 1 |
| Namami Gange | 0.35 B | 23 B | 60% | 10 |
| External Assistance | 3.38 B | 220 B | 5% | 8 |
| Total | | | | 46 |

Taking into account all the available sources of funds for wastewater, only Rs 46 is allocated per capita.

Slide 24

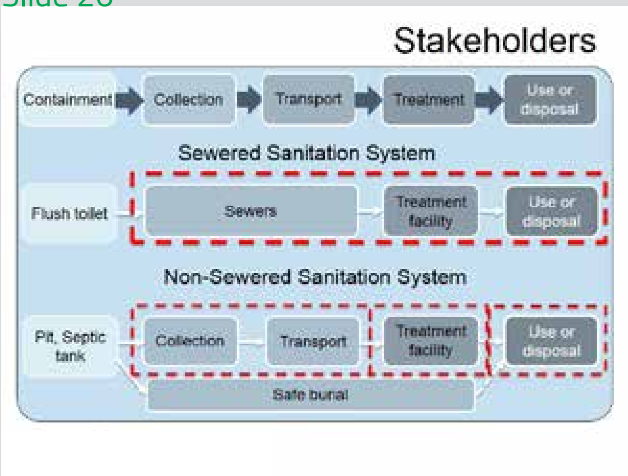



On the other hand, Rs 20000 per capita is required to build sewer lines for the whole population. Since sufficient funds are not available in order to build sewer systems, there is a need for an economically viable alternative.

Slide 25


The goals of FSM are to ensure that all the components i.e. containment, conveyance, treatment and reuse is carried out with the greatest possible efficiency thereby ensuring environmental sustainability and economic viability.

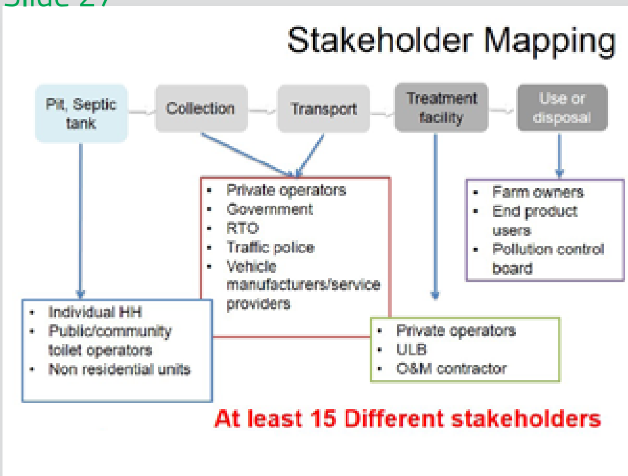
Slide 26




In case of sewered sanitation, the sewers, treatment facility and disposal mechanism acts as a single entity working closely with each other. Usually, all three are managed by one single agency.

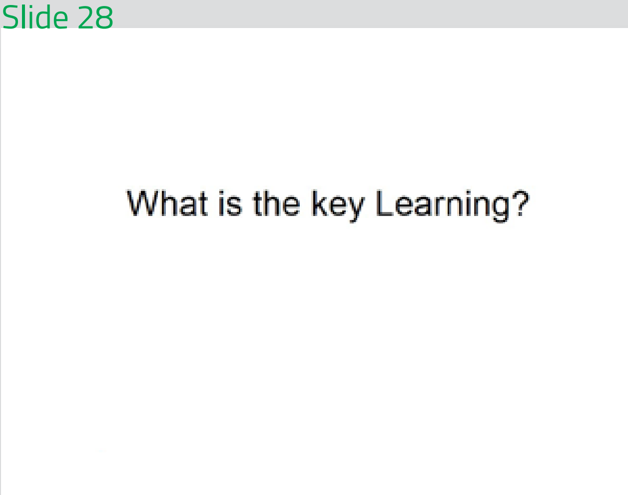
FSM, on the other hand, involves multiple stakeholders each managing one component of the value chain.

Slide 27

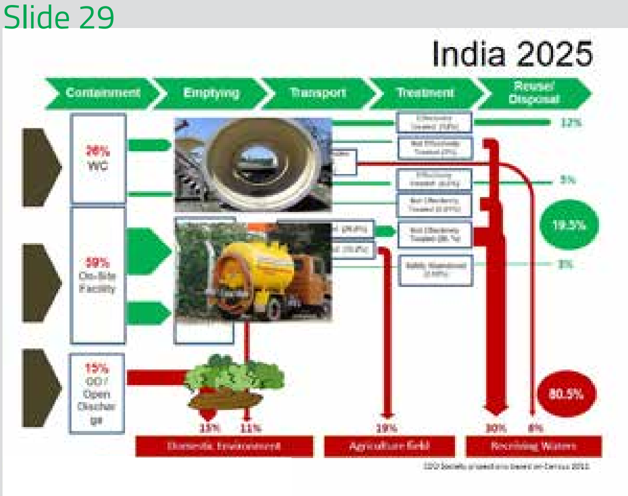



FSM involves variety of stakeholders in the form of users, masons, cesspool operators, treatment plant operator, consumers of end products (such as farmers) and the overall governance and institutional mechanism (ULB, pollution control board etc.) within which the system will function.

Slide 28

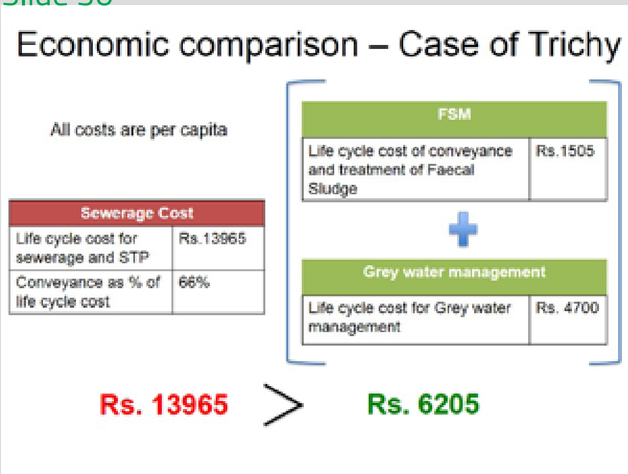



Slide 29




With the current rate, the problem of unsafe sanitation will not be solved even in 2025.

Slide 30




The case of Trichy shows that FSM and greywater management together proves to be a low-cost alternative to sewerage. For more details refer Economics Comparison (Praveen, 2017).

# References

Praveen, N. (2017). Economic Comparison : Assessment of FSM vs Piped sanitation: Case of Tiruchirapalli. Bengaluru: CDD Society.

(n.d.). Technical Brief: Introduction to Faecal Sludge Management. Centre for Affordable Water and Sanitation Technology.

(n.d.). Technical Brief: What is faecal sludge? Centre for Affordable Water and Sanitation Technology.


Kitchen

## Day 1 - Session 2

# Faecal Sludge Management Overview

The process leaders who are designated with the responsibility for planning and implementing a city- wide faecal sludge management (FSM) system often face a complicated situation, characterised by diverse levels of service and a patchwork of uncoordinated and independent stakeholders managing various activities. FSM planning aims to transform such a complex situation into a well-organised and coordinated management framework, which is usually initially expressed in the form of a city sanitation plan or citywide sanitation strategy and later translated into action plans and concrete implementation. This is no easy task as stakeholders have different and even conflicting interests, needs and constraints.

However, it is a crucial task, as urban sanitation planning is the key to sound investment and clear action plans greatly assist in sourcing funding. If donor money is being sought, a detailed plan with a clear strategy will be necessary. The problem with urban sanitation is not only a lack of investment, but also the lack of a plan. FSM planning is about understanding and matching stakeholders' interests, needs and constraints with an appropriate and accepted management scheme and financial mechanisms.

Experience in FSM shows that every solution should be context-specific and integrated. Moreover, experience in Asia demonstrates that any number of approaches can be successful when implemented in conjunction with a comprehensive legal and regulatory framework, clear delineation and appropriate delegation of roles and responsibilities, and dedicated public funding.

In the past, many water and sanitation projects have failed because of the lack of an integrated approach. The development of physical infrastructure is only one component of a functioning FSM program, which also depends upon sustained public sector commitment and funding, effective policies, appropriate implementation and compliance enforcement.

Day 1

### Session 2 Outcomes

- Participants will understand the components of FSM
- Participants have an understanding of the problems in FSM implementation and also have an idea about tentative solutions to overcome these problems

# Objectives of the session

Familiarise the participants with various components of an enabling environment.
Introduction to mechanisms to create an enabling environment

## Slide 2


The enabling environment for FSM constitutes the following:

- Physical facilities: the existing and upcoming infrastructure
- Awareness levels among the stakeholders
- Existing regulatory mechanism and gaps in the same
- Existing institutional mechanism and gaps in the same
- Capacity building: existing level of training and gaps in the same
- Financial resources available and potential sources of finance
- Management: the existing system of coordination among various stakeholder in the value chain

## Slide 3

Who can do what?

What should the state government do?

What should the ULB do?

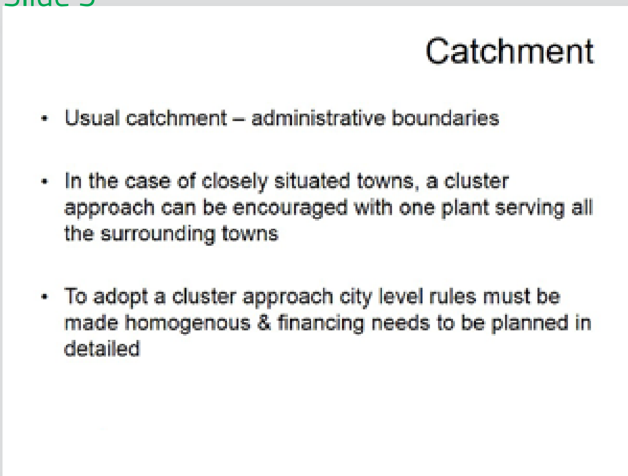
The first step towards FSM in a town is how the work is to be distributed. This involves:

- Determining the role of each stakeholder will play
- Determining the extent of government involvement for ensuring the efficiency of the system.

Slide 4


The bucket list for state includes all the regulatory and institutional mechanisms at state level which can be uniformly applied across the state in order to monitor the efficiency and compliance of FSM components.

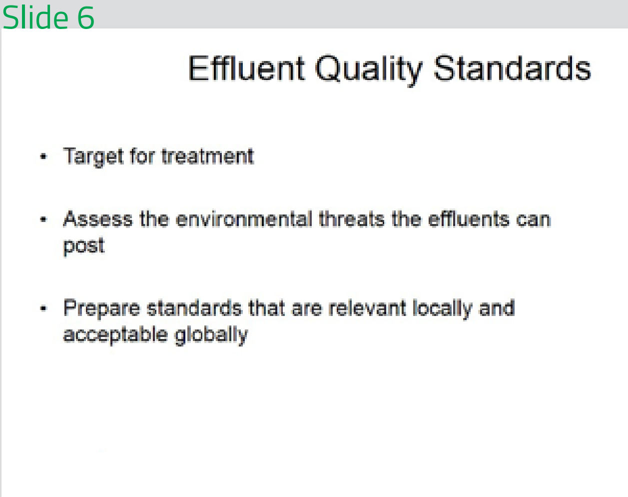
Slide 5




Catchment is a mechanism used by the bodies implementing FSM to set the boundary for the FSM activities.

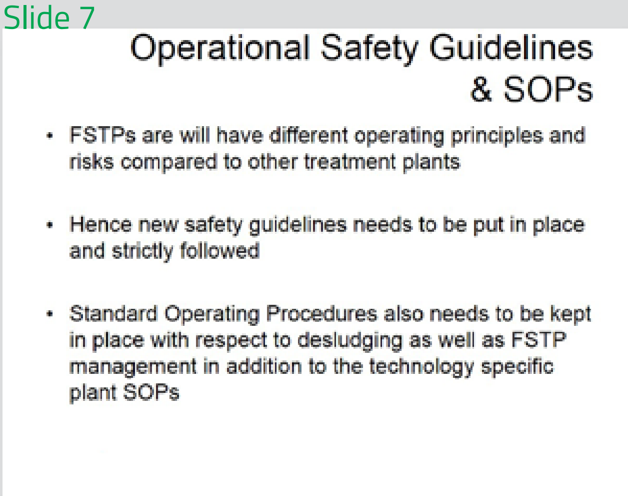
The catchment can be limited to one town or multiple towns if the towns are located close to each other. This approach of clustering multiple urban local bodies is called cluster approach, which is beneficial in terms of economic considerations.

Slide 6



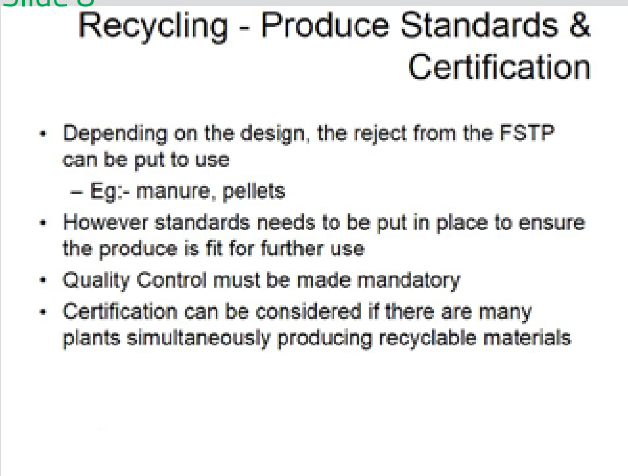

The effluent quality standards should be aimed at keeping the threat to environment posed by the effluent at the minimal. The standards should be designed depending on the local conditions and the possible reuse options

Slide 7




Operational safety guidelines and SOPs are needed in order to ensure that standards are maintained in order to ensure the safety of those performing FSM operations (such as the cesspool and treatment plant operators) and those living around it.

Slide 8

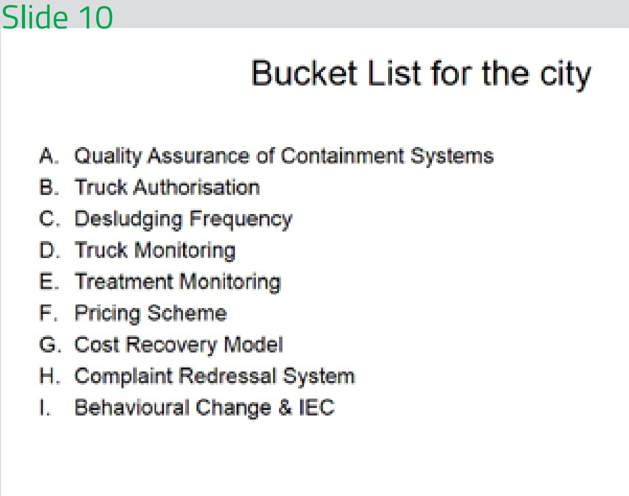



Along with the effluent standards, the quality standards of the by-products i.e. the bio-solids should be in place in order to ensure safe re-use.

Slide 9

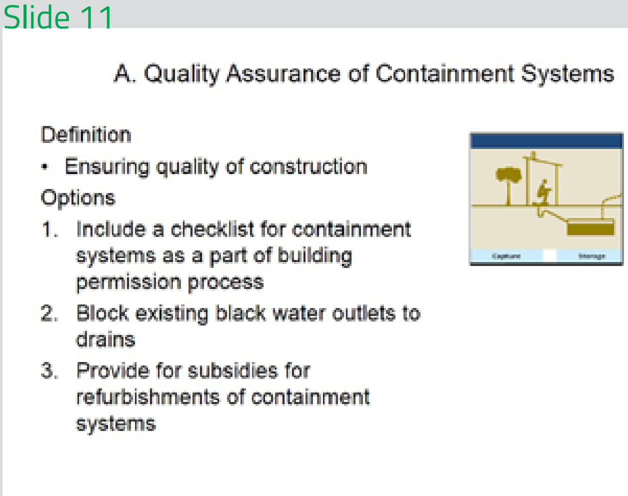

Construction of containment units should be standardized in order to avoid unintentional leakages from them.

Slide 10




The bucket list for city includes all the regulatory and institutional mechanisms at city level which are customized to meet the local needs for FSM.

Slide 11




Standardization of containment units will aim at making the containment units accessible for desludging and to avoid any unintentional leakages into the environment. Each town has to create its own checklist for building containment systems as per local topographical, physical conditions (soil type and water table etc.) and land available to households of different income segments etc.

## Slide 12

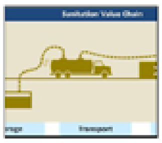
### B. Truck Authorisation

Definition

- To ensure only trucks of certain service quality operates in the city

Options

1. Municipality owns & runs the truck directly
2. Municipality outsources the work to one contractor
3. Municipality to issue licences to operators who satisfies the selection criteria & SOPs



Truck authorization is a means to ensure that the faecal sludge conveyance service provided by trucks (both government and private) meet the standards which ensures that the desludging operation from collection to disposal is performed in a manner which is safe to the workers performing it and the environment.

## Slide 14

### D. Truck Monitoring

Definition

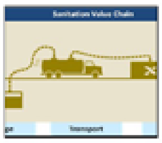
•To ensure the trucks deliver their service and dispose the faecal sludge at the plant

Options

1.Manual – Signature sheets at every interface

2.Paper based – Coupons system – Trucks have to collect coupons at every interface

3.GPS based – Realtime tracking of trucks on its routing & timing



Truck monitoring is one of the most essential components to ensure compliance to the standards with desludging standards.

## Slide 13

### C. Desludging Frequency

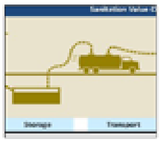
Definition

•To ensure desludging of all the containment units happen at proper intervals

Options

1. Scheduled system – needs routing plan & communication to the residents

2.On-demand – Help-desk to attend the calls



Frequent desludging is important in order to ensure that the desludging operations are carried out with ease.

Desludging frequency is determined by the following factors:

- Size and time taken by the containment unit to get filled up
- Number of cesspool vehicles available
- Plant capacity

Depending on the above factors a ULB can decide whether to schedule a desludging system by ensuring that all containment units get desludged at regular intervals, or cater to on-demand desludging by requiring the request to be routed through a call center or help-desk.

## Slide 15

### E. Treatment Monitoring

Definition

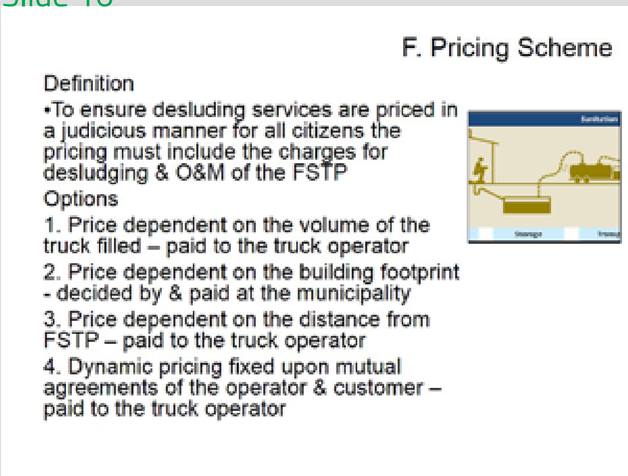
- To ensure the FSTP is working at its optimal efficacy

Options

1. Record keeping at the FSTP by the operator/manager
2. Third party assessment on a regular basis
3. Online monitoring with sensors

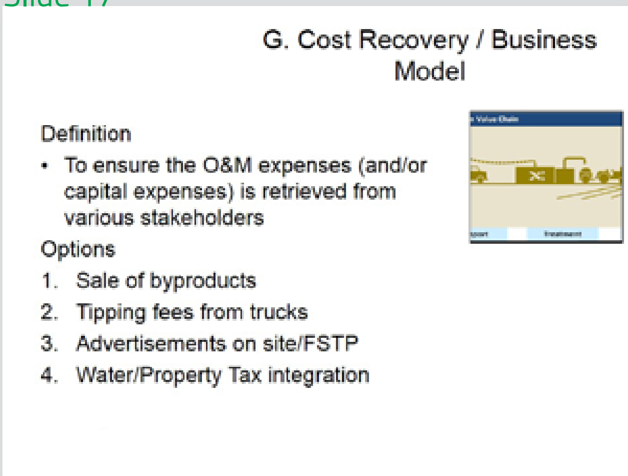
Truck monitoring is one of the most essential component to ensure compliance to the standards with desludging standards.

### Slide 16



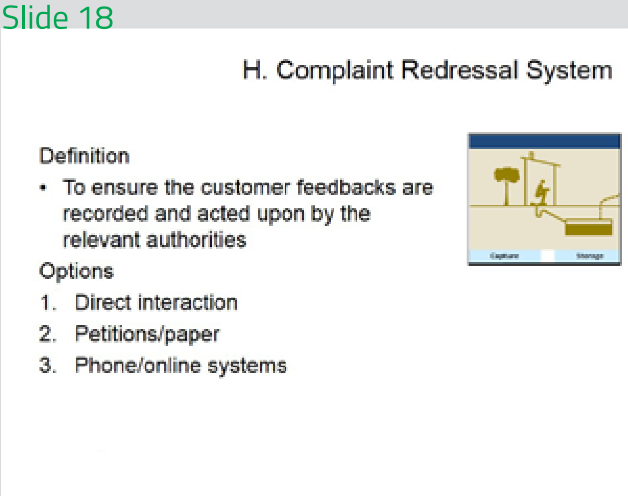

Setting pricing mechanism ensures that the desludging services and O&M of the FSTP are financially viable and judicious to all the stakeholders.

### Slide 17




For any kind of FSM to be financially viable, it is important that the system is designed with view of recovering the cost incurred. Sale of by-products is the best option to recover cost. The advertisements on site can be an option if the site is located on a prominent site.

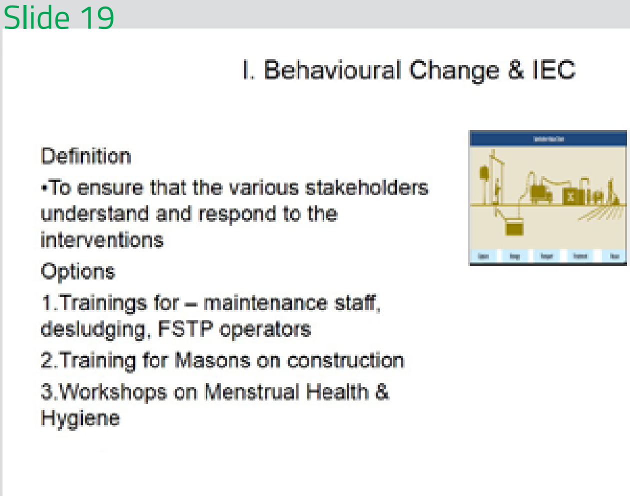
### Slide 18




Complaint redressal mechanism is to record the feedback of the consumers and ensure that the issues are addressed at the earliest. Complaint redressal system is usually of three types:

- Direct interaction : By direct face to face interaction with the service provider
- Petition / paper: putting down the complaints, the redressal procedure and results on document
- Phone/ online: Recording the complaints, the redressal procedure and result via electronic means

### Slide 19




Behaviour change and IEC are key components in FSM intervention which ensure that the stakeholders involved are adequately informed and equipped to play their roles.

## Case Scenario

Two years ago Sheetalpur town (pop: 40,000 census 2011) in Uttar Pradesh built a bright and shiny Fecal Sludge Treatment Plant with help from DEE Society and UPJN. The plant was inaugurated with a lot of fanfare and speeches were made. Now, however, many problems are occurring.

The commissioner of Sheetalpur is worried. Truck operators are upset; sludge is being dumped in the lakes. They have formed an association and are asking for a meeting. She has called for a meeting with all the stakeholders.

With your experience in FSM, and as a representative of the Urban Local body, you have been invited to attend the meeting and give advisory inputs to the city to make policy decisions. The meeting starts!

**Commissioner:** Thank you all for coming for the meeting! We understand the condition of our lakes are getting worse and one of the reasons for it is the dumping of faecal sludge into open fields and nalas without considering its consequences. During the last 2 years with the help of UPJN we have set up this Faecal Sludge Treatment Plant. We want to make a new rule that no sludge falls into the environment without treatment! We will install GPS on all your trucks.

**Truck Operator:** The new law is threatening our daily earnings. The FSTP is at one corner of the city and it takes a lot of our diesel and we will lose whatever small earnings that we get in this business. There are more and more operators coming up and with such competition we can't increase the prices. Also there are many houses where we are sure that desludging is not happened in the last 6-8 years. We need the laws to support and ensure us proper business before penalizing us.

**Health Officer:** Our safai karmacharis have informed us that at many locations truck operators are not providing timely service. They promise to come but do not show up.

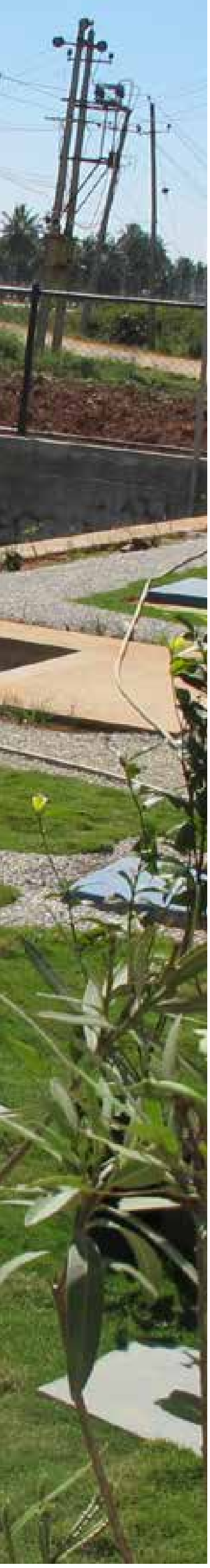
Suddenly another person enters the meeting room and asks to speak, he is operating the FSTP:

**FSTP Operator:** On some days we receive less than 5 loads but on others we get calls from more than 35 trucks. No plant can deal with this variation, I cannot operate this plant, please take back my contract!!

Please advise your friend the Commissioner. What will you do?

Make a list of 2-3 points which can be developed as regulatory or institutional changes which will be able to solve the FS crisis in the city in a holistic manner.


STABILISATION TANK



## Day 1 - Session 3

# Case Studies

Case studies hold prime importance as they provide excellent learnings and helps us understand the operational difficulties while constructing and running an FSTP.

This section provides the case study of Devanahalli along with the treatment concept, the efficiency of the treatment plant and the lessons learnt from it.

Day 1

Session 3

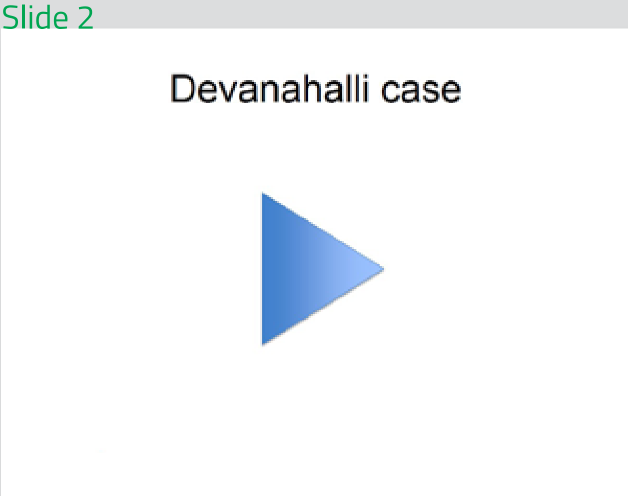
Outcomes

- Participants will understand the components of FSM
- Participants have an understanding of the problems in FSM implementation and also have an idea about tentative solutions to overcome these problems

# Objectives of the session

Case study on FSM at Devanahalli, Leh, Unnao and Senegal
Explanation of 3 types of sludge treatment methods

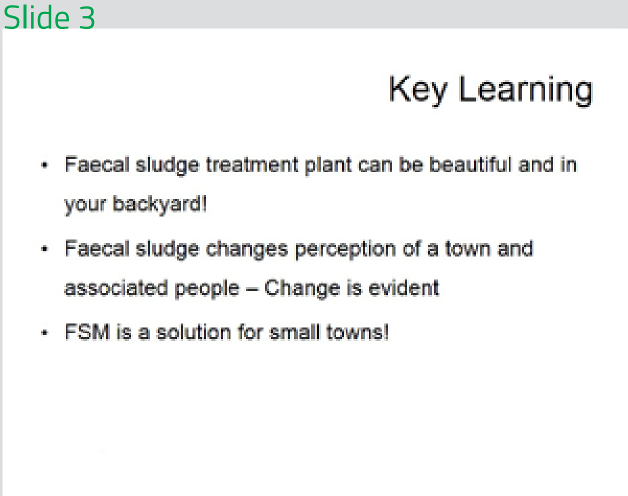
Slide 2




This video highlights the steps taken at Devanahalli at each segment of the value chain to create an efficient FSM system. This included:

- Assessment of the town: Survey of containment units, cesspool operators and existing disposal practices
- Land allocation
- Create regulatory environment- Regulations, licensing and monitoring of trucks, operation and maintenance procedures
- Financial model: low cost FSTP with low cost maintenance
- Community engagement: capacity building of farmers using compost derived from sludge as soil conditioner and awareness program for the larger community

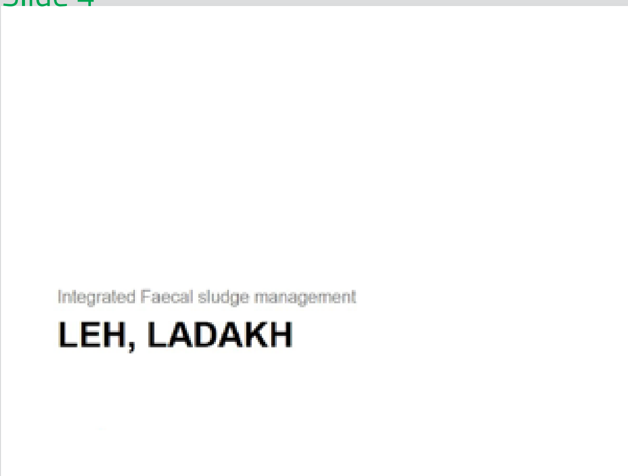
Slide 3




Devanhalli FSTP is the first of its kind treatment plant which has been designed to be aesthetically appealing. It aimed at changing the perception of nuisance and disgust associated with treatment plant. The FSM component focusses on making the stakeholders an integral part of the process. This is an ideal case for FSM implementation in small towns.

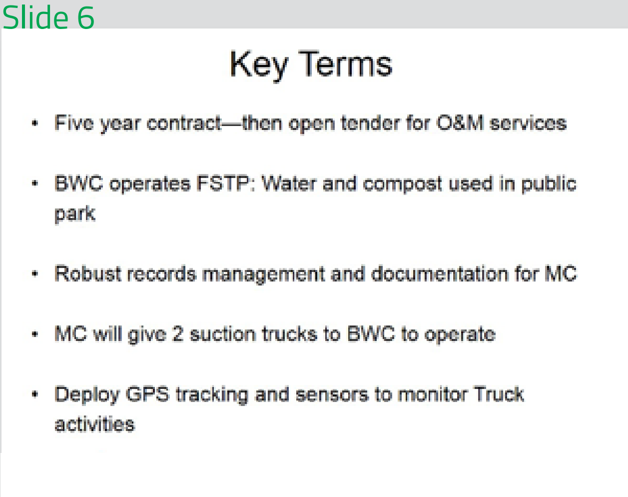
For more details refer Faecal Sludge Management, Devanahalli: A case study (Dash, 2017)

Slide 4



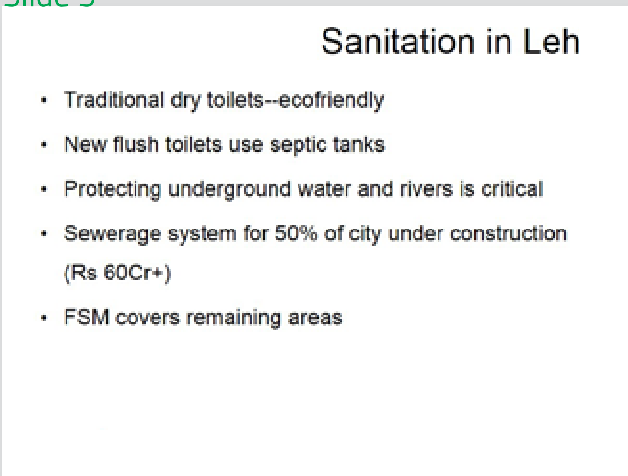

Leh is one of the highest FSTPs ever built. Built at more than 12000 feet in very cold and dry climatic conditions, it presents a unique case of sanitation in regions where FSM activities can take place for only few months in a year.

Slide 6




The truck operations and the O&M of the FSTP have been outsourced to a private company. It will also provide documentation of all the operations to the Municipality. At the same time, the private company will make available treated effluent and compost from the plant to be used for landscaping of public parks in the town.

Slide 5




Traditionally, the toilets in Leh were dry toilets which are suited for the climatic conditions and sparse population of the place. With increase in population due to tourism activities and defense forces activities, the new toilets constructed are usually flush toilets with septic tanks. This has resulted in increased FS generation. This increase in FS generation without adequate facilities for treatment poses a threat to the environment in general, especially to the drainages basins of 3 major rivers: Indus, Shyok and Nubra. Therefore, improvements of sanitation at Leh are essential to protection of these water resources from contamination.

Presently, there is a sewerage system under construction for 50% of the city. For the rest of areas FSM provides an alternate solution.

Slide 7

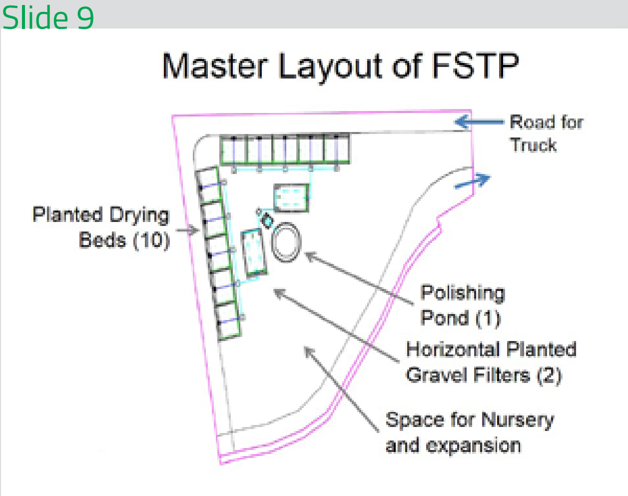

FSTP Description

| Parameters | Specifications |
|---|---|
| Capacity | 12 m³/day |
| Area | 624 m² |
| Technology | Gravity based aerobic stabilization using **Planted Drying Beds** |
| Structure | Civil construction |
| Capital Cost | Rs 54 Lakhs |
| O&M Cost | Rs 10 Lakhs per year |
| Operating Life | 30+ years |

The treatment plant is based on a very simple technology of planted drying bed in which sludge is treated using evapotranspiration from plants, which are planted on the sludge drying bed.

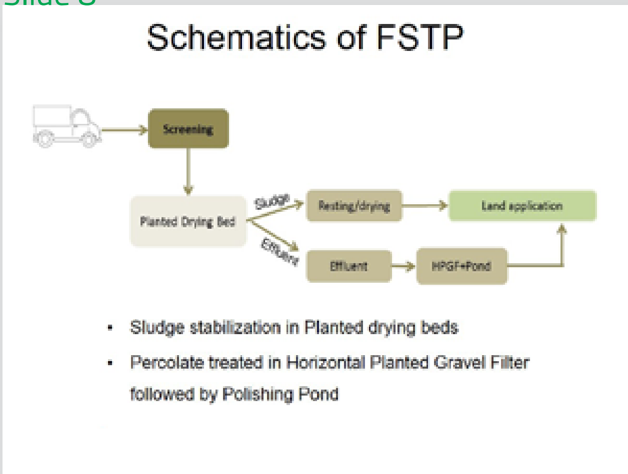
The per capita capital cost of Leh FSTP comes to less than Rs 350 (considering only half of a town population of 30870). The per capita operation cost is less than Rs 65. With an operating life of more than 30 years, this treatment plant is an example of low cost enduring system.

Slide 9




Master layout highlighting the different treatment modules.

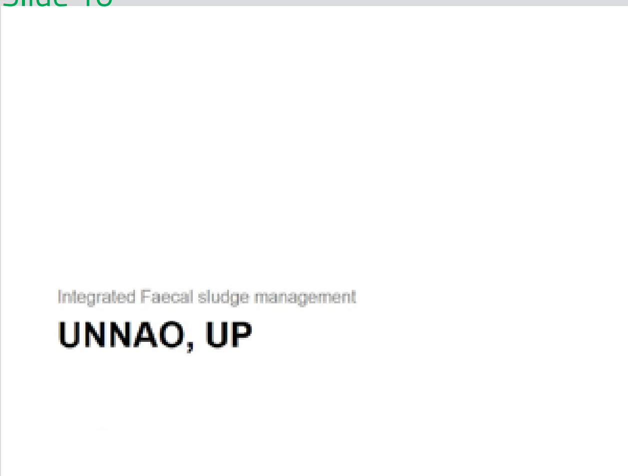
Slide 8



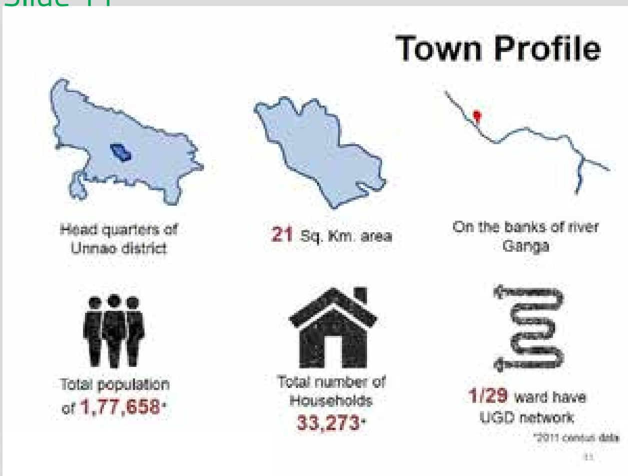

Faecal sludge is discharged into screen and grit chamber, where materials such as plastics, paper, fabric, soil and silt are removed using bar screen and gravity settling. The screened sludge is disposed into planted drying bed, which is filled with sand and gravel to support vegetation and to act as a filter media. The filtrate or effluent flows down through the media and is collected in drains, while the solids remains on the filter surface and is dewatered through percolation and evapotranspiration. The main advantage of the planted drying bed is that the filters do not need to be de-sludged after each drying cycle. Therefore, fresh sludge can be directly applied over the previous layer with interval between subsequent applications. The plants and their root systems maintain the porosity of the filter and hence the beds require de-sludging only once every 2-3 years. The end product from drying bed is the bio-solids, which is stabilized and rich in nutrients, which can be used directly as a soil conditioner or co-composted with municipal organic waste to produce compost.

The percolate collected from the bottom of the drying bed is treated through a planted gravel filter followed by a polishing pond.

Slide 10

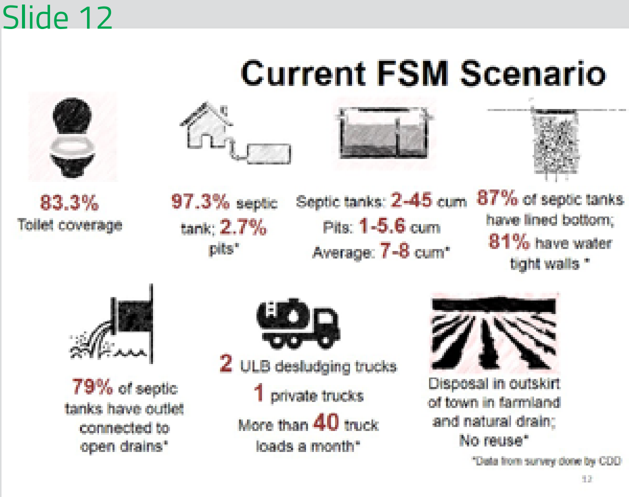



Slide 11



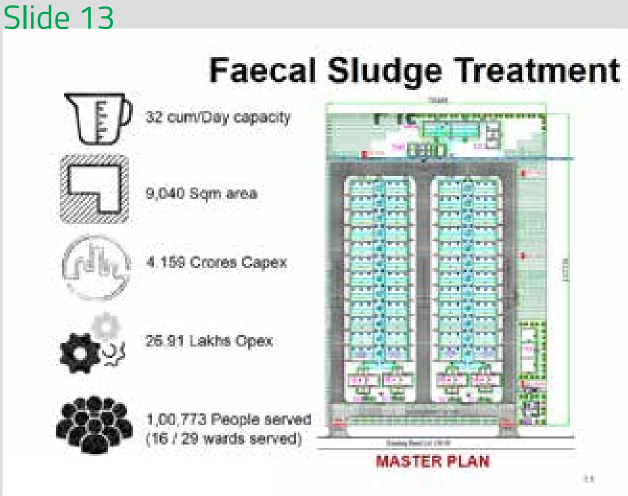

Unnao is a town located on the banks of river Ganga in Uttar Pradesh. Underground drainage system covers only 1 out of the 29 wards in the town.

Slide 12



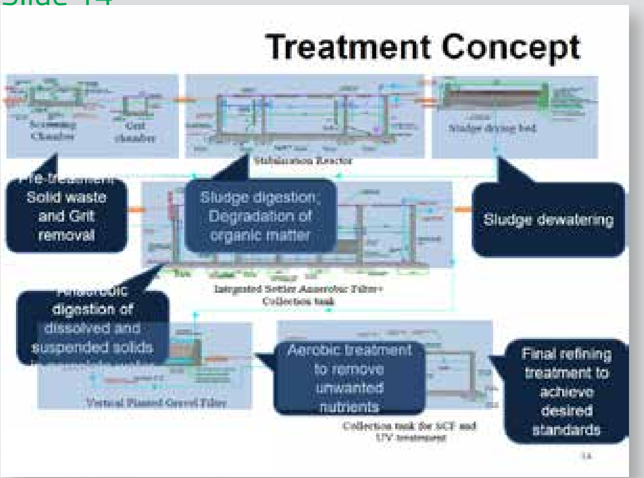

Due to the high water table, most of the containment units in the town are water tight septic tanks. In case of septic tanks, in 79% cases the effluent is let out into drains directly. When desludged, the faecal sludge is directly disposed of into the environment.

Slide 13




A 32 cum capacity FSTP is proposed for the town to take care of the faecal sludge generated. It will serve half of the town. The per capita cost of the capex of the FSTP comes to Rs 412 while the O&M cost comes to Rs 26.

Slide 14

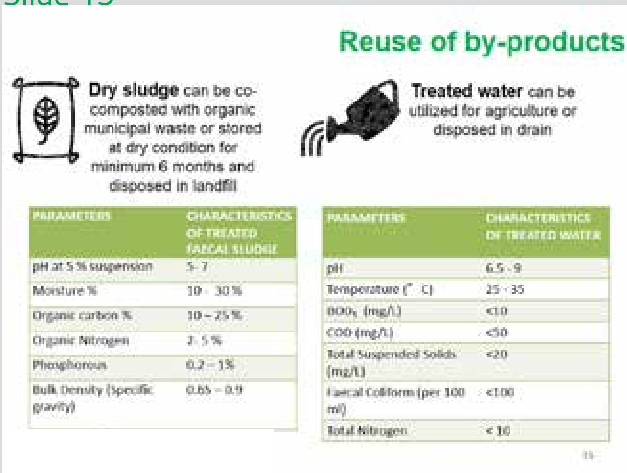



Faecal sludge is discharged into screen and grit chamber, where materials such as plastics, paper, fabric, soil and silt and grit are removed using bar screen and grit chamber. The sludge then moves to a stabilization reactor where the organic matter in the sludge decomposes. The solid components from there, moves to the unplanted sludge drying bed which dewaters the sludge. The unplanted drying bed is filled with filter material, usually gravel at the bottom and sand on top. The bottom of the bed is lined and sloped with perforated pipes to drain away the liquid (called effluent or leachate). The liquid component from stabilization reactor and the effluent from the sludge drying beds are treated in an integrated settler and anaerobic filter. The effluents then moves to the vertical planted gravel filter (VPGF) where the plants take up the nutrients in the effluent and release oxygen into the water. The effluent from the PGF then moves to the collection tank for tertiary and final stage of treatment by exposure to UV rays from sunlight and sand & carbon filter which removes traces of odour, colour and turbidity.

## References

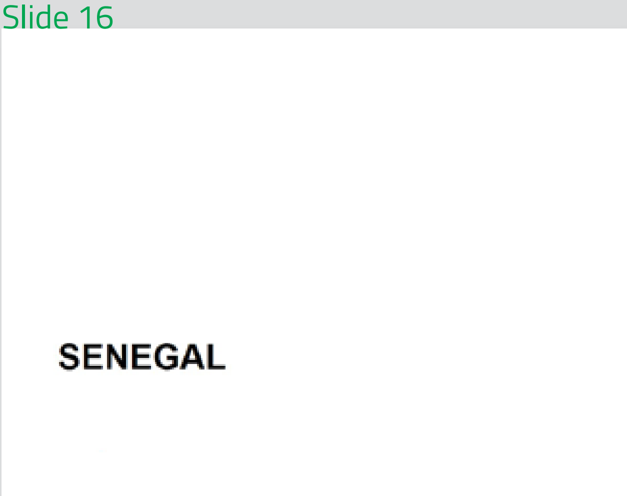
Dash, I. (2017). Faecal Sludge Management, Devanahalli : A case study. Bengaluru: CDD Society.

Slide 15




Though there are a number of reuse options for by products and the end products of an FSTP, the most popular one is the agriculture reuse in which the bio-solids are co-composted with wet waste and used as a soil conditioner while the treated effluent is used for landscaping.

Slide 16




The video explains the treatment process of the Janicki Omni Processor. This is a treatment plant for faecal sludge which converts raw sludge into energy, water and ash as output.


SEWAGE
WATER
CLEANING
Cell
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சுத்தமே
SOUNDHORN
சுகாதாரம்

## Day 1 - Session 4

# Collection and Conveyance of Faecal Sludge

Collection mechanisms if not estimated properly for its demand and technical viability, could lead to resorting to manual scavenging at a few instances. One technology for collection and conveyance cannot satisfy the diverse needs of the city. It is hence required that various options be considered and implemented as per the efficacy of the ULB or private party.

This session provides few guidelines for the collection mechanism and conveyance mechanism for a safe and effective operation.

Day 1

Session 4

Outcomes

- Participants are aware of various options for collection and conveyance of faecal sludge
- Participants are able to estimate the number of trucks for their town/city.

# Objectives of the session

Familiarize the technology options and equipments used in desludging
Planning for collection and transportation options

Slide 2

Manual scavenging is the key problem when it comes to the collection and desludging of the containment systems. Even though it is out lawed, the practice continues due to the fact that a large number of containment systems are not accessible by mechanized cesspool vehicles.
If gravely affects the health and well-being of workers cleaning the containment system without protective equipment.
Also, since these systems are inaccessible, they are not desludged for long period of time resulting in leakages into the environment.

For more information refer to (Technical Brief: Sanitation Systems: Faecal Sludge Treatment)

Slide 3

- Are all areas accessible?
- What is the cost of desludging? Can all afford it? How can we bring the cost down?
- Is the current method a safe operating practice?

In order to effectively eliminate the need for manual scavenging the questions given in the slide needs to be thought upon.

Slide 4


Given the current scenario where a number of the containment systems are inaccessible by mechanized vehicles, safe forms of semi-manual procedures can be considered. These equipments are usually small and can be carried easily by one person thereby giving access to the narrow lanes, which are inaccessible by the vehicles. If operated using adequate protective gear, these equipments can solve a large number of issues related to desludging.
For details refer to Technical brief:
Sanitation systems: Faecal Sludge Treatment

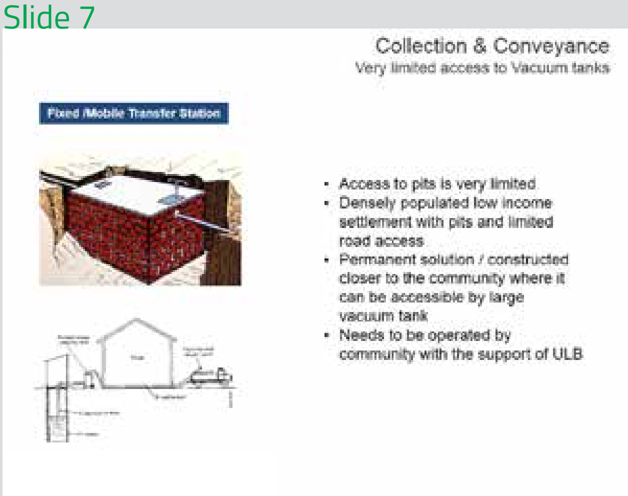
Slide 6


Containment systems along larger road which can be accessed by larger vehicles such as trucks can be desludged using larger mechanized equipments as shown in the slide.

Slide 5

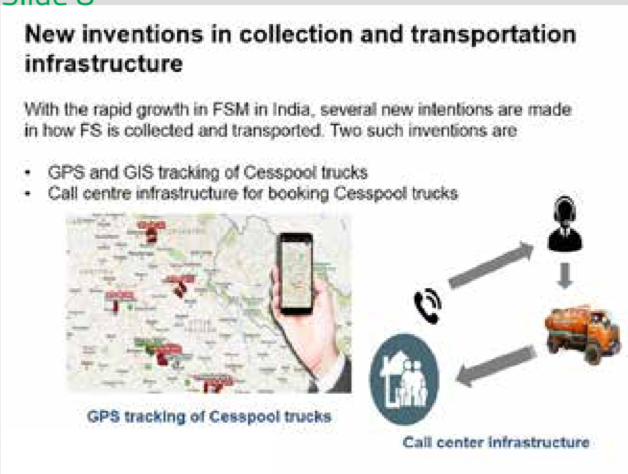

Containment systems along smaller road which can be accessed by smaller vehicles can be desludged using smaller mechanized equipments as shown in the slide.

Slide 7




A sludge transfer station can work along with a cesspool vehicle by providing the vehicle access to inaccessible containment units.

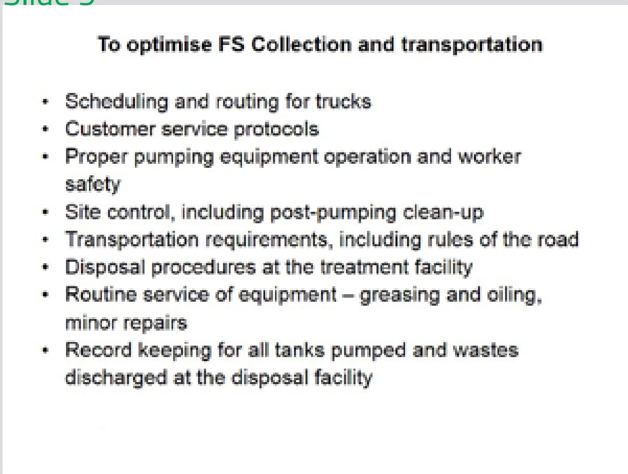
## Slide 8




Tracking cesspool vehicles with GPS allows the authorities to

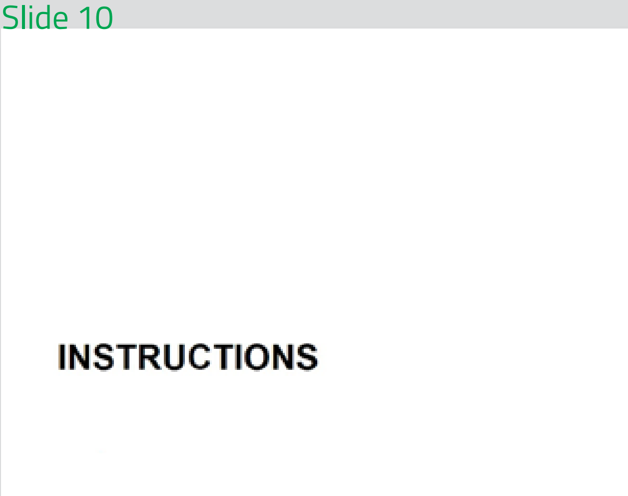
- prevent illegal disposal of sludge
- record feedback from customers on the desludging services
- use the data collected to optimise the vehicle routes in order to reduce transportation cost

## Slide 9

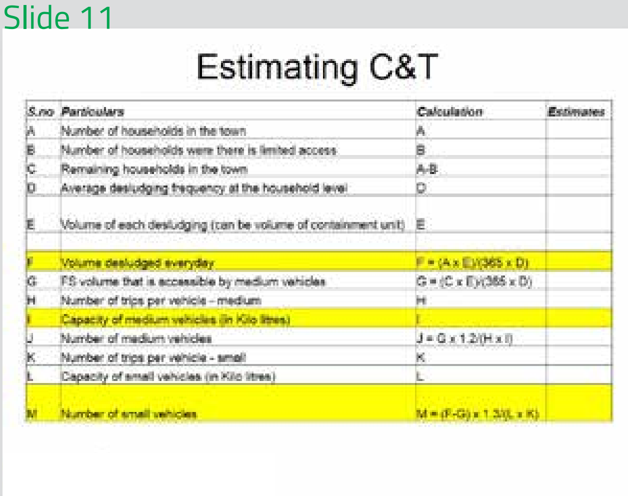



FS collection and transportation can be optimized by putting in place, mechanisms to reduce the transportation cost; and mechanisms to ensure that the standard operating procedures are followed while the desludging operations.

## Slide 10




## Slide 11


Estimating C&T

| S.no | Particulars | Calculation | Estimates |
|---|---|---|---|
| A | Number of households in the town | A | |
| B | Number of households were there is limited access | B | |
| C | Remaining households in the town | A-B | |
| D | Average desludging frequency at the household level | D | |
| E | Volume of each desludging (can be volume of containment unit) | E | |
| | | | |
| F | Volume desludged everyday | F = (A x E)/(365 x D) | |
| G | FS volume that is accessible by medium vehicles | G = (C x E)/(365 x D) | |
| H | Number of trips per vehicle – medium | H | |
| I | Capacity of medium vehicles (in Kilo litres) | I | |
| J | Number of medium vehicles | J = G x 1.2/(H x I) | |
| K | Number of trips per vehicle - small | K | |
| L | Capacity of small vehicles (in Kilo litres) | L | |
| M | Number of small vehicles | M = (F-G) x 1.3/(L x K) | |

Planning for collection and conveyance needs considering the following:

- Sludge generation
- Accessibility to containment systems
- Desludging frequency

# References

Technical Brief: Sanitation System: Faecal Sludge Treatment. (n.d.). Centre for Affordable Water adn Sanitation Technology.

## ESTIMATION OF TRUCKS REQUIRED FOR FS COLLECTION AND TRANSPORTATION

## NAME OF THE TOWN:

## DISTRICT:

| S.no | Particulars | Calculation | Estimates |
|---|---|---|---|
| A | Number of households in the town | A | |
| B | Number of households where there is limited access | B | |
| C | Remaining households in the town | A-B | |
| D | Average desludging frequency at the household level | D | |
| E | Volume of each desludging (can be volume of containment unit) | E | |
| F | Volume desludged everyday | F = (A x E)/(365 x D) | |
| G | FS volume that is accessible by medium vehicles | G = (C x E)/(365 x D) | |
| H | Number of trips per vehicle - medium | H | |
| I | Capacity of medium vehicles (in Kilo litres) | I | |
| J | Number of medium vehicles | J = G x 1.2/(H x I) | |
| K | Number of trips per vehicle - small | K | |
| L | Capacity of small vehicles (in Kilo litres) | L | |
| M | Number of small vehicles | M = (F-G) x 1.3/(L x K) | |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## Day 1 - Session 5

# Approach to Faecal Sludge Treatment

It is necessary to understand the characteristics and quantities of faecal sludge from on-site sanitation technologies, like a pit latrine or septic tank. This information is essential to plan and design appropriate faecal sludge management options.

The first step is to know what faecal sludge is.
Where does it come from? What is it made of?
How much is there? Faecal sludge from one onsite sanitation technology can be very different than sludge from another technology. It is highly variable in consistency, concentration, and quantity. The characteristics and quantities of faecal sludge depend on various technical, operational, and environmental factors.
Characterizing and quantifying faecal sludge is often overlooked because implementers are not aware of its importance. As well, faecal sludge is often still treated like wastewater despite differences in their characteristics. With more research and pilot projects, the sanitation sector will grow its capacities and knowledge on this topic. Guidelines or standards for characterizing and quantifying faecal sludge will also be developed.

Day 1

Session 5

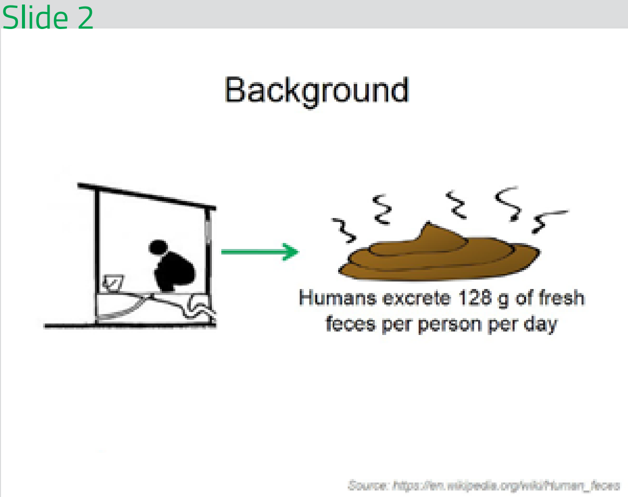
Outcomes

- Participants understand the difference between sewage and faecal sludge.
- Particpants are familiar with treatment principles objectives and outcomes.

# Objectives of the session

- Characteristics of faecal sludge
- Objectives of treatment
- Stages of treatment
- Treatment mechanisms

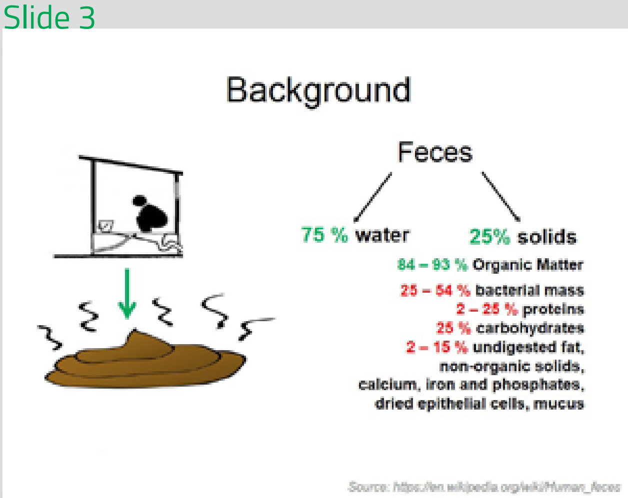
Slide 2




This is the average quantity of human excreta generated which can vary based on the diet and health of a person.

For more information refer to (Technical Brief: What is faecal sludge?)

Slide 3




The human excreta is usually consists of 75% water and 25% solids.

For more information refer to (Technical Brief: What is faecal sludge?)

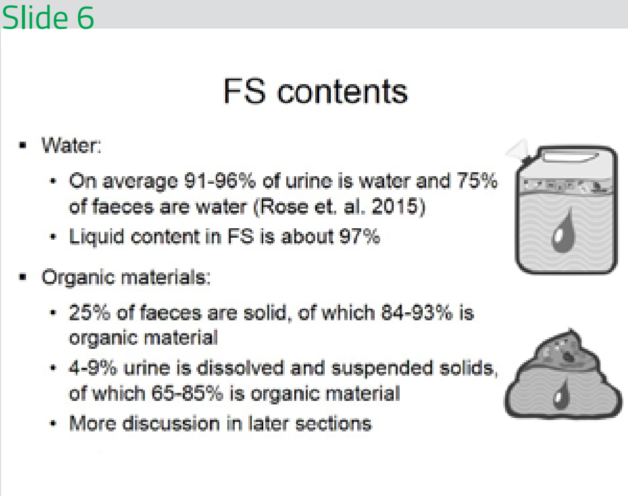
## Slide 4


Faecal sludge is the excreta-derived sludge collected from containment systems such as pits and septic tanks.

## Slide 5


Wastewater is different from faecal sludge in terms of source and characteristics. Fecal sludge comes from an on-site sanitation technology, whereas wastewater is transported through a sewered system.
Therefore, the treatment infrastructure will be different for each of them.

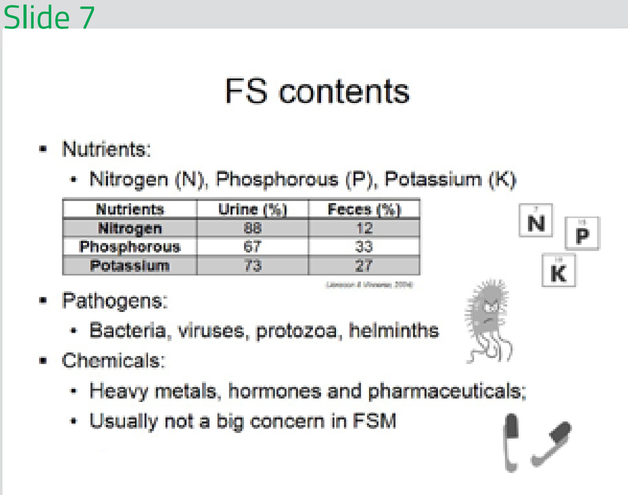
## Slide 6




Faecal sludge consists of several contents like: water, organic matter, nutrients, chemicals and pathogens

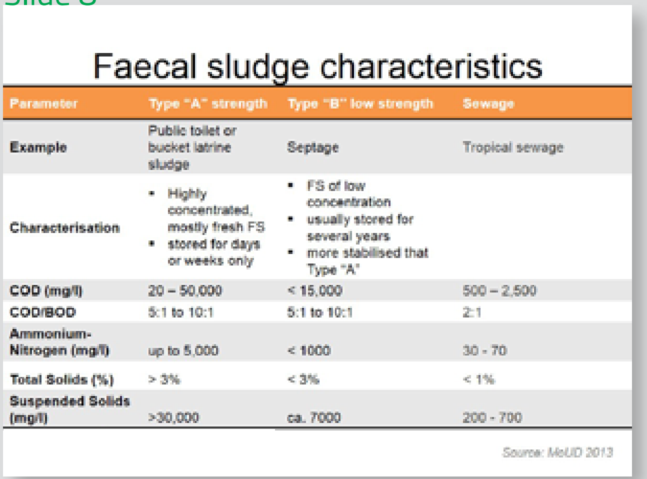
For more information refer to (Technical Brief: What is faecal sludge?)

## Slide 7




Faecal sludge is a rich source of nutrients such as nitrogen, phosphorous and potassium. But at the same time they consist of a host of pathogens and at time chemicals.

## Slide 8



Faecal sludge characteristics

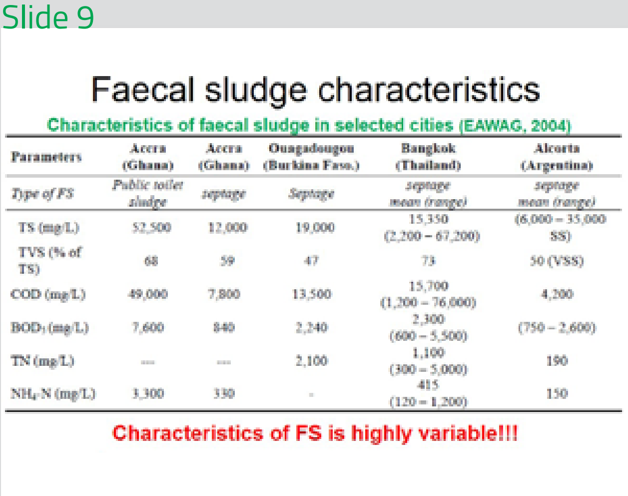
| Parameter | Type "A" strength | Type "B" low strength | Sewage |
|---|---|---|---|
| Example | Public toilet or bucket latrine sludge | Septage | Tropical sewage |
| Characterisation | • Highly concentrated, mostly fresh FS<br>• stored for days or weeks only | • FS of low concentration<br>• usually stored for several years<br>• more stabilised that Type "A" | |
| COD (mg/l) | 20 – 50,000 | < 15,000 | 500 – 2,500 |
| COD/BOD | 5:1 to 10:1 | 5:1 to 10:1 | 2:1 |
| Ammonium-Nitrogen (mg/l) | up to 5,000 | < 1000 | 30 - 70 |
| Total Solids (%) | > 3% | < 3% | < 1% |
| Suspended Solids (mg/l) | >30,000 | ca. 7000 | 200 - 700 |

Source: MoUD 2013

The key difference of faecal sludge and wastewater is as follows:

- Variability: Faecal sludge is highly variable in consistency, concentration and quantity because it comes from different types of on-site sanitation technologies, different uses, different households, and different management styles. Wastewater is more homogenous and consistent because it is mixed as it is transported through the sewers.
- Stability: Wastewater is transported directly from the home to the wastewater treatment facility through a sewered system. Whereas faecal sludge is stored for a certain period of time in a containment technology (like a latrine pit or septic tank). Depending on the length of storage, faecal sludge can be more degraded and stabilized than wastewater.

## Slide 9



Faecal sludge characteristics

Characteristics of faecal sludge in selected cities (EAWAG, 2004)

| Parameters | Accra (Ghana) | Accra (Ghana) | Ouagadougou (Burkina Faso.) | Bangkok (Thailand) | Alcorta (Argentina) |
|---|---|---|---|---|---|
| *Type of FS* | *Public toilet sludge* | *septage* | *Septage* | *septage mean (range)* | *septage mean (range)* |
| TS (mg/L) | 52,500 | 12,000 | 19,000 | 15,350 (2,200 – 67,200) | (6,000 – 35,000 SS) |
| TVS (% of TS) | 68 | 59 | 47 | 73 | 50 (VSS) |
| COD (mg/L) | 49,000 | 7,800 | 13,500 | 15,700 (1,200 – 76,000) | 4,200 |
| $BOD_5$ (mg/L) | 7,600 | 840 | 2,240 | 2,300 (600 – 5,500) | (750 – 2,600) |
| TN (mg/L) | --- | --- | 2,100 | 1,100 (300 – 5,000) | 190 |
| $NH_4$-N (mg/L) | 3,300 | 330 | - | 415 (120 – 1,200) | 150 |

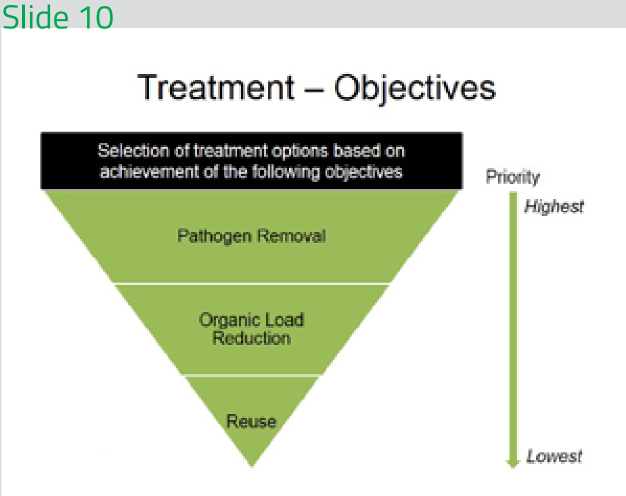
Characteristics of FS is highly variable!!!

Faecal sludge characteristics are highly variable and depend on the following characteristics:

- Source and type of containment unit
- Geo-climatic conditions
- Frequency of desludging

For more information refer to (Technical Brief: What is faecal sludge?)

## Slide 10



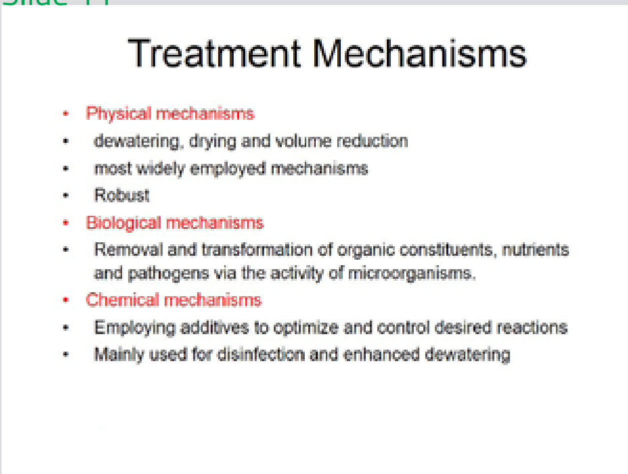

Any treatment method should have at least 3 objectives in the order of priority:

Pathogen removal: removing of the microbes from the sludge to make it safe for discharge into the environment

Organic load reduction: reducing the level of BOD and COD

Reuse: Treating the by-products for reuse and sale so as to recover the cost incurred in the plant.

Slide 11

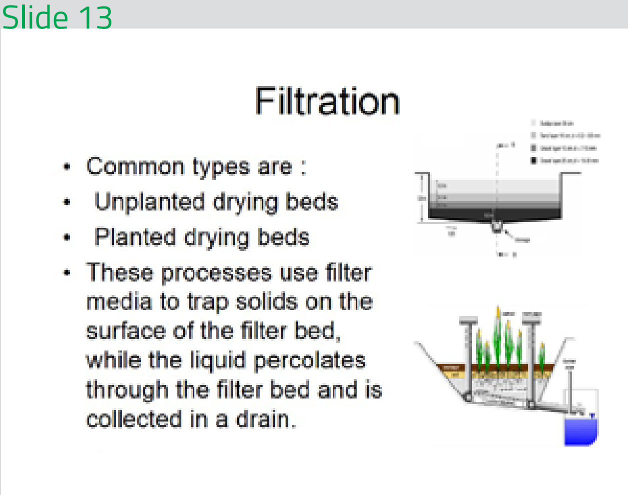



Treatment mechanisms for faecal sludge are broadly classified into three types:

- Physical
- Biological
- Chemical mechanisms

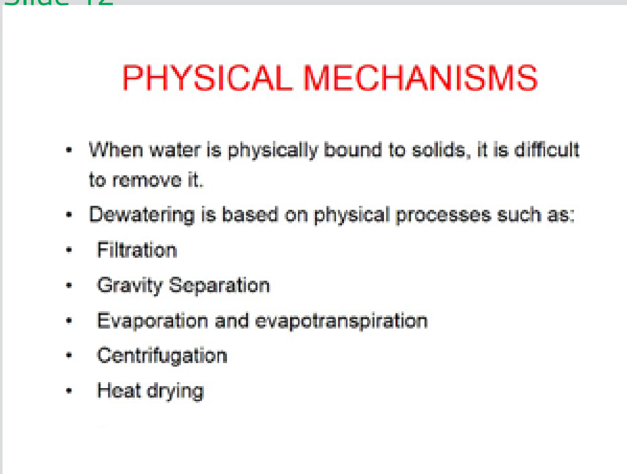
For more information refer to (Technical Brief: Sanitation System: Faecal Sludge Treatment)

Slide 13



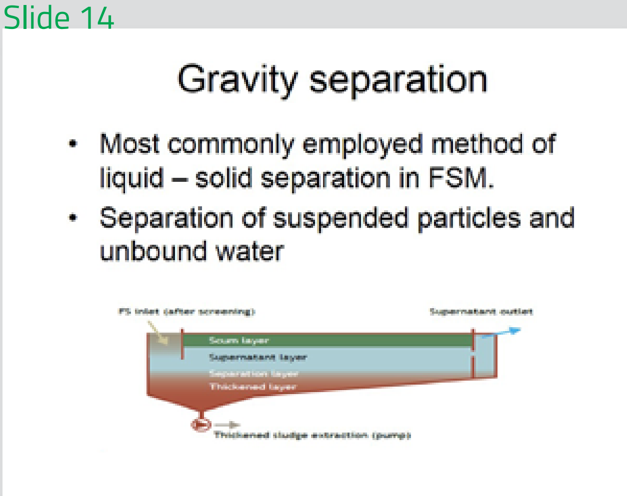

Filtration is one of the most commonly applied physical treatment process as there are two ways this is done, namely: Unplanted drying beds and planted drying beds.

Slide 12




The aim of physical treatment is to separate the solid and liquid components.

Slide 14




Gravity separation is employed for separation of the heavy solids and the supernatant liquid. Settling-thickening tank works on this principle.

## Slide 15

### Evaporation and Evapotranspiration

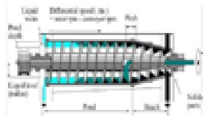
- Evaporation - water is released as vapour
- Transpiration- plants release water vapour as part of their metabolic processes
  - Evapotranspiration = Evaporation + Transpiration
- ➢ Dewatering
- In drying beds – filtration + evaporation
- In planted drying beds - evapotranspiration
- ❑ Evaporation - influenced by climate, available heat, moisture content of air and wind speed.
- ❑ Rate of evapotranspiration > Rate of evaporation alone

Evaporation and evapotranspiration is a method which seeks to separate the solids and liquid by means of evaporation and transpiration by plants. Planted drying beds are an example of it. This helps in dewatering the sludge faster. The time required for dewatering depends on several factors such as climate, temperature, humidity and wind speed.

## Slide 16

### Centrifugation

- Sludge is placed inside the centrifuge while it rotates at a high speed.
- centrifugal forces accelerate the sedimentation process
- Solids settle out at the centrifuge walls, where they are pressed and concentrated
- liquid and solid fractions are then collected separately

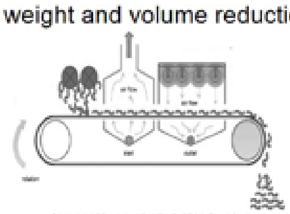


This is a mechanized treatment mechanism where centrifugal force is applied on the sludge mass which pushes the solids to side wall and the water is collected separately. Centrifuge decanter works in this principle.

## Slide 17

### Heat Drying

- The temperature of the sludge is increased through energy transferred from an external heat source
- Heat drying is used to evaporate and dewater wastewater sludge.
- achieves both weight and volume reduction



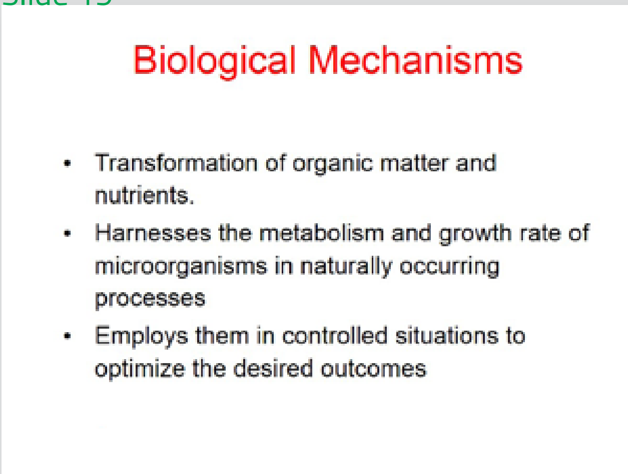
This type of treatment involves application of heat to the sludge mass. This serves dual purpose of dewatering and pathogen inactivation. Thermal drying and LaDePa use this mechanism.

## Slide 18

### Physical Treatment Options

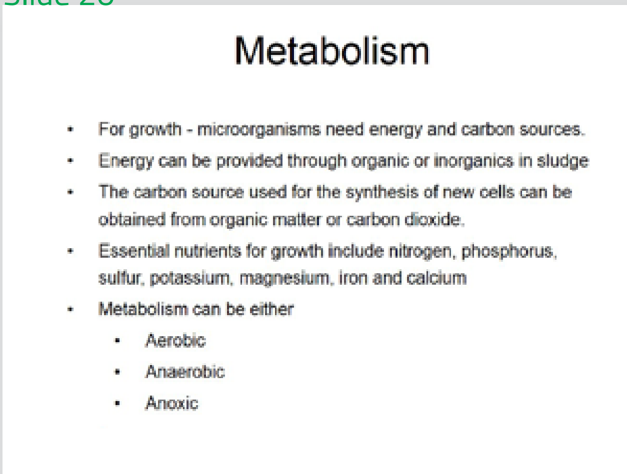

Few instances of physical treatment mechanisms.

Slide 19




Biological treatment mechanism mainly focus on reducing the organic contents of the sludge by means of using activated microorganisms.

Slide 20

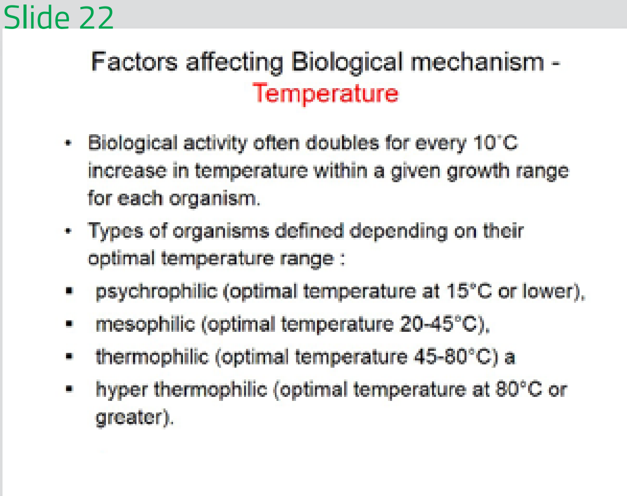



Metabolism is a process in which microorganism feed of other substances for energy and growth. This is the primary mechanism in biological treatment approach.

Slide 21

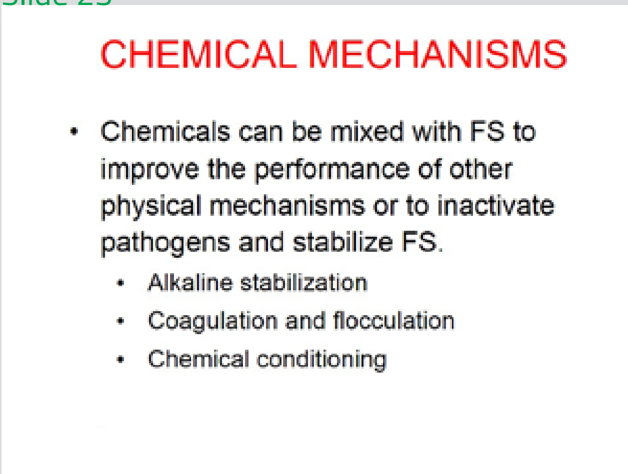

Composting is a controlled process in which the heat generated in the compost heap inactivates the pathogens in the dried sludge. The end product is rich in nutrients and can be used for agriculture.

Slide 22



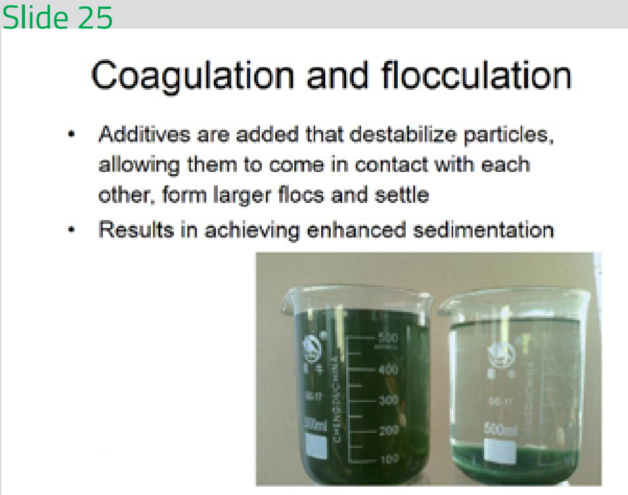

Biological treatment mechanisms are highly sensitive to the changes in temperature. Bacterial activity occurs only in certain temperature ranges and therefore the biological treatment mechanisms need to maintain the temperature ranges which are ideal for the microorganisms used in the treatment process.

Slide 23



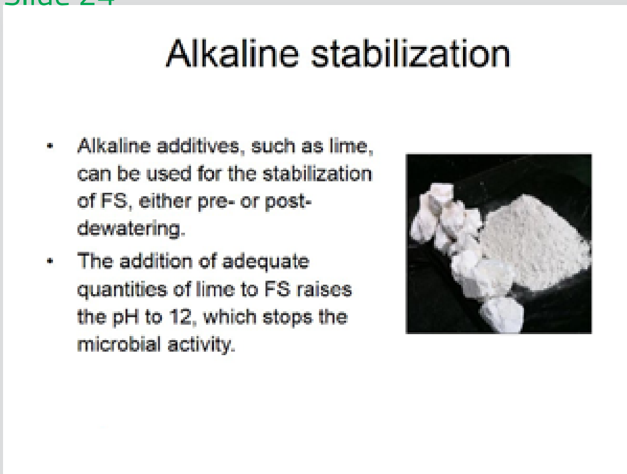

Chemical mechanisms include addition of chemical compound to the sludge which starts a chemical reaction in order to obtain desired outcomes. The chemical mechanisms are used both for solid liquid separation and for removing the microorganism which remain in the sludge after the reduction of organic load.

Slide 25



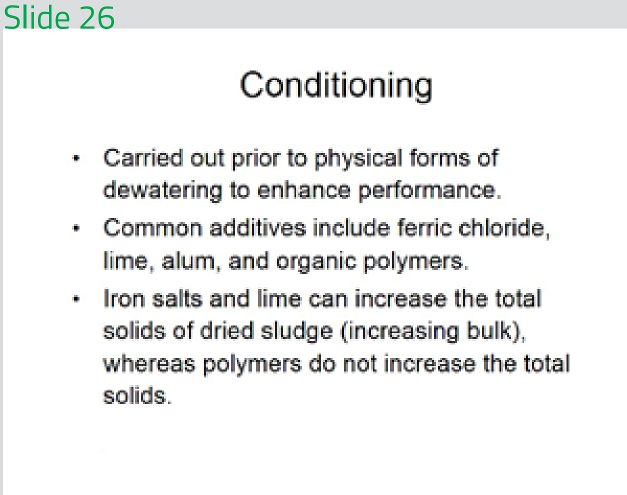

Coagulation/flocculation is the process of adding chemical enhancers in order to increase the sedimentation. This is done prior to dewatering so that the process becomes more convenient.

Slide 24




This involves addition of alkaline compounds like lime to the sludge which in turn increases the pH thereby inhibiting microbial activity.

Slide 26




Conditioning is a method of adding certain chemical compounds which enhances the dewatering ability of the sludge. They may change the composition of the sludge after addition of the chemical compounds.

## Slide 27

### Faecal sludge characteristics

| Parameter | Type "A" strength | Type "B" low strength | Sewage |
|---|---|---|---|
| Example | Public toilet or bucket latrine sludge | Septage | Tropical sewage |
| Characterisation | • Highly concentrated, mostly fresh FS<br>• stored for days or weeks only | • FS of low concentration<br>• usually stored for several years<br>• more stabilised that Type "A" | |
| COD (mg/l) | 20 – 50,000 | < 15,000 | 500 – 2,500 |
| COD/BOD | 5:1 to 10:1 | 5:1 to 10:1 | 2:1 |
| Ammonium-Nitrogen (mg/l) | up to 5,000 | < 1000 | 30 - 70 |
| Total Solids (%) | > 3% | < 3% | < 1% |
| Suspended Solids (mg/l) | >30,000 | ca. 7000 | 200 - 700 |

*Source: MoUD 2013*

Reiterating the characteristics of FS and that they are different from sewage for treatment.

## Slide 28

### Treatment – Approach

- Solid-Liquid Separation
- Dewatering
- Sludge Stabilization
- Liquid Treatment

Faecal sludge treatment focuses on 4 components:

- Solid liquid separation aims at separating the settlable solids from water
- Dewatering aims at reducing the moisture content from the settled solids
- Sludge stabilisation aims at reducing the organic load
- Liquid treatment aims at treating the supernatant or effluent

## Slide 29

### Reuse potential

| Produced Product | Treatment or Processing Technology |
|---|---|
| Soil conditioner | Untreated FS<br>Sludge from drying beds<br>Compost<br>Pelletising process<br>Digestate from anaerobic digestion<br>Residual from Black Soldier fly |
| Reclaimed water | Untreated liquid FS<br>Treatment plant effluent |
| Protein | Black Soldier fly process |
| Fodder and plants | Planted drying beds |
| Fish and plants | Stabilisation ponds or effluent for aquaculture |
| Building materials | Incorporation of dried sludge |
| Biofuels | Biogas from anaerobic digestion<br>Incineration/co-combustion of dried sludge<br>Pyrolysis of FS<br>Biodiesel from FS |

The by-products of treated faecal sludge can be put in multiple uses and the intended use of the by-product is a major factor in determining the type of treatment mechanism/s employed.

## Slide 30

### Nutrients

Table 10. 3 Nutrient content of urine and faeces and mass of nutrients required to grow 250 kg of cereals from Drangert (1998)

| Nutrients | Urine[1] (kg) | Faeces[2] (kg) | Total (kg) | Nutrients needed for 250 kg cereals (kg) |
|---|---|---|---|---|
| Nitrogen (N) | 4.0 | 0.5 | 4.5 | 5.6 |
| Phosphorus (P) | 0.4 | 0.2 | 0.6 | 0.7 |
| Potassium (K) | 0.9 | 0.3 | 1.2 | 1.2 |
| Total amount of N+P+K | 5.3 | 1.0 | 6.3 | 7.5 |

[1] 500 L/capita/year; [2] 50 L/capita/year

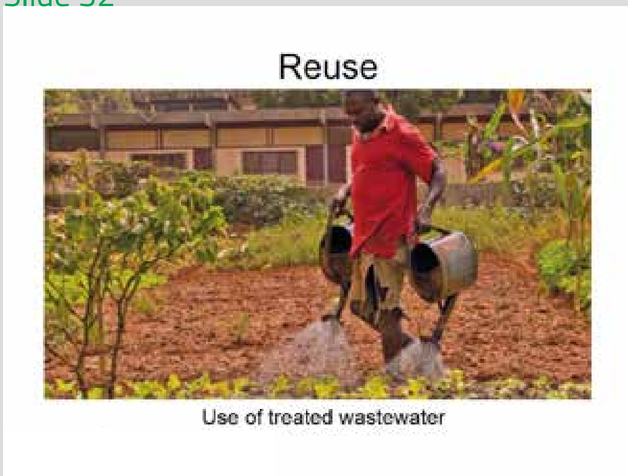
Theoretically, the quantity of FS produced yearly by a human contains nearly enough plant nutrients to grow the quantity of food they require in a year

Agricultural use of faecal sludge as soil conditioner is very common. The table summarizes the nutrient composition of urine and faeces and comparing it with the amount of nutrients required for cereals to grow.

Slide 31


Crops grown with dried faecal sludge is used as fertilizer in Cameroon.

Slide 32




Picture depicting the reuse of treated wastewater for agriculture. Treated wastewater can help meeting the water demand for irrigation to a great extent.

## References

Technical Brief: Sanitation System: Faecal Sludge Treatment. (n.d.). Centre for Affordable Water adn Sanitation Technology.

(n.d.). Technical Brief: What is faecal sludge? Centre for Affordable Water and Sanitation Technology.

Participants Kit. (n.d.). CDD Society .

Strande, L., Ronteltap, M., & Brdjanovic, D. (2014). Faecal Sludge Management: Systems Approach for Implementation and Operation. London: IWA Publishing.

Day 1 - Session 6

# Faecal Sludge Treatment Technologies

There are many technologies available to treat faecal sludge, each with different treatment objectives, treatment products, and level of development. Faecal sludge treatment is a process. To effectively treat faecal sludge, several treatment technologies may be needed in a particular order. For instance, sludge may have a lot of water, which often needs to be removed before other technologies can be used, like composting or incineration.

The choice of technologies will largely depend on the following factors:
Final goal: It is important to keep the final goal in mind when selecting appropriate treatment technologies. You first need to know how the sludge will be used or disposed of so you know what treatment is required. For example, you need to focus on dewatering, stabilization and inactivating pathogens to a safe level if you are using faecal sludge for agriculture. However, if the goal is to produce energy, then dryness is important while pathogen inactivation may be a lower priority.

Sludge characteristics and quantity: Sludge from one on-site sanitation technology can be very different than sludge from a different technology. The composition of sludge (what's in it), as well as its consistency (how liquid or solid it is) and quantity will depend on various factors. These include the type and number of on-site sanitation technologies, amount of greywater added, emptying method, and climate. It is important to know the characteristics of the sludge to choose the appropriate treatment technologies. Some treatment technologies, for example, work better with dry sludge (like composting) while others treat wet sludge (like a settlingthickening ponds).

Day 1

Session 6

Outcomes

- Participants are aware and remember at least five treatment technologies
- Participants understand the need for combination of treatment technologies

# Objectives of the session

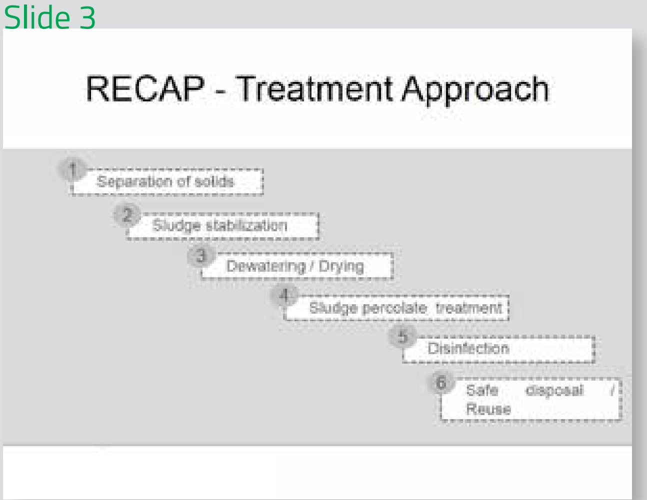
Treatment technologies

Slide 2


Treatment systems provide multiple benefits:

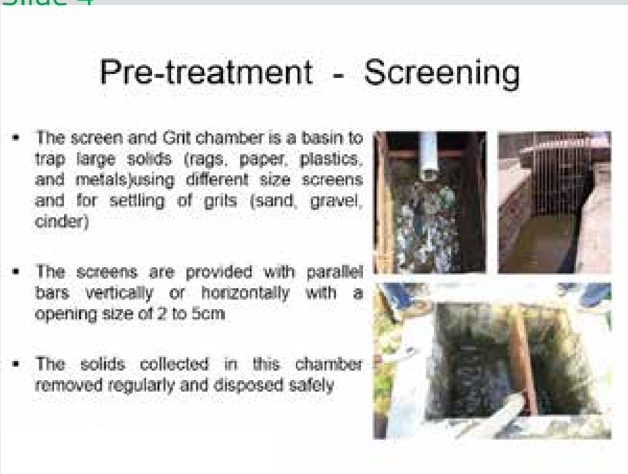
- Environmental and public health benefits by reducing levels of pollution
- Aesthetic benefits by control of smell and scattering of waste
- Resource recovery by creating reusable by-products
- Revenue generation by sale of by-products

Slide 3



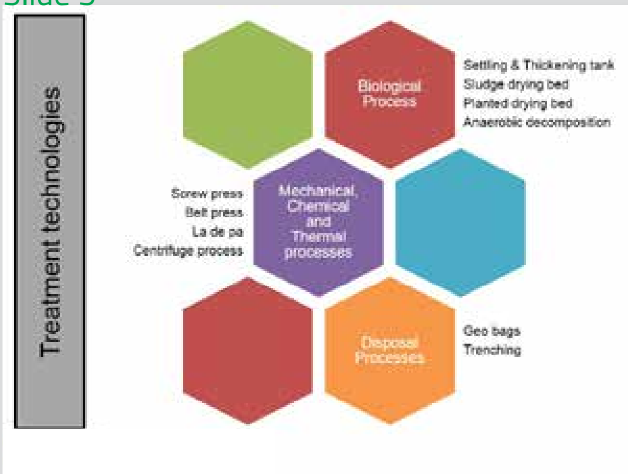

Any sludge treatment approach should provide for these 6 components.

## Slide 4




Pre-treatment are methods employed to screen out and remove elements which cannot be treated or can pose a hindrance to the functioning of the treatment plant. Usually solid waste and grit are removed this stage.

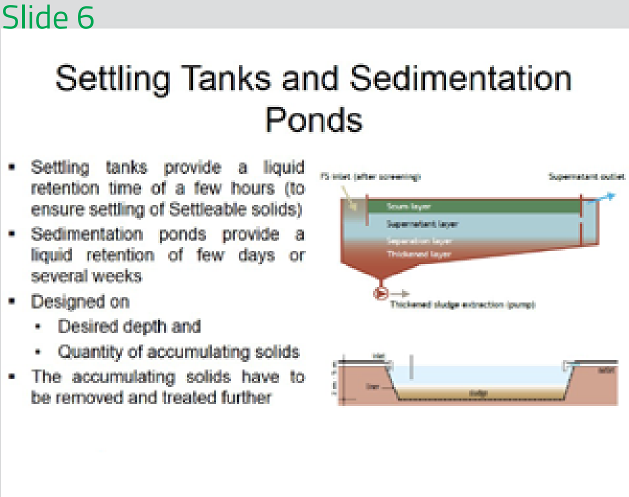
## Slide 5




Mechanism of treatment technologies that are available for the treatment of faecal sludge can be categorized into following:

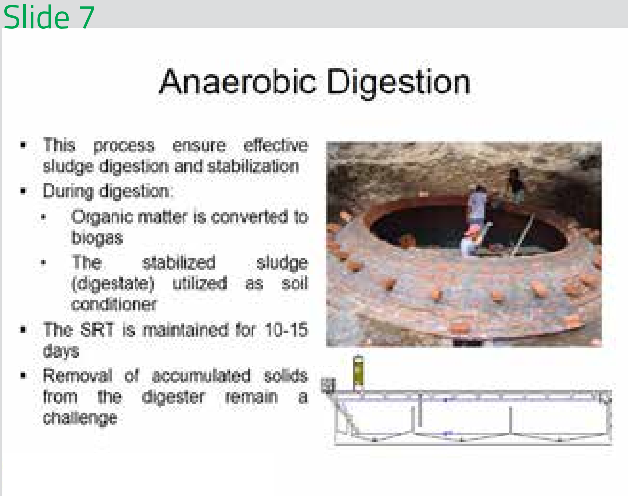
- Biological Processes
- Mechanical, Chemical and Thermal Processes
- Disposal Processes

## Slide 6




Settling tanks/ponds are a physical treatment method which helps in separation of the solid and liquid. It provides a liquid retention time of a few hours thereby ensuring that the settleable solid separate out from the liquid. The suspended solid still remain.

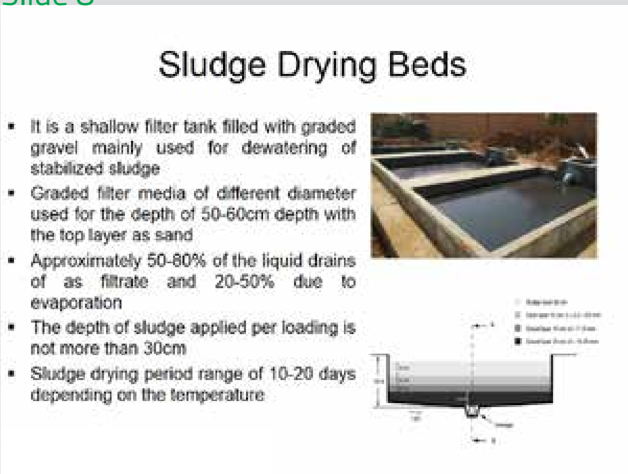
## Slide 7




Anaerobic digestion is a biological treatment technology which is applicable for temperate and tropical regions. It is used to reduce the organic load by means of sludge digestion and stabilization.

For more information refer to FSM Book (Strande, Ronteltap, & Brdjanovic, 2014).

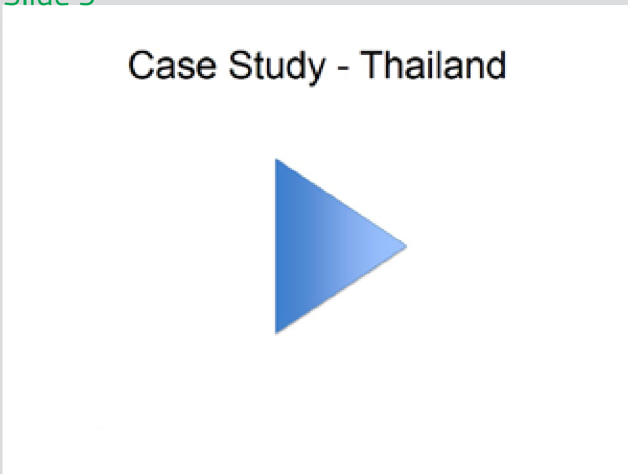
Slide 8




Sludge drying beds are mainly used for dewatering of stabilized sludge.

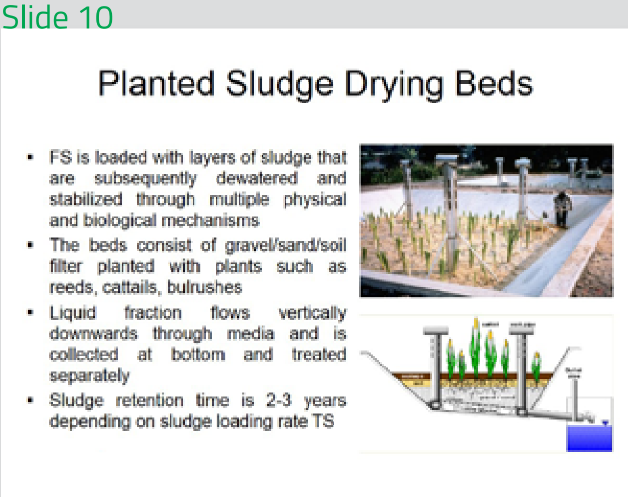
For more information refer to FSM Book (Strande, Ronteltap, & Brdjanovic, 2014).

Slide 9




Case study – Thailand. The video explains the functioning of an anaerobic based treatment system.

Slide 10

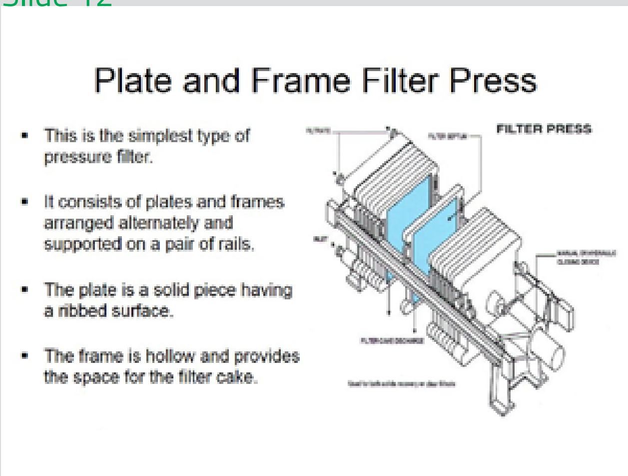



Planted drying bed dewaters the sludge using two methods of evaporation and evapotranspiration by means of plants. The bed consists of gravel/ sand/ soil filter through which the liquid flows vertically downwards and is collected and treated separately. This process helps in dewatering the sludge faster.

Slide 11

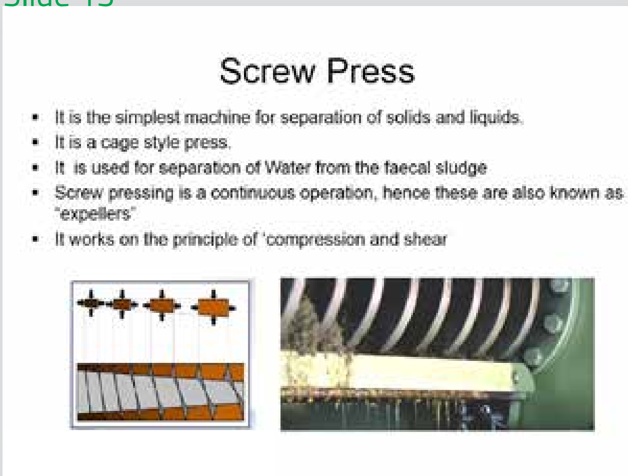

The mechanical treatment options require energy for the operation. These systems require high investment and maintenance costs. They provide a way for faster dewatering of the sludge and increase compactness of the treated sludge.
For more information refer to FSM Book (Strande, Ronteltap, & Brdjanovic, 2014).

Slide 12




Construction and working of a plate and frame filter press for mechanical dewatering.
For more information refer to FSM Book (Strande, Ronteltap, & Brdjanovic, 2014).

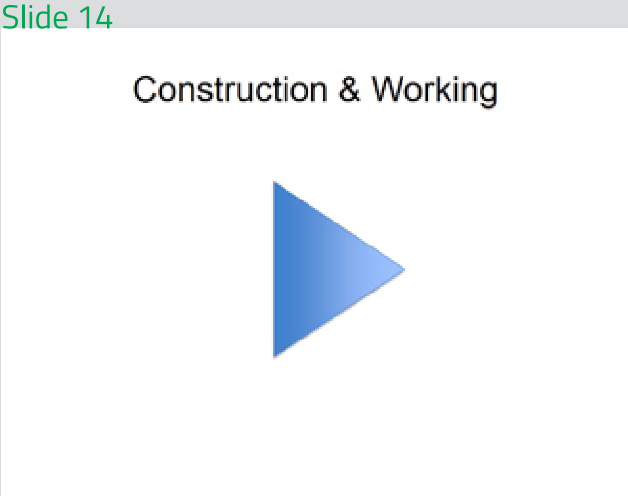
Slide 13




Construction and working of a screw type of press for dewatering

For more information refer to FSM Book (Strande, Ronteltap, & Brdjanovic, 2014).

Slide 14

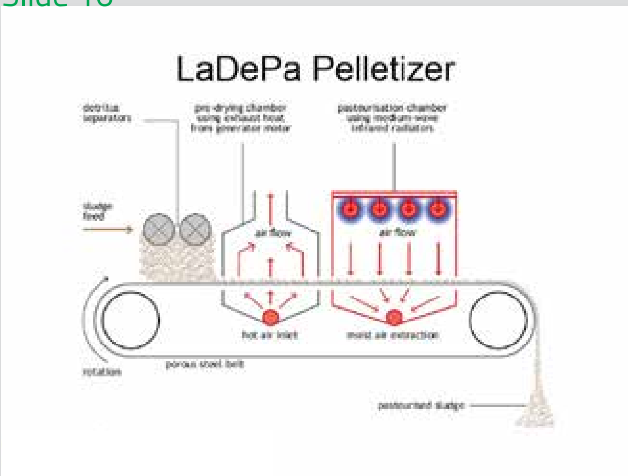



Video explaining the working of a screw press.

Slide 15

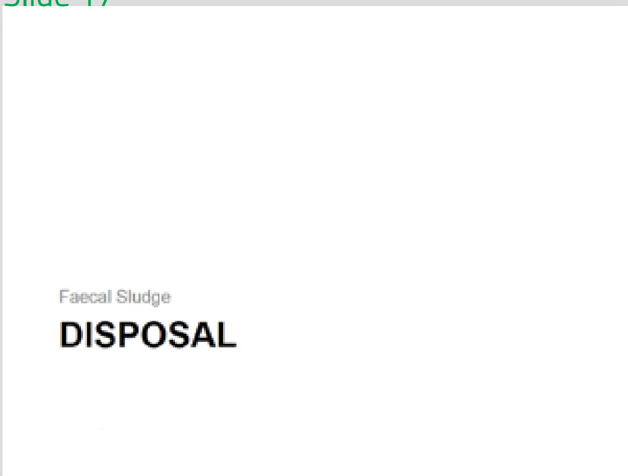

LaDePa Pelletizer uses thermal treatment. The machine works on the pyrolysis process which decomposes matters using heat in the absence of oxygen. Although it is energy intensive, a part of the energy can be provided by the pellets created from faecal sludge.
For more information refer to FSM Book (Strande, Ronteltap, & Brdjanovic, 2014).

Slide 16

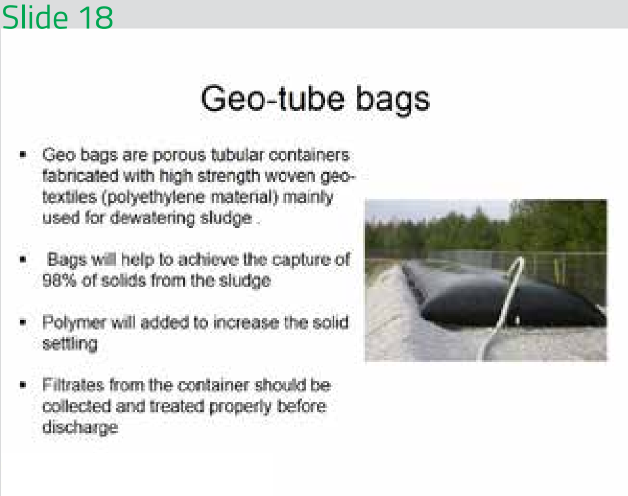



Schematic showing the working of a LaDePa pelletizer

Slide 17




Slide 18




There are few techniques are purely for disposal of the faecal sludge and there is reuse option to this method. For more information refer to (Participants Kit).

Slide 19


Trenching is a simple technique in which the faecal sludge is buried as a temporary option.

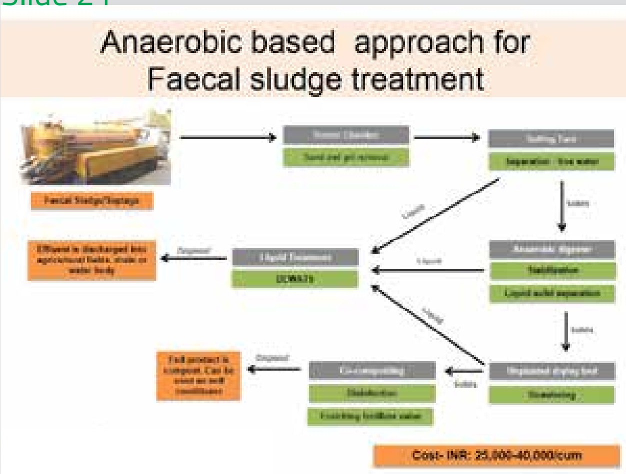
### Slide 20

Faecal Sludge

**SYSTEMS APPROACH TO TREATMENT**

The systems-level approach includes evaluating in existing systems what can be done for improvement at each step in the chain, and how all the steps integrate and influence each other. For more information refer to FSM Book (Strande, Ronteltap, & Brdjanovic, 2014).

### Slide 21




Systems approach of faecal sludge treatment looks at combining these treatment modules in order to achieve the treatment objective.

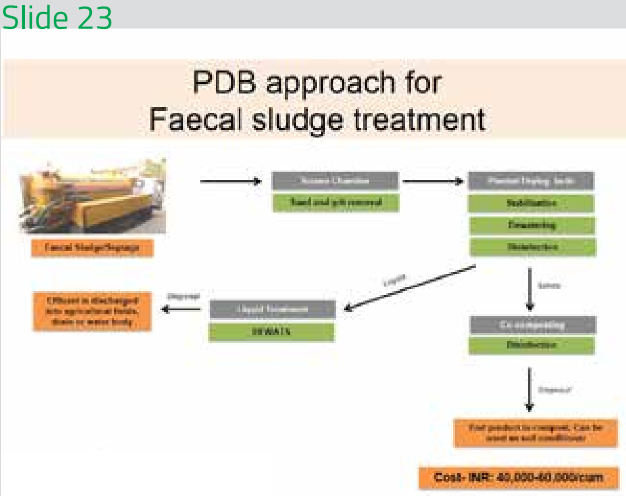
### Slide 22

Anaerobic based approach for Faecal sludge treatment

- Regular operator is required. O&M is simple
- Capital cost is high and recurrent cost is minimal
- Large area requirement (UG+OG)
- Suitable for large quantity (20cum)
- Good treatment efficiency
- Regular feeding is not a issue

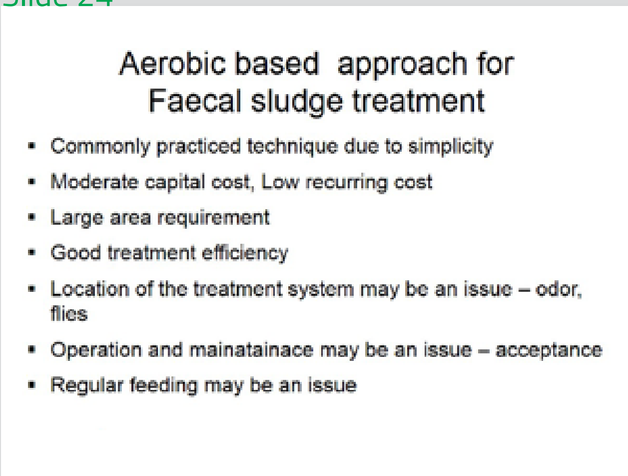
Key features of the anaerobic approach of faecal sludge treatment

### Slide 23




Treatment process flow for the PDB approach with the several treatment modules involved.

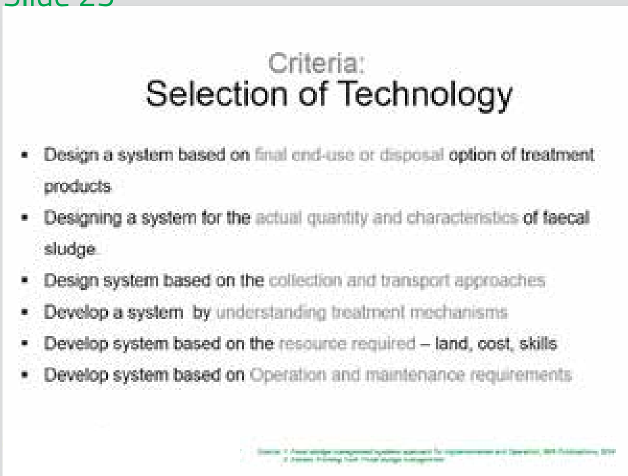
Slide 24




Key points for the PDB approach for faecal sludge treatment

For more information refer to FSM Book (Strande, Ronteltap, & Brdjanovic, 2014).

Slide 25




The technology selection should take into consideration the following:

- Sludge generation
- Collection and disposal practices
- Reuse objectives

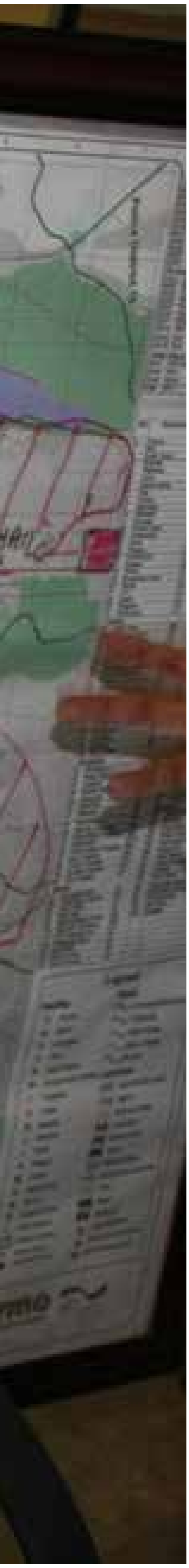
Financing options for the capital and operational costs

## References

Participants Kit. (n.d.). CDD Society .

Strande, L., Ronteltap, M., & Brdjanovic, D. (2014). Faecal Sludge Management: Systems Approach for Implementation and Operation. London: IWA Publishing.


Kabul Map
Police District #1



## Day 1 - Session 7

# Planning for FSTP Implementation

The most important part of the planning is the estimating the quantity of faecal Sludge that needs to be treated. In this session, various methodologies for estimating the same is discussed.

Day 1

Session 7

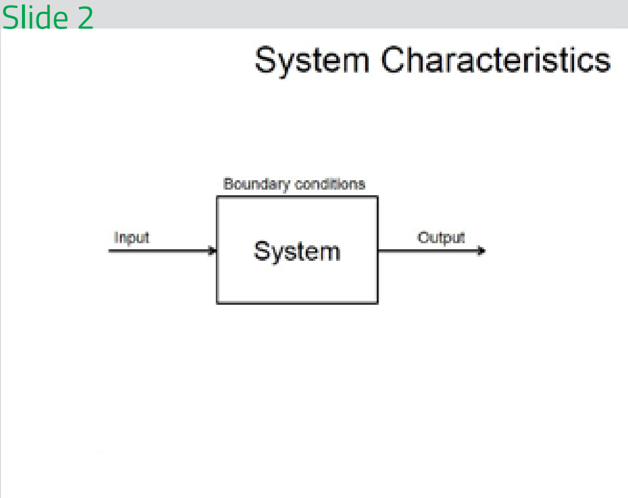
Outcomes

- Participants are aware of the process involved in implementing an FSTP for their cities
- Participants are aware of various contract methods for implementing FSTP

# Objectives of the session

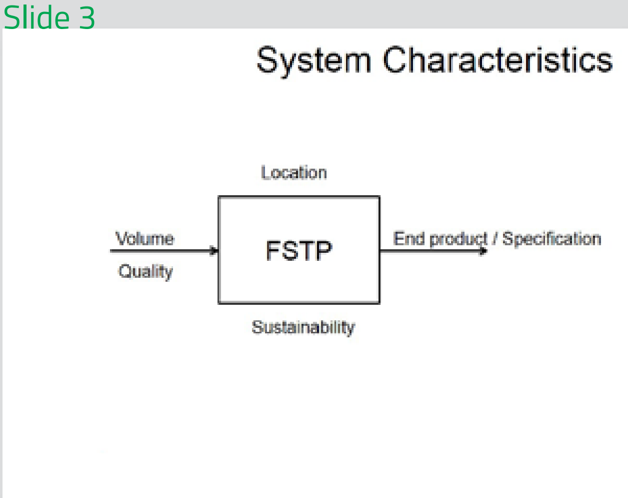
Systems approach in FSTP implementation
Contract models in FSTP

Slide 2

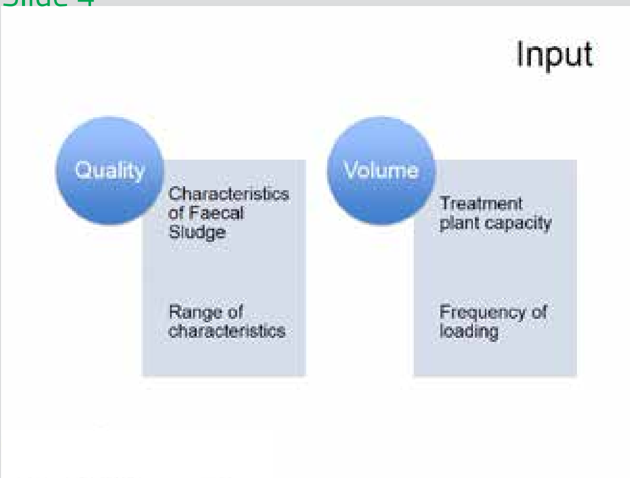



A FSTP system can be represented into a modelling a system with boundary conditions which has an input and output.

Slide 3

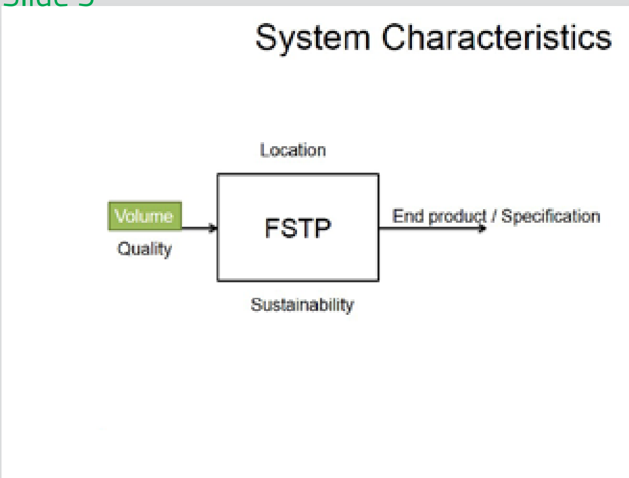


Slide 4



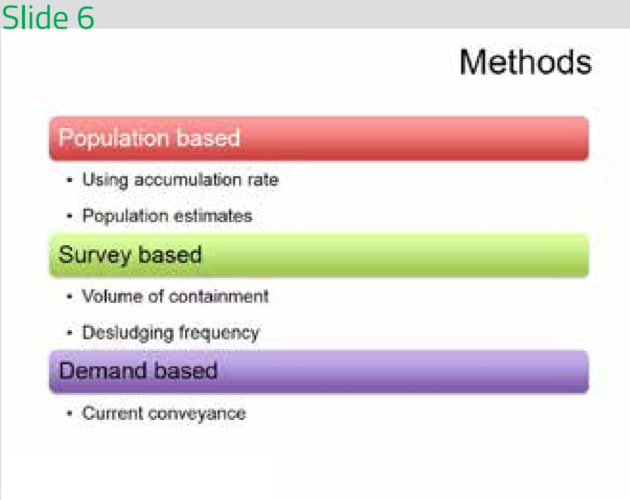

Input to a FSTP system can be classified under two buckets: Quantity and quality of the sludge.

Slide 5




The volume of FS input into the system can be predefined and regulated in order to be accommodated in the plant capacity.

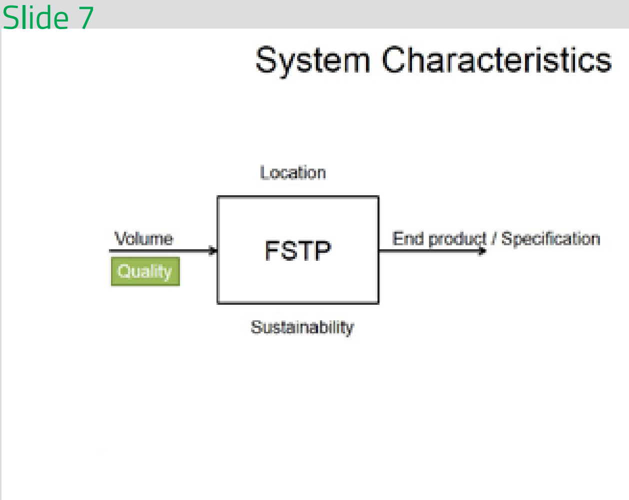
Slide 6




The three established ways of calculating the quantity/ volume faecal sludge that should be input into the system.

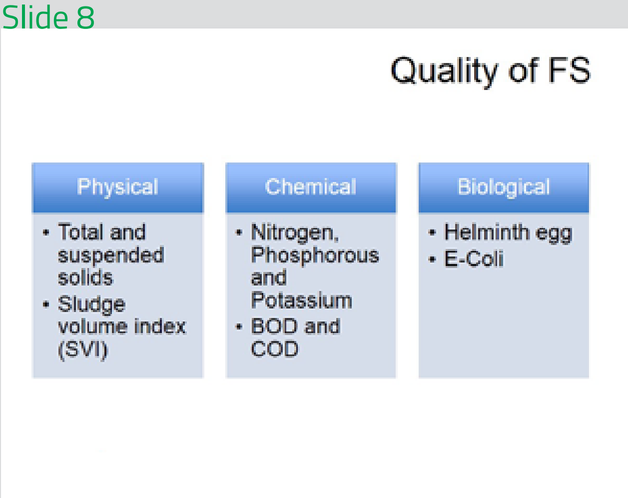
For more information refer to FSM Book (Strande, Ronteltap, & Brdjanovic, 2014).

Slide 7



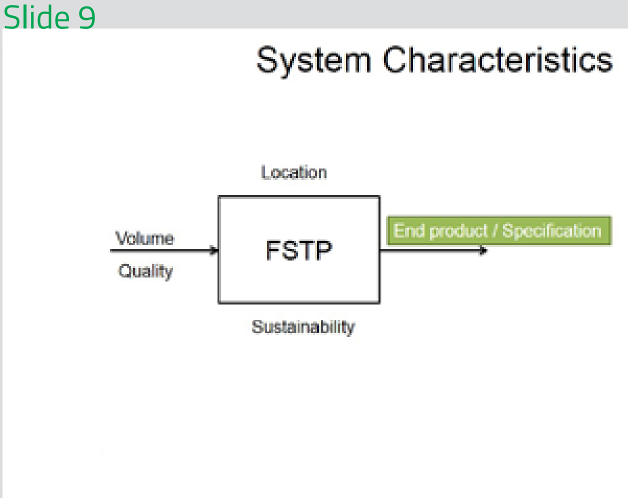

It is unrealistic to identify the quality of FS every time it is input into the system. Thus a range of characteristics are used for the defining the system characteristics.

Slide 8



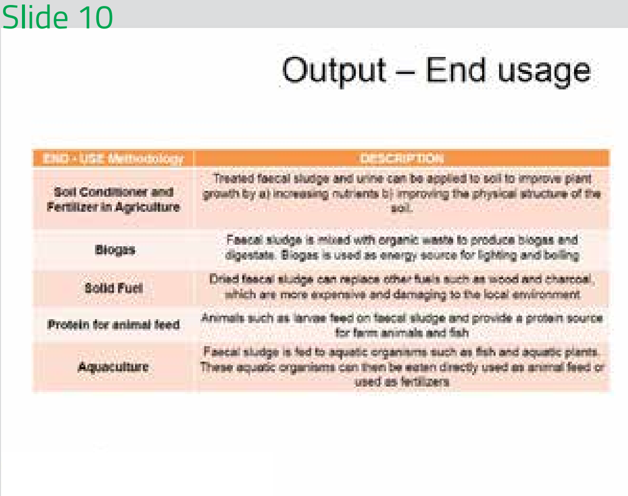

Quality of FS is bucketed under Physical, Chemical and Biological parameters which are crucial for deciding the type of treatment system required.

Slide 9



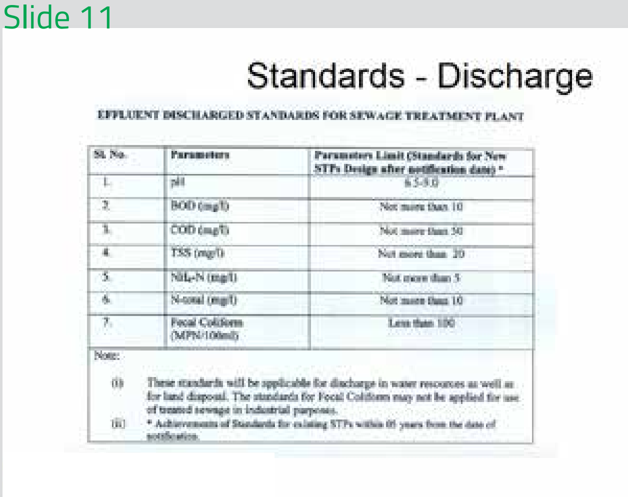

End products play an important role in defining the system characteristics in terms of extent of treatment and type of treatment required to give desired end product.

Slide 10



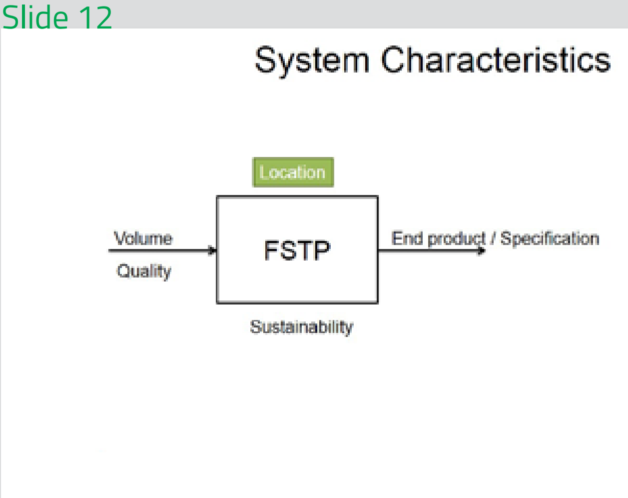

Faecal sludge can be used in a range of activities such as agriculture, energy generation and as a feed for livestock and aquaculture.

Slide 11

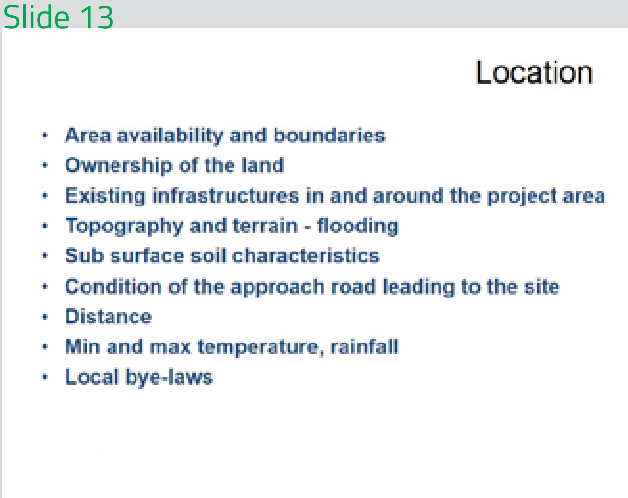



Effluent discharge standards for sewage treatment plants are very stringent. The treatment system must meet the standards.

Slide 12



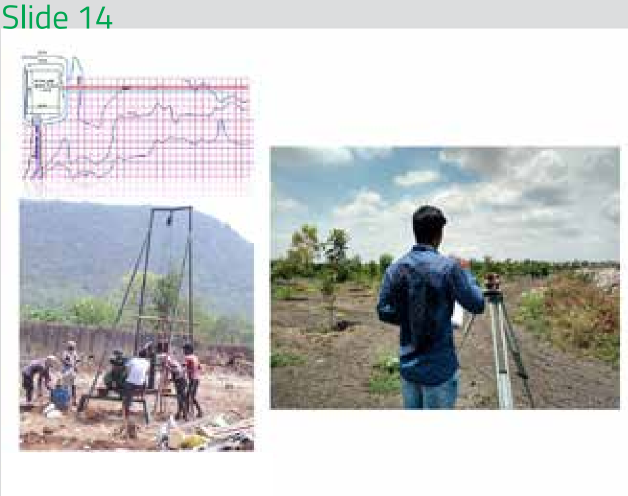

Slide 13




Several factors should be looked into for selection of location of the FSTP.

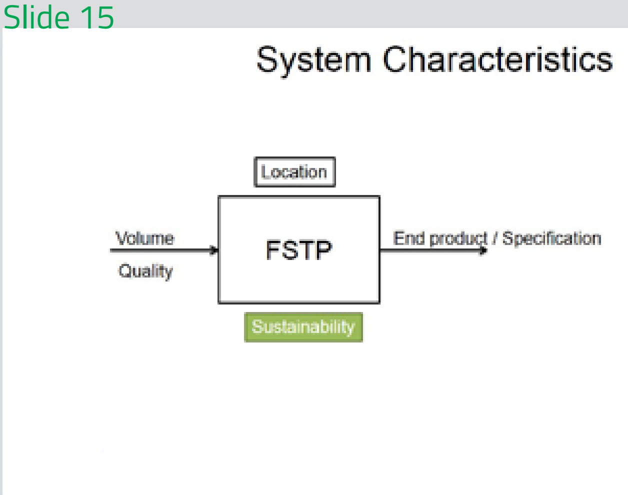
For more information refer to FSM Book (Strande, Ronteltap, & Brdjanovic, 2014).

Slide 14

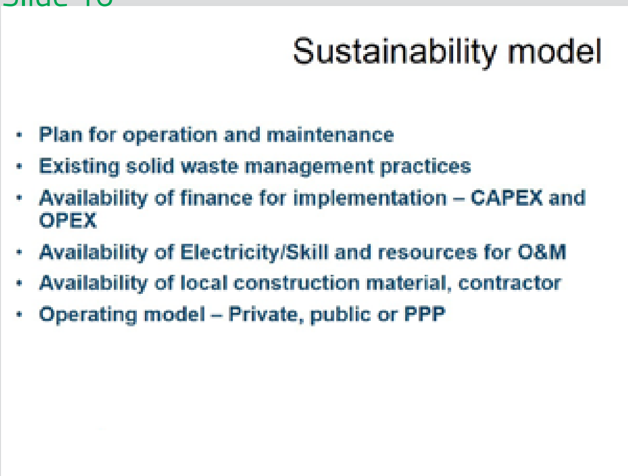


Some pictures showing land survey and soil investigation being carried out at the FSTP location.

Slide 15

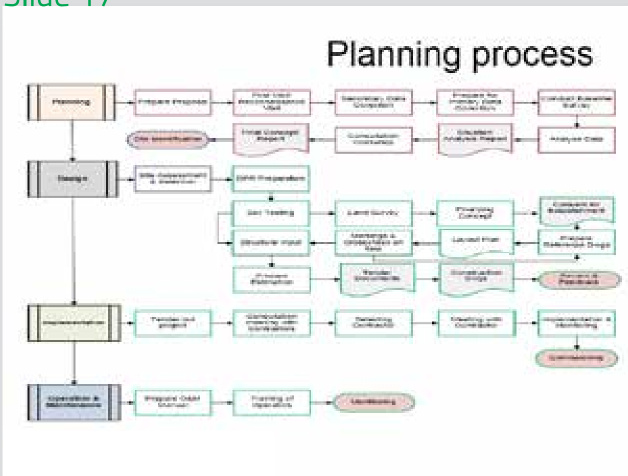


## Slide 16



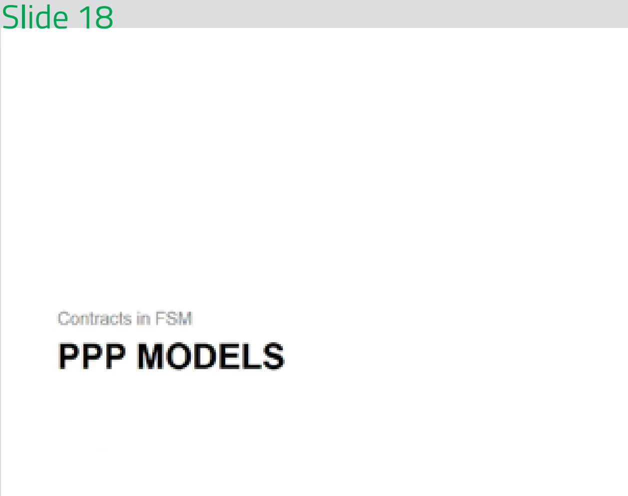

Sustainability of FSTP depends on the existing resources and means to recover the cost incurred in the setting up and operations of the plant.

## Slide 17




Summary of FSM Planning process at different milestones are shown in the picture.

## Slide 18

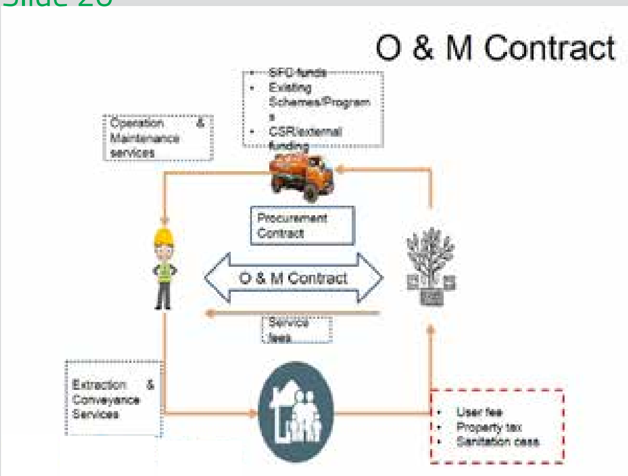



PPP model is a long term contractual agreement between the government and private entity to provide public services. Under this model the government shares the burden of cost through partnership with private entities.

## Slide 19

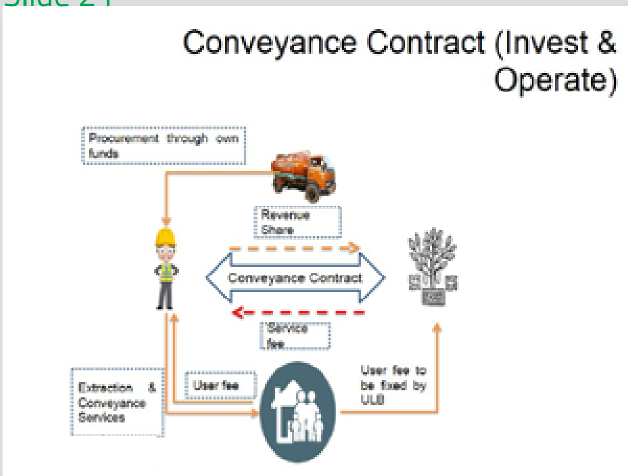

This involves the contracts for emptying the containment systems and conveying the faecal sludge to the designated treatment/ disposal sites.

Slide 20




In the O&M contract model, the vehicles are procured by the municipality and the operations are provided by a private party who is given a service fee by the municipality in return of the services. The users pay to the municipality in form of user fees and property tax and/ or sanitation cess.

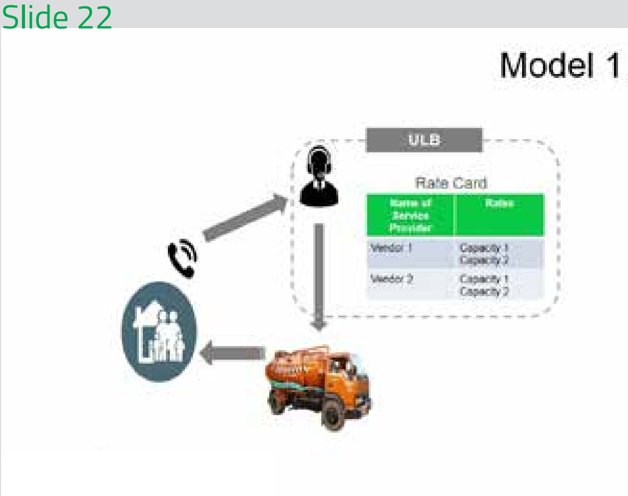
Slide 21




In case of conveyance contracting model, the cesspool vehicle is owned and operated by the private party under a conveyance contract. Depending on the nature of the contract there are two possibilities of revenue sharing:

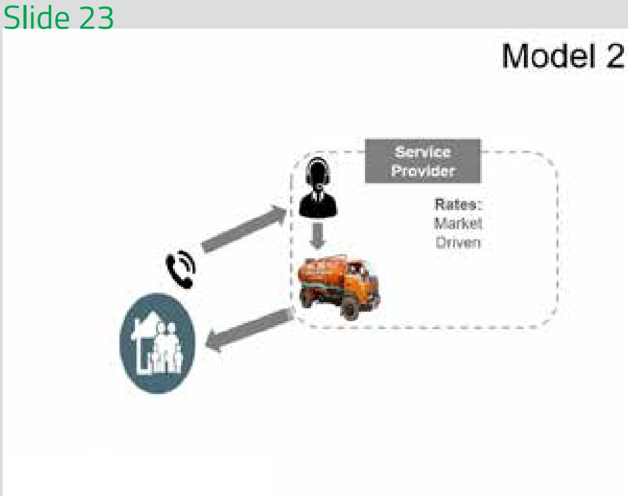
- The user fee is collected by the municipality and a service fee is given to the cesspool operator.
- The user fee is collected by the cesspool operator, who shares a part of the revenue with the municipality

Slide 22




The first model wherein the ULB sets a tariff for emptying and deploys a truck operator for providing the service.

Slide 23

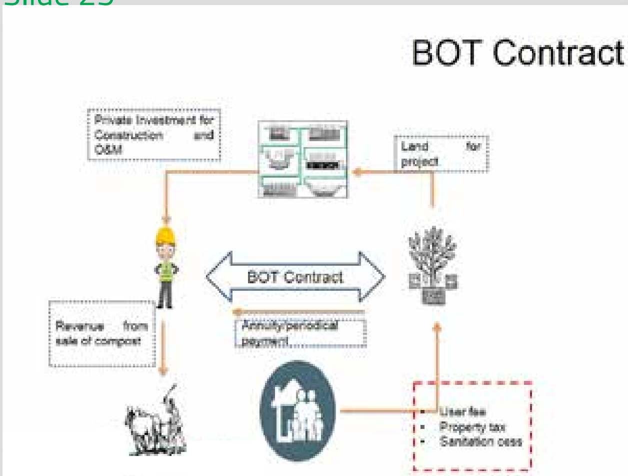



The second model where a service provider himself takes up jobs directly and deploys trucks for the emptying service.

Slide 24

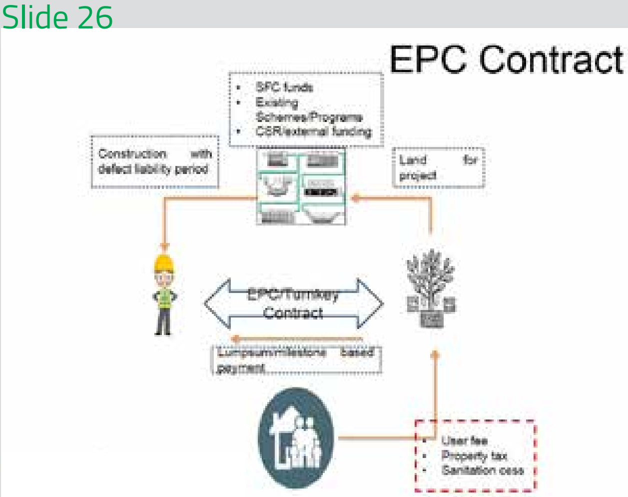

This involves the contracts for construction and operation and maintenance of the treatment plant.

Slide 25



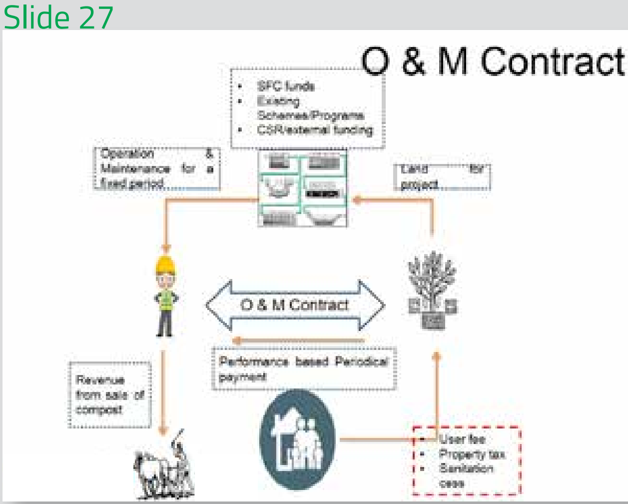

The plant is built and operated by private investment and the land is provided by the government. The government pays the private party periodically. The private party keeps the revenue generated from the sale of by-products. The users pay to the municipality in form of user fees and property tax and/ or sanitation cess.

Slide 26



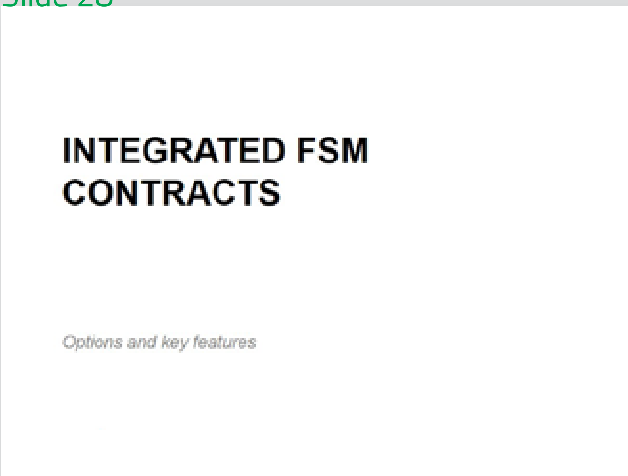

In this model, the private party is involved in the construction of the plant and running the plant from the initial stage until the handover. The land and funds for construction are provided by the government. The users pay to the municipality in form of user fees and property tax and/ or sanitation cess.

Slide 27



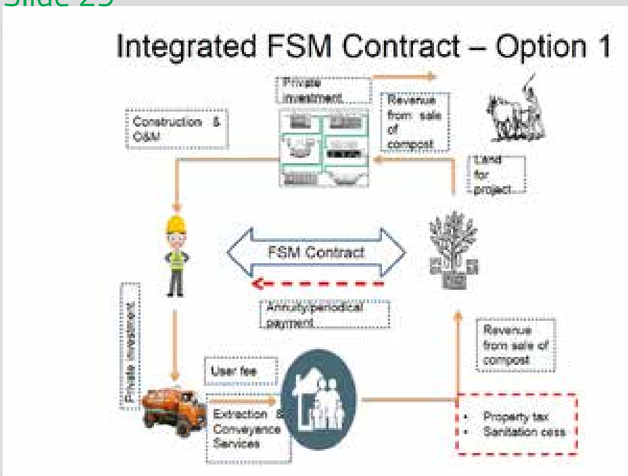

In this model, the private party is involved in the O&M of the plant. The land and funds for construction is provided by the government. The private party also keeps the revenue generated from the sale of by-products. The users pay to the municipality in form of user fees and property tax and/ or sanitation cess.

Slide 28



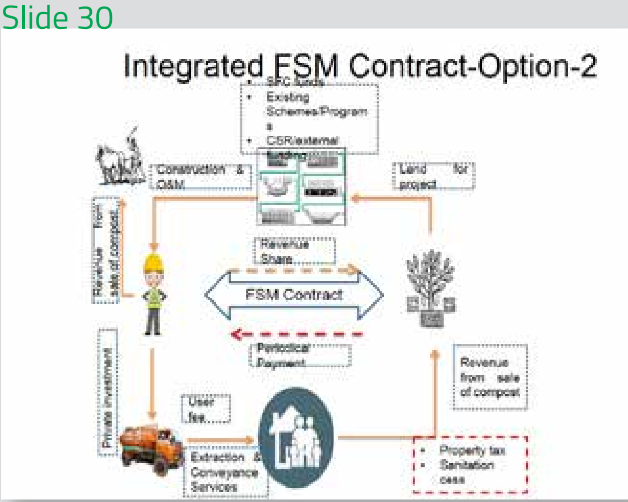

When a ULB chooses to bundle all components of FSM and give it to one private party, it is called integrated FSM contract.

Slide 29




In this option, the ULB provides the land for the construction of the treatment plant. The private party invests on procurement of cesspool vehicle and construction of the treatment plant. Also, the entity handles the O&M operations. In return of these services, the ULB pays the private entity annuity/ periodic payments. The private party keeps the revenue generated from the sale of by-products.

Slide 30

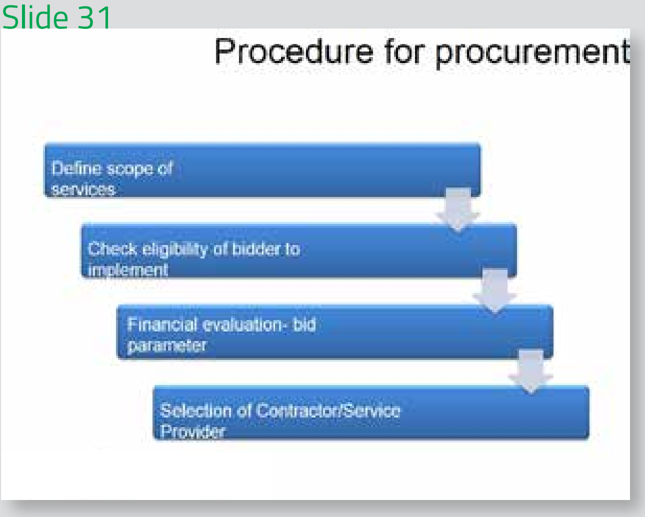



In this option, the land and funds for construction are provided by the government. The private party is involved in procurement and O&M cesspool vehicles. The same entity also provides the O&M of the treatment plant.

The cost sharing between the ULB and the private entity can manifest in two forms:

- The property tax or sanitation cess and the revenue from sale of compost are collected by the municipality and a service fee is given to the cesspool operator as a part of the periodical payment.
- The user fee and the revenue from sale of compost are collected by the cesspool operator who shares a part of the revenue with the municipality

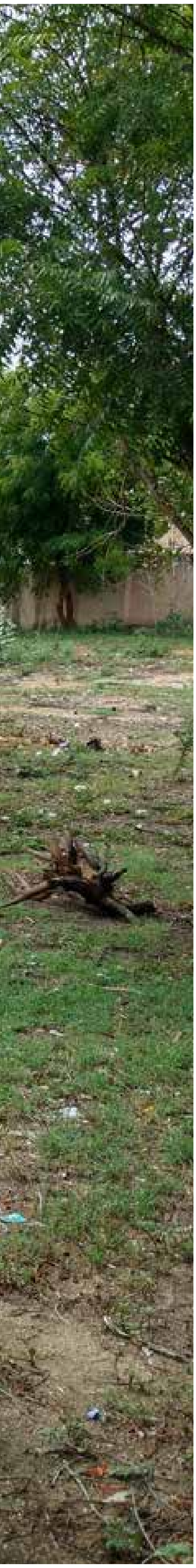
Slide 31




Step by step points for the procurement process.

## References

Strande, L., Ronteltap, M., & Brdjanovic, D. (2014). Faecal Sludge Management: Systems Approach for Implementation and Operation. London: IWA Publishing.



## Day 1 - Session 8

# Preparation for Feasibility study

The most important part of the planning is the estimated quantity of faecal Sludge that needs to be treated. In this session, various methodologies for estimating the same is discussed.

Day 1

Session 7

Outcomes

- Participants are aware of the process involved in implementing an FSTP for their cities
- Participants are aware of various contract methods for implementing FSTP

# Objectives of the session

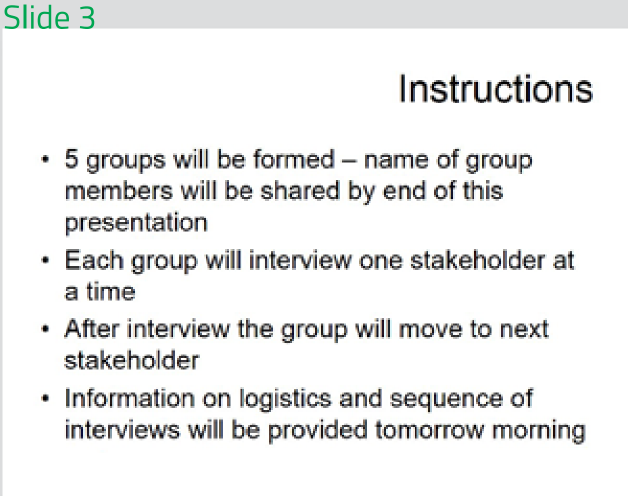
Stakeholders in FSM
Type of information to be collected from each stakeholder group

Slide 2

Agenda

| Timings | Agenda |
|---|---|
| 0930 | Assemble at training venue |
| 0930 – 0950 | Agenda setting and instruction for the site visit |
| 0950 -1100 | Travel to site |
| 1100 – 1300 | Data collection |
| 1300 – 1345 | Lunch |
| 1345 – 1500 | Travel back to training venue |
| 1500 – 1515 | Debriefing |
| 1515 – 1700 | Group work |

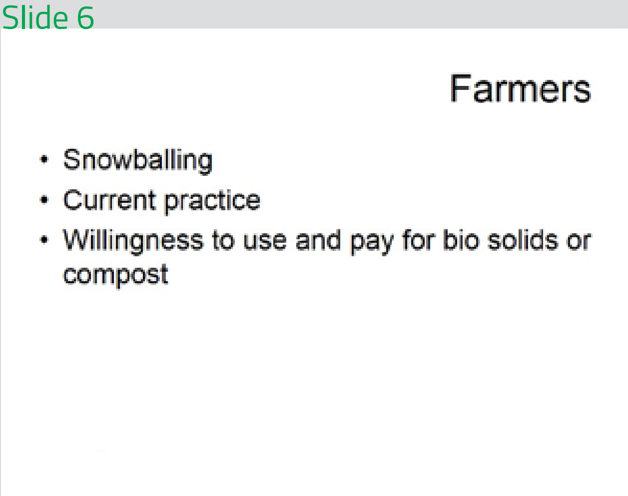
Slide 3



Slide 4

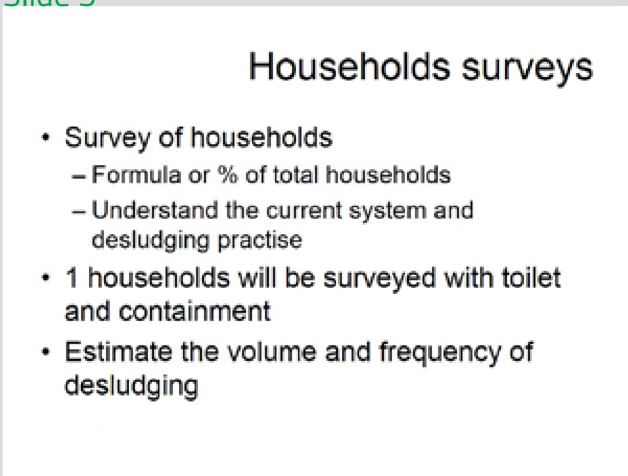

Interviews play a crucial role in data collection on field and to understand the current situation.

Slide 6



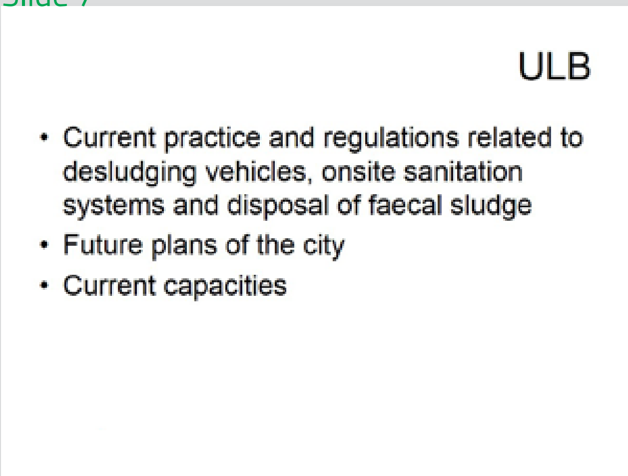

The interviews are aimed at understanding the existing practice of agricultural reuse of faecal sludge and market demand for compost derived from faecal sludge.

Slide 5



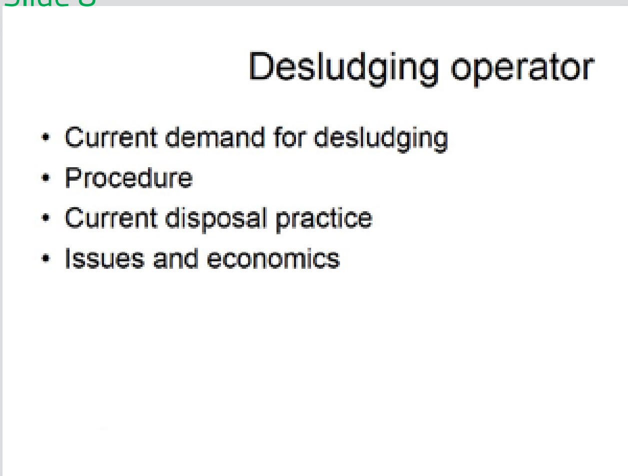

The surveys should help in estimating the quantity of sludge generated from different containment systems, the age of containment unit and the frequency of desludging.
Usually, at least 5% of the total households are surveyed to arrive at a representative answer.
The most commonly used method is stratified proportionate random sampling. This method seeks to represent different strata of the society (based on a particular criterion such as income; area of residence etc.) adequately within a given sample. In order to do so, the proportion of the strata in the population and within the same should be the same. Further, in order to remove any bias in selection of the households while sampling, the households from different strata should be selected randomly.

Slide 7



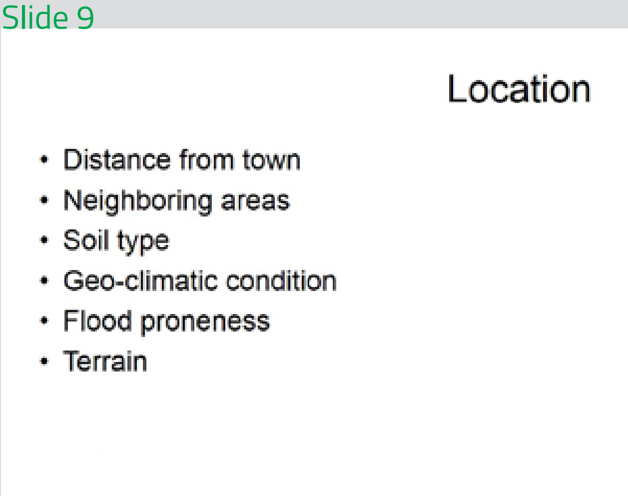

The interviews are aimed at understanding the institutional and regulatory framework in which the FSM operations are taking place and understanding the way to strengthen them.

Slide 8



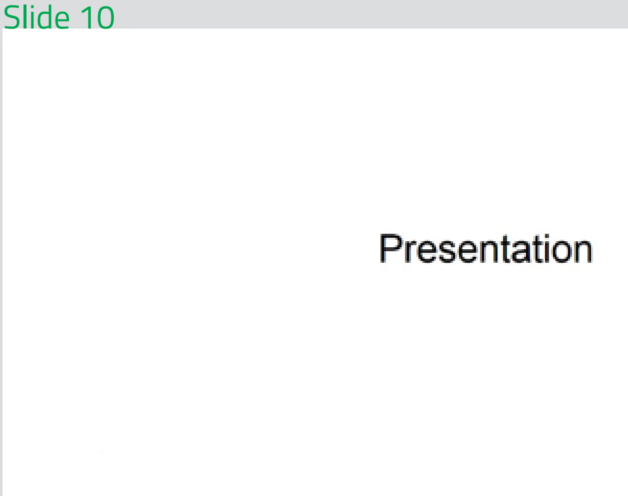

Interviews and observations are aimed at understanding the amount of sludge collected from the city on a daily basis, the operation model, gaps in the current operations and how to optimize it, and collect information about the sizes and types of containment systems in order to triangulate it with the information collected from households and ULB.

Slide 9




The details pertaining to the existing or possible location of FSTP is critical for feasibility analysis and needs to be recorded.

Slide 10



Slide 11

FSM Canvas

Link the hyperlink to FSM canvas document.

Slide 12

Presentation on
Day 2
Time: 10 – 11 am
Duration: 5 minutes for each group

Day 2

# Checklist for site selection

**Checklist for FSTP Site selection**

This document can be used to collect information about proposed sites for faecal sludge treatment plant.

Name of the surveyor:

Date:

GPS Pin number:

Location:

Town/City/District:

State:

Proposed treatment capacity (m3 per day):

**Approach**

1. What is the distance between the centre of town/cluster (place around which most household that require desludging services are located) and the proposed site?

2. Does the approach road to the site have a width of less than 3 metres? Can the desludging vehicle ply freely on the approach road?

3. Condition of the approach road
   ☐ Concrete ☐ Tar road ☐ Gravel and mud ☐Stone/gravel
   ☐Others (Please specify)

4. Can the road be used during rains?

5. Does the approach road lead into the property?
   ☐ Yes ☐ No, it stops at a distance of _______ metres after which there is ______________

**Property details**

1. What is the total area available for construction of FSTP? ( also mention the units)

2. Does the property have any other system/ infrastructure? If yes, what is it?) ( Check if the manpower can be shared for FSTP operation)

3. Does the property have a boundary wall? (to prevent trespassers and animals)

4. What is the distance to nearest habitat (household where people live)?

5. What is the terrain/soil type of the proposed site?
   ☐ Rocky ☐ Sandy ☐ clay ☐ Wetland ☐Farmland ☐Plantation natural ☐others, specify
   ________________________________

6. What is the depth to water table?

7. Is there an open well/ bore well/hand pump/tube well nearby? If yes, at what distance from the property?

8. Is there a natural drain/river/canal/pond nearby? If yes, at what distance from the property?

9. Is portable water available at the property? If yes, what is the source and frequency?

10. Does the property have access to electricity? If yes, please specify the number of hours in a day it is available and the phase ( 3 phase or single phase)

11. Is there a provision for an operator room/house?

12. Is the place located on the lower regions of natural drainage basin? Is the area flood prone?

13. Details of neighbouring land parcels

| Direction | Mention the usage of the land |
|---|---|
| North | |
| East | |
| West | |
| South | |

14. Does the land have a natural slope? ( if yes please mention in the sketch)

15. Does the land require felling of big trees for FSTP construction?

**General details**

1. Climate details

| Months | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rainfall ( in mm) | | | | | | | | | | | | |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Average temp ( in $^{0}$ C) | | | | | | | | | | | | |

2. Does the site have adequate incidence of sunlight? ( check for shadow regions or regions covered under natural/man made cover)

3. Is there a solid waste management yard in the vicinity? ( If yes, please specify, the type of SWM, distance and quantity handled per day)

4. Who is the current owner of land? Is any transfer proposed? If yes, to whom and when?

5. What is the proposed development in the surrounding region for the next 30 years? (Are there any layouts, institutions, etc. planned)

## Schematic

In the next page make the following markings along with a detailed sketch of the site

a. Detailed boundary map
b. Topography details on the schematic map (mark slopes)
c. Wind direction
d. Location of other infrastructure (SWM centres, well, tank etc.)
e. Location of ponds, stream, river etc.
f. Location of surrounding human habitation.


K.S
செப்டிக் டேங்க் கிளீனிங்
99425 71463
9942831463

## Day 2

# Desludging

Advanced
Training on
Faecal Sludge
Management

## Cesspool Operator Survey

Please take a few minutes to fill out this survey on the current sanitation status at ____________________.
Your responses would be kept confidential. Thank you for your participation.

Name of the surveyor: ______________________________________________

Date: ______________________________________________

Location: ______________________________________________

### General Information

1) Name

2) Years of Operations (by the owner)

3) Number of Trucks currently owned by the owner

### Operations

4) What are the services offered?

☐ Septic tank cleaning ☐Collection ☐Transport of FS ☐Water Supply

5) What time of the day and Month do customers usually call? (If not the usual operation time for the operators) ( Please tick operating hours)

| | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 00 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 |

Which month of the year has most desludging request from households?

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |

6) What is the cost to consumer for desludging?

7) What is the maximum number of trips of Faecal Sludge conveyed in a month?

8) What is the maximum number of trips of faecal sludge conveyed in a day?

9) Do you desludge chemical wastes from institutions such as industries and small scale units? (Please fill this for chemical and industrial waste only, not for black water from toilets) ☐Yes ☐No

If yes, where do you dispose these waste?

Which industry types do you desludge most often from?

## Collection

10) Are there certain pockets within the town which are not accessible by the operator?

Areas:

## Conveyance

| Characteristics - Tank | |
|---|---|
| Tank Capacity | |
| Outlet valve diameter | |
| Height of the outlet valve (bottom) from the ground level | |

11) Where do you dispose the sludge? ( probe for factors affecting the place of disposal)

12) Do you face problems of disposal at specific months or seasons? If yes, when?

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |

Day 2

# Farmers Survey

Advanced Training on Faecal Sludge Management

## Reuse (Farmers) Survey (This survey is only looking at the aspect of reuse of wastewater and faecal sludge for irrigation)

Please take a few minutes to fill out this survey on the current sanitation status at ____________________ &____________________. Your responses would be kept confidential. Thank you for your participation.

Name of the surveyor: ________________________________________________

Date: ________________________________________________

Farm location (Name of road/ward number): ________________________________________________

GPS Pin number: ____________________________________

### Fresh Water Irrigation

1. Where do you get fresh water supply for irrigation from
   ☐ Municipality water supply ☐ Canal water ☐ Water tanker ☐ Borewell ☐ Open wells ☐ Rainwater ☐ Others, ____________________________

2. Is freshwater available for irrigation throughout the year ☐ Yes ☐ No

3. If No, then in which seasons are freshwater not available __________________

4. What kinds of crops and vegetables are yielded with freshwater ______________________________
   ______________________________________________________________________________

5. Do you use cow dung manure in farming? If yes, how much do you pay?
   ______________________________________________

6. How do you use the fertilizers ☐ Mechanical spraying ☐ Hand mixed with soil ☐ Mixed with irrigation water ☐ Others, ______________________________

### Wastewater Irrigation. Fill if farmer uses wastewater

7. Do they use wastewater for irrigation ☐ Yes ☐ No

8. Why do you use wastewater for irrigation ☐ High nutrient value ☐ Lack of freshwater ☐ Water management *(No place to dispose)* ☐ Others, ________________________________________

9. What is the source for wastewater ☐ Nearby nala ☐ STP outlet ☐ Own septic tank/soak pit/pit ☐ Others, ______________________________________

10. Where do you get wastewater from ☐ Municipality ☐ Private Supplier ☐ Others, ________________

11. How much do you pay for wastewater *(in terms of quantity – per liter or per cubic meter)* _____________________

12. Is there any transportation required to avail wastewater ☐ Yes, Cost ______________ ☐ No

13. Do you use any kind of basic filtration process before using the wastewater ☐ Yes, What ____________________________________________ ☐ No

14. Do you store the wastewater before using it ☐ Yes ☐ No

15. If Yes, is there mosquito breeding ☐ Yes ☐ No

16. Do you use any pesticide to avoid mosquitoes and other pests ☐ Yes ☐ No
17. What crops do you grow using wastewater ______________________________________________

18. Do you use any protective equipments while using wastewater for irrigation ☐ Yes, What ____________________________________________________, Cost per annum ______________ ☐ No

19. Has anybody in your family got any of the following diseases ☐ Yes, ☐ Diarrhea ☐ Cholera ☐ Typhoid ☐ Hepatitis ☐ Others,______________ ☐ No

20. Did you receive any complaints regarding the quality of crops/vegetables grown in wastewater ☐ Yes, What ____________________________________________________________________________ ☐ No

21. If treated water is made available, how much would you pay for 1 tractor load (3-4 Kilo litres)______________________________

## Faecal Sludge as a soil conditioner – Fill if farmer uses Faecal Sludge

22. Do you use faecal sludge as a soil conditioner ☐ Yes ☐ No

23. Nature of faecal sludge ☐ Dried ☐ Fresh from vaccutugs

24. When do you apply faecal sludge to the soil ☐ During cultivation ☐ Before cultivation, how many days before ______________________________

25. Who disposes the faecal sludge ☐ Municipality ☐ Private desludging operators ☐ Others

26. Do you pay any amount for availing faecal sludge ☐ Yes, how much ________________________ ☐ No

27. If No, does the disposer pay any amount for disposing the sludge ☐ Yes, how much ________________________ ☐ No

28. What crops do you grow using faecal sludge __________________________________________________

29. Is there any mosquito breeding due to the use of faecal sludge ☐ Yes ☐ No

30. Do you use any pesticide to avoid mosquitoes and other pests ☐ Yes, Expenditure on pesticides _____________________ ☐ No

31. Do you use any protective equipments while using faecal sludge as soil conditioner ☐ Yes, What ___________________________________________________________, Cost _________________________ ☐ No

32. Did you receive any complaints regarding the quality of crops/vegetables grown using faecal sludge ☐ Yes,What________________________________________________________________________________ ___ ☐ No

33. If treated faecal sludge is made available which is safe and stabilized, ideal for farm applications. How much would you be willing to pay for 1 tractor load of 3 tons? _________________________________

## Notes

34. How is the faecal sludge discharged from vaccutugs, diverted and used for irrigation:

Day 2

# User Interface (Individual Toilet) Observation Checklist

Advanced Training on Faecal Sludge Management

## User Interface (Individual Toilet) Observation Checklist

Please take a few minutes to fill out this survey on the current sanitation status at _____________________ Your responses would be kept confidential. Thank you for your participation.

Name of the surveyor: ____________________________________________________

Date: ____________________________________________________

Location (Name of road/ward number): ____________________________________________

Survey ID: __________________________________, GPS I.D:_________________________________

### User Interface and General

1. What is the type/condition of the main house:
   ☐ Permanent ☐ Semi-Permanent ☐ Temporary (Serviceable) ☐ Temporary (Non-Serviceable)

   ***Permanent:*** *wall materials of G.I., Metal, Asbestos sheets, burnt bricks, stone or concrete and with roof materials of tiles, slates, G.I., Metal, Asbestos sheets, bricks, stone or concrete*
   ***Semi-permanent*** *houses are with either wall or roof made of permanent materials and the other made of temporary materials.*
   ***Temporary:*** *Houses with wall made of temporary materials such as grass, thatch, bamboo, etc, mud, plastic, polythene, un-burnt bricks or wood and roof made of grass, thatch, bamboo, wood, mud, plastic or polythene;* ***Temporary serviceable*** *houses are with wall materials of mud, un-burnt bricks or wood.*
   ***Non-serviceable temporary*** *houses are with wall materials of grass, thatch, bamboo, etc, plastic or polythene*

2. What is the kind of flushing system inside the toilet ☐ Cistern flush ☐ Pour flush ☐ Others (Dry toilet)

3. Where is the toilet outlet connected to
   ☐ Connection to a piped sewer system ☐ Connection to a septic system ☐ Pit latrine without slab ☐ Pit with slab ☐ Ventilated improved pit ☐ Composting unit ☐ Elsewhere (not into a pit, septic tank, or sewer)

4. Where are the utensils washed ☐ Kitchen ☐ Other place,___________________

5. Where does the wastewater from kitchen go
   ☐ Septic tank ☐ Pit ☐ Public sewer ☐ Kitchen garden ☐ Storm water Drain ☐ Roadside ☐ Ditch ☐ Canal ☐ others, ________________________

6. Where is the bathing water disposed
   ☐ Septic tank ☐ Pit ☐ Public sewer ☐ Kitchen garden ☐ Storm water Drain ☐ Roadside ☐ Ditch ☐ Canal ☐ Others, _____________________________

7. Condition of the drain which the household is connected to
☐ Blocked or choked ☐ not deep enough ☐ Broken ☐ without cover ☐ Covered

8. What is colour of liquid waste flowing through the storm water drain
☐ Black ☐ Grey ☐ Brown ☐ Others, ________________________

## Containment

9. What is type of containment unit
☐ Septic tank ☐ Twin Pit ☐ Single Pit ☐ Others_______________________

### In case of a single pit

a. How many rings are there in the pit _________________

b. What is the height of each ring (in feet) ________________

c. What is the diameter of the ring (in feet) ____________________

d. In case the pit is not made of rings, what is the depth of the pit (in feet) _______________________

e. Is the pit located near to an open well/ tube well/ bore well ☐ Yes, distance_________ ☐ No

f. Does the pit cover have a provision for desludging pipe
☐ Yes: mention the type of arrangement____________________________________________ ☐ No

g. Is there an outlet in the pit, through which faecal matter overflows
☐ Yes, where does it overflow to_________________ ☐ No

h. What is the distance of pit from place where desludging vehicle can be parked
☐ 10 meters ☐ 10 – 20 meters ☐ 20 – 30 meters ☐ 30 – 50 meters ☐ More than 50 meters

### In case of a twin pit

a. How many rings are there in each pit _____________________

b. What is the height of each ring (in feet) ____________________

c. What is the diameter of the ring (in feet) _____________________

d. In case the pit is not made of rings, what is the depth of the pit (in feet) _______________________

e. Is there an interlinking connection between the two pits ☐ Yes ☐ No

f. Is the pit located near to a open well or tube well ☐ Yes, distance_________ ☐ No

g. Is there an outlet in the pit, through which faecal matter overflows ☐ Yes, where does it overflow to________________ ☐ No

h. What is the distance of pit from place where desludging vehicle can be parked
☐ 10 meters ☐ 10 – 20 meters ☐ 20 – 30 meters ☐ 30 – 50 meters ☐ More than 50 meters

### In case of a septic tank

a. What is the length of septic tank (in feet) ____________________

b. What is the width of septic tank (in feet) _____________________

c. What is the depth of the septic tank (in feet) *(use a rod and a tape for measuring) (to be measured from below the outlet pipe)* _____________________________

d. How many number of chambers are there in the septic tank _________________

e. Where are the partition walls located
☐ Centre of the tank ☐ One third of the tank and equally distributed ☐ others, _______________

f. Is the septic tank located near to a open well/ tube well/ bore well ☐ Yes, distance________ ☐ No

g. Does the septic tank have manhole covers ☐ Yes, number_________ ☐ No

h. Is the septic tank connected to a soak pit ☐ Yes ☐ No, outlet connected to________________

i. Distance of septic tank from the nearest main road ______________________

j. What is the width of the road near the septic tank
☐ More than 3 meters ☐ 2 meters to 3 meters ☐ Less than 2 meters

## Notes

Day 2

# User Interface (Individual Toilet) Survey

Advanced Training on Faecal Sludge Management

## User Interface (Individual Toilet) Survey (This survey is only for individual toilets. There is a separate survey for public toilets)

Please take a few minutes to fill out this survey on the current sanitation status at ____________________. Your responses would be kept confidential. Thank you for your participation.

Name of the surveyor: ________________________________________________

Date: __________________________________________________

Location (Name of road/ward number): ______________________________________________

Survey I.D: ____________________________________, GPS I.D:___________________________

### Water Supply

1. What is the primary source of potable water?
   ☐ Municipal piped supply ☐ Household owned tube-well ☐ Community tube well ☐ Pond ☐ River/canal ☐ Own source (pump motor) ☐ Neighbor tube well ☐ Private tankers ☐ Others,_____________

2. What is the distance between the nearest water source and the toilet containment structure
   ☐ 0-3 meters ☐ 3-5 meters ☐ More than 5 meters ☐ Not applicable

3. What is the frequency of potable water supply ☐ Everyday ☐ Once in two days, hours of supply ___________ ☐ Once in three days, hours of supply ____________ ☐ Once per week, hours of supply _______________

4. What is the per month water bill including tips and other miscellaneous expenses ________________________________________

5. How is your water supply charged ☐ Metered ☐ On basis of the pipe diameter ☐ Fixed billing ☐ Others, _______________________

6. On a scale of 1-5 (5 being highly satisfied), how satisfied are you with the level of piped water supply
   ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ No comments

### Toilet – User Interface, Containment and Emptying

7. What is the kind of containment unit that is connected to the toilet ☐Septic tank ☐Twin Pit ☐Single Pit ☐others, _________________________

8. What happens when a single pit is filled
   ☐ Toilet super structure is shifted to a new place with a new containment unit ☐ Desludged ☐ Toilet outlet connected to a new containment unit ☐ Others,_______________________________________

9. Why did the household call for desludging
   ☐ Backflow of water inside the toilet ☐ Foul smell ☐ Overflow of containment unit ☐ Others, _______________________________

10. When was the pit/septic tank last desludged __________________________

11. How often do you desludge the pit/septic tank
    ☐ Every six months ☐ Every year ☐ Once in two years ☐ Once in three years ☐ Once in five years ☐ More than five years

12. Who desludges the pit/septic tank
    ☐ Self ☐ Local Sweeper ☐ Municipal Sweeper ☐ Municipal Vaccutug ☐ Private Vaccutug ☐ Others,_______________

13. How much do you pay for desludging service __________________________

14. Where is the faecal matter disposed
    ☐ In adjacent drain ☐ Canal ☐ River ☐ Low land ☐ Burying under soil ☐ Treatment plant ☐ Do not know

15. Are you satisfied with the prevailing faecal sludge desludging system ☐ Yes ☐ No

16. If No, what is the reason behind discontent ______________________________

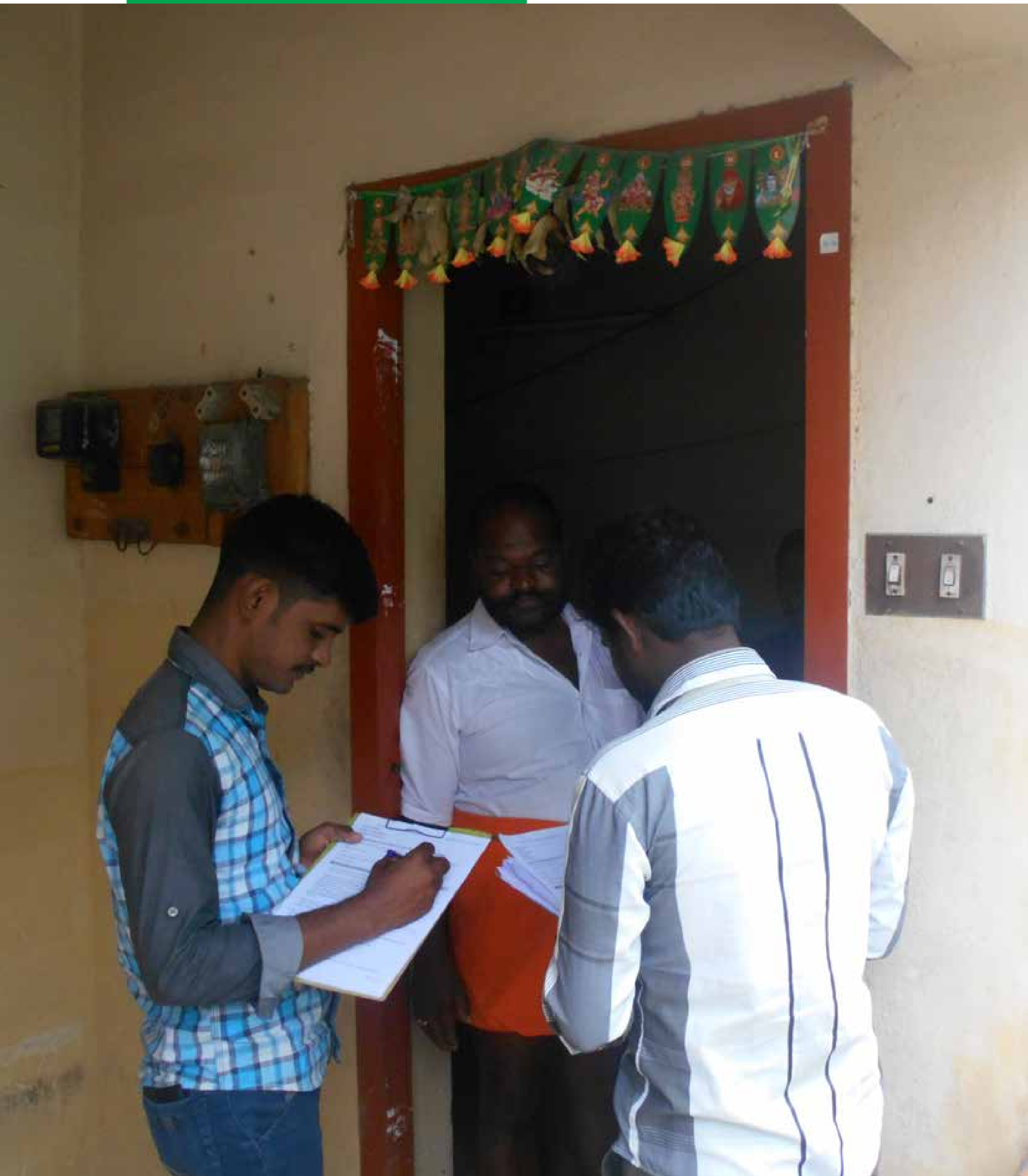
17. If No, are you willing to pay charges for improved desludging service ☐ Yes, how much____________
    ☐ No

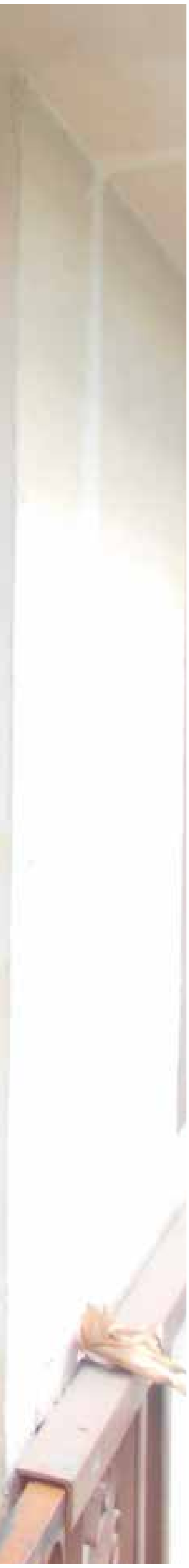
## General Information

18. Name of respondent ______________________________________

19. Gender __________________

20. Number of people in the family/household _____________________





Day 2

# Institutional Questionnaire

Advanced
Training on
Faecal Sludge
Management

## Institutional Questionnaire (This survey is for collecting data from the Municipality)

Please take a few minutes to fill out this survey on the current sanitation status at ____________________. Your responses would be kept confidential. Thank you for your participation.

Name of the surveyor: ________________________________________________

Date: ________________________________________________

Location (Municipality Office): ________________________________________________

Name and position of staff interviewed: ________________________________________________

### General

1. What is the type of Urban Local Body (ULB)?

   ☐ Nagar Nigam ☐ Nagar Parishad ☐ Nagar Palika

2. What is the total number of wards in the ULB _______________
3. What is the total population of the ULB: _______________;
4. What is the total number of residential holdings in the ULB ______________
5. What is the total number of non residential holdings in the ULB _______________
6. What is the number of taxable *(property tax)* holdings ______________
7. What is the number of non-taxable *(property tax)* holdings _____________
8. How much is the property tax paid by each holding ________________
9. What is total number of holdings having access to piped water supply *(provided by the ULB)* _____________
10. What is the volume of water supplied to the citizens per day ___________________
11. How much does the ULB charge for water supply _________________

### Sanitation

12. Which department of the ULB looks after sanitation related activities ____________________________
13. Is there any sanitation (wastewater/fsm) committee available in the ULB ☐ Yes *(Collect the organogram of the committee)* ☐ No
14. If there is a committee available, what are the current activities of the committee ________________________________________________

______________________________________________________________________________
______________________________________________________________________________

15. How many individual toilets are there in the city ______________________

16. How many functional community/public toilets are there in the city ________________________;

17. Is the toilet containment unit shown in the plan before approval ☐ Yes ☐ No

18. Is there a provision in the ULB, that the septic tank/pit outlet cannot be directly connected to the open drains ☐ Yes, what is the penalty if rule not followed ______________________ ☐ No

19. Is there a faecal sludge collection system (desludging vehicles) in the ULB ☐ Yes ☐ No

    a. If yes, what is the capacity of the vehicle ___________________
    b. How many trips does the vehicle carry out in a day _______________
    c. What is the cost of desludging (per trip or per containment unit) _________________________
    d. How much is the operation and maintenance expense on the collection system _________________
    e. How many staff including driver, worker and supervisor is engaged for fecal sludge management __________________________________

20. Is there land available for the establishment of faecal sludge/wastewater treatment plant with the ULB
    ☐ Yes, area available ______________ *(Collect a copy of layout, potential sites to be illustrated on map)*
    ☐ No, price of land in the ULB ____________________________

    If area available,
    a. Is there an approach road to the site ☐ Yes, width of road _______________ ☐ No
    b. Types of nearby buildings/structures ________________________________________

## Finance

21. Evaluation of information on Municipal Finance:

| **Head** | **2013-14** | **2014-15** | **2015-16** | **2015-17** | **Remarks** |
|---|---|---|---|---|---|
| Revenue Income (Own) | | | | | |
| Grants | | | | | |
| Expenditure-Total | | | | | |
| Surplus/(Deficit in negative) | | | | | |

## Others

22. Inventory of following kinds of projects (underway or completed) in your ULB *(Provide a list of the Projects undertaken within the ULB):*
    a. Wastewater treatment infrastructure:
    ______________________________________________
    ______________________________________________
    ______________________________________________
    b. Wastewater conveyance infrastructure:
    ______________________________________________
    ______________________________________________
    ______________________________________________
    c. Faecal sludge conveying services:
    ______________________________________________
    ______________________________________________
    ______________________________________________
    d. Faecal sludge treatment sites:
    ______________________________________________
    ______________________________________________
    ______________________________________________

23. ULB staff engaged in sanitation activities:

| Sl. No. | Name | Designation | Role/Responsibility | Years of experience |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

24. List of documents to be collected
    a. Map of the municipality with ward boundary *(both soft and hard copy)*
    b. Layout plan for sites identified for FSM/WW plants

## FSM CANVAS

FSM

### Situation

General data

Town (District):

Population:

Households:

Non residential units:

Max, floating population:

Water table:

Water supply:

Sanitation

% of HH connected to sewer:

% of HH with toilets:

% of HH with unhygienic toilets:

% of HH with septic tanks:

% of HH with pits:

Number of public toilets:

Desludging vehicles

| Size/Capacity | Number of vehicles | Ownership |
|---|---|---|
| | | |
| | | |
| | | |

Faecal sludge

Generation:

Current Demand:

ULB

Revenue:

Deficit / Surplus

Number of staff for MSW and Sanitation:

### Economics

| | | |
|---|---|---|
| A | OPEX for Truck | |
| B | OPEX for Treatment | |
| C | Administrative expenses per annum | |
| D | Total expense per annum for the ULB (A+B+C) | |

| | | |
|---|---|---|
| F | Revenue from Truck | |
| G | Revenue from end products | |
| H | Revenue from taxes | |
| I | Revenue from other sources | |
| J | Total Revenue per annum (F+G+H+I) | |

| | | |
|---|---|---|
| K | Net surplus or deficit (J-D) | |

### Onsite

1. What type of onsite system is most suitable?

2. What is the solution for households where onsite system construction is not possible?

### Collection and conveyance

| Type | Capacity | N |
|---|---|---|
| Hand held | | |
| Auto mounted | | |
| Tractor mounted | | |
| Truck mounted | | |
| Transfer stations | | |

Desludging cost per HH:

Cost of licencing per annum

### Regulation

1. How to ensure the HH desludge in given time periods?

2. How to ensure that trucks discharge in the treatment plant

Canvas

| | |
|---|---|
| | |
| | |
| | |
| | |

| | |
|---|---|
| | |
| | |
| | |
| | |
| | |

| Numbers | Cost |
|---|---|
| | |
| | |
| | |
| | |
| | |

:

t?

Behaviour change

| Stakeholders | Change | Method |
|---|---|---|
| Households | | |
| Desludging operators | | |
| Farmers | | |
| ULB | | |

Treatment

Treatment capacity:

Treatment modules:

Location of land:

Size of land:

SBC:

CAPEX:

OPEX:

Use of end products

| S.no | End product | Quantity | Sale price |
|---|---|---|---|
| | | | |
| | | | |
| | | | |

Capacity building

1. What additional skill sets do the ULB staff require to regulate and monitor the FSM plan?


BenQ

## Day 3 - Session 1

# Presentation on Feasibility study

Slide 2

## Instructions

- Duration: 5 minutes per group + 2 minutes for Q&A
- Time keeper will signal at last 1 minute remaining
- Please try and complete all aspects of the planning and stick to time for others to present

Slide 3

## What to present?

- FSM Canvas
  - What is the proposal for infrastructure
  - What is the plan to ensure the infrastructure will be used as desired
- What is the learning from this exercise?

Slide 4

**Some additional information**

**Faecal sludge generation rate: 0.00021 m3 per person per day**

**Treatment plant Estimations**

| Per KL estimations | Mechanical | Biological | Thermal |
|---|---|---|---|
| Capex | Rs. 7,00,000 | Rs. 10,00,000 | Rs. 8,00,000 |
| Opex, per annum | Rs. 1,00,000 | Rs. 50,000 | Rs. 1,50,000 |
| Area (in Sqm.) | 100 | 150 | 75 |

Slide 5

**Some additional information**

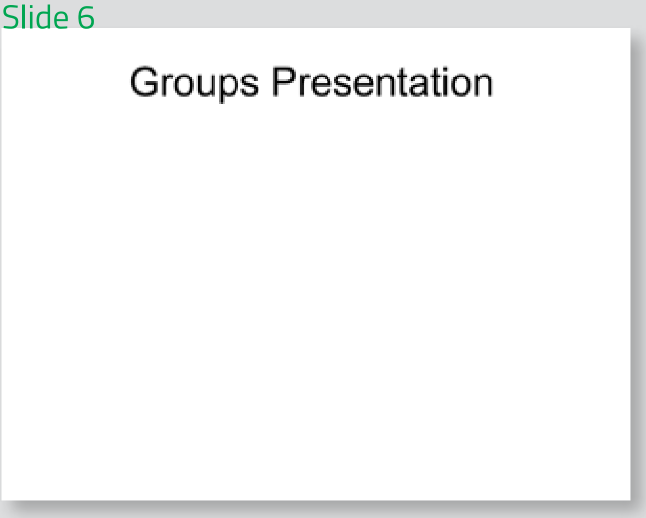
**Desludging truck Estimations**

| Per KL estimations | Small | Medium | Large |
|---|---|---|---|
| Capex | Rs. 10,00,000 | Rs. 15,00,000 | Rs. 22,00,000 |
| Opex, per annum | Rs. 6,00,000 | Rs. 8,00,000 | Rs. 12,00,000 |

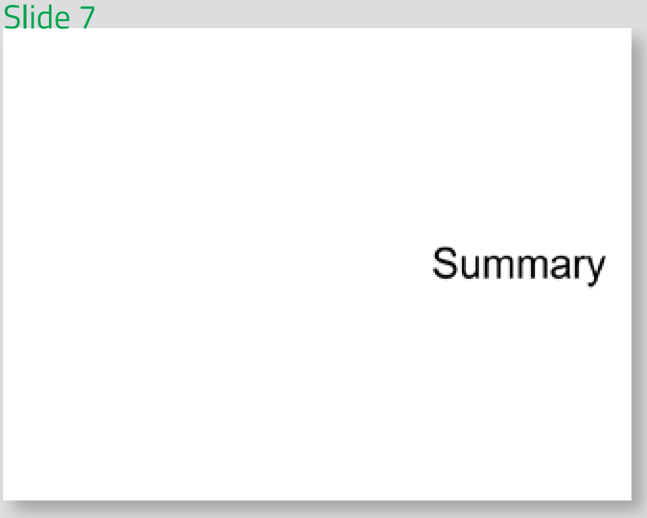
**End Product specifications**

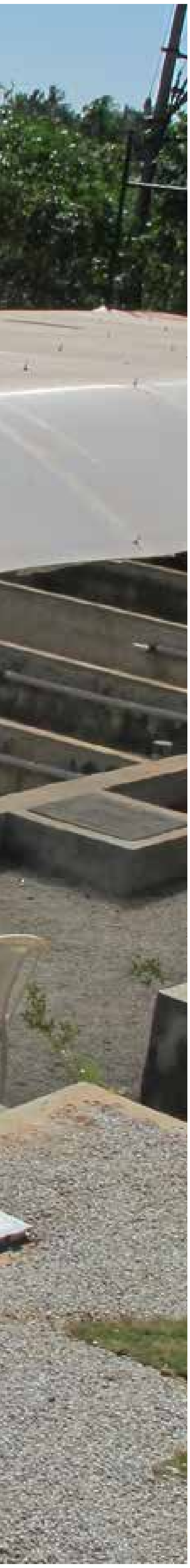
| End Products | Specific Quantity |
|---|---|
| Water | 90% of input in KL |
| Bio solids | 10% of input in Kgs |
| Bio gas | 0.2 m3 per KL of FS |

Slide 6




Slide 7





## Day 3 - Session 2

# Treatment concept - Sludge Drying Beds

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.

Day 3

Session 2

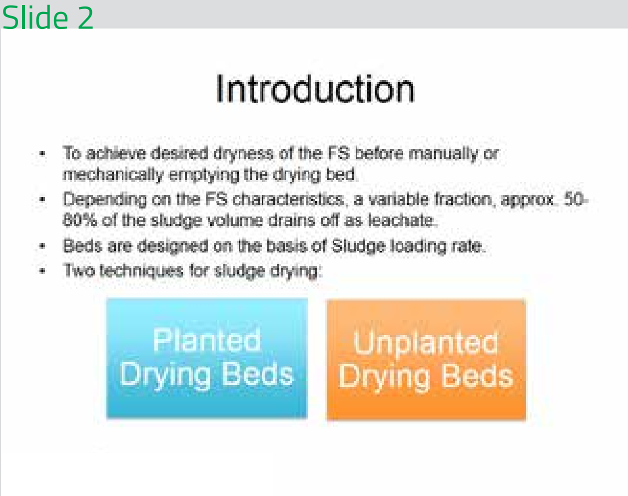
Outcomes

- Participants carry out preliminary design of the treatment module Sludge drying and planted sludge drying bed

# Objectives of the session

Types of sludge drying bed
Working principle of sludge drying beds
Details of unplanted and planted drying beds

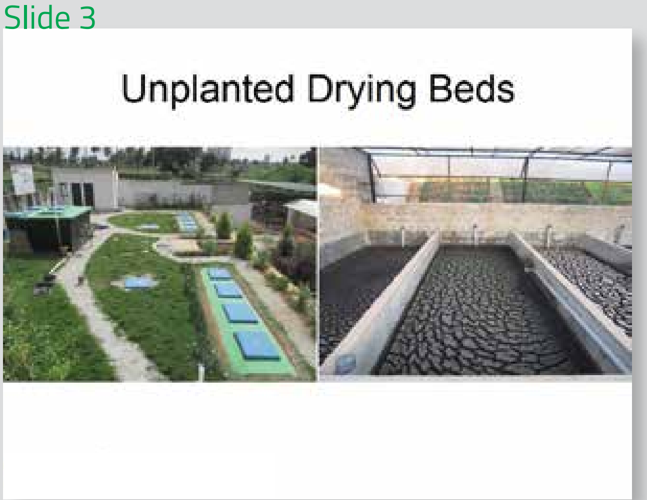
Slide 2




Sludge drying beds are one of the most natural ways to dewater sludge. The sludge is dewatered by the process of evaporation and percolation.
Sludge drying beds can be categorized into planted and unplanted.

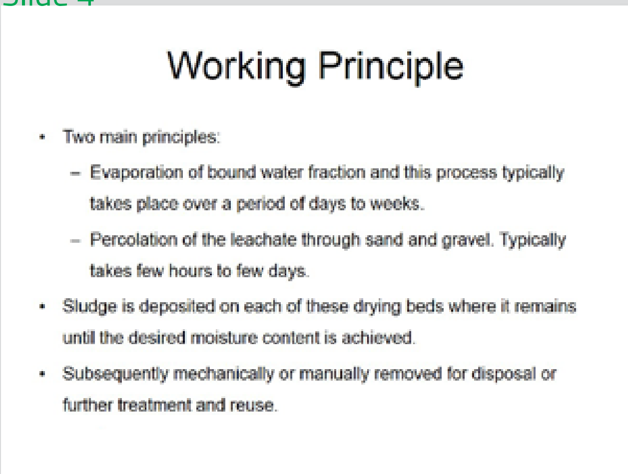
For more details refer to FSM Book (Strande, Ronteltap, & Brdjanovic, 2014)

Slide 3




Few glimpses of Unplanted drying beds at Devanahalli.

Slide 4




Principles under which the unplanted drying beds work, namely: Evaporation and percolation. The percolated leachate should be further treated.

For more details refer to FSM Book (Strande, Ronteltap, & Brdjanovic, 2014)

Slide 5

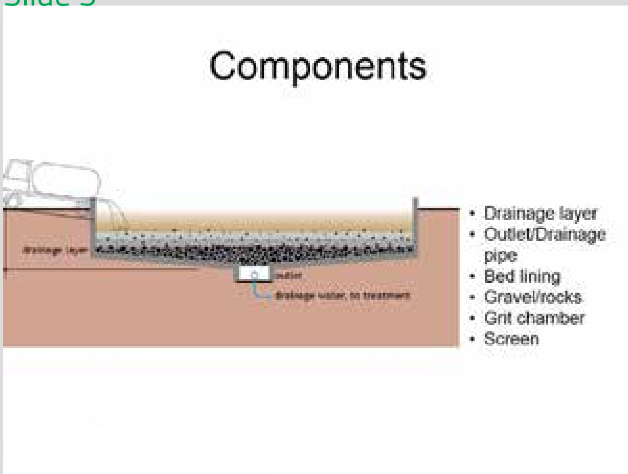
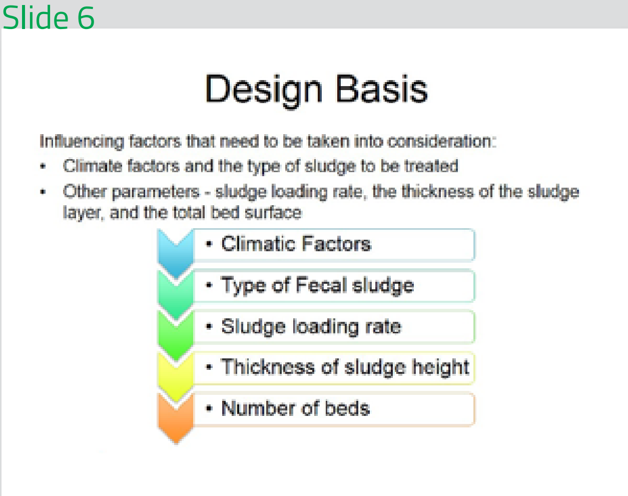


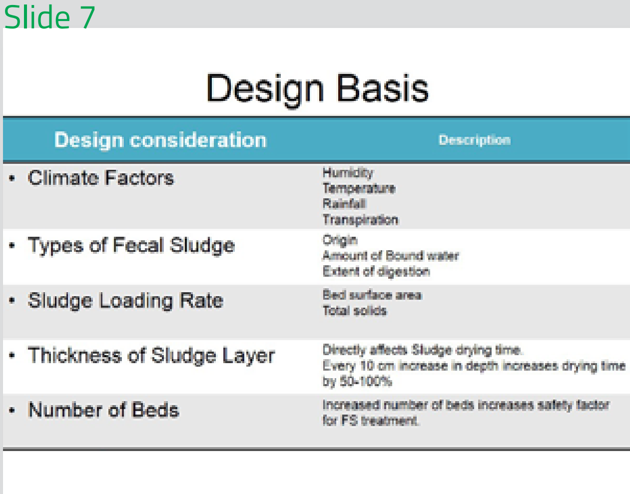

Figure representing the various components of an unplanted drying bed.

Slide 6




List of influencing factors which affect the design of an unplanted drying bed can be seen above.

Slide 7




| Design consideration | Description |
|---|---|
| • Climate Factors | Humidity<br>Temperature<br>Rainfall<br>Transpiration |
| • Types of Fecal Sludge | Origin<br>Amount of Bound water<br>Extent of digestion |
| • Sludge Loading Rate | Bed surface area<br>Total solids |
| • Thickness of Sludge Layer | Directly affects Sludge drying time.<br>Every 10 cm increase in depth increases drying time by 50-100% |
| • Number of Beds | Increased number of beds increases safety factor for FS treatment. |

Summary of the influencing factors which affect the design of unplanted drying beds.

Slide 8

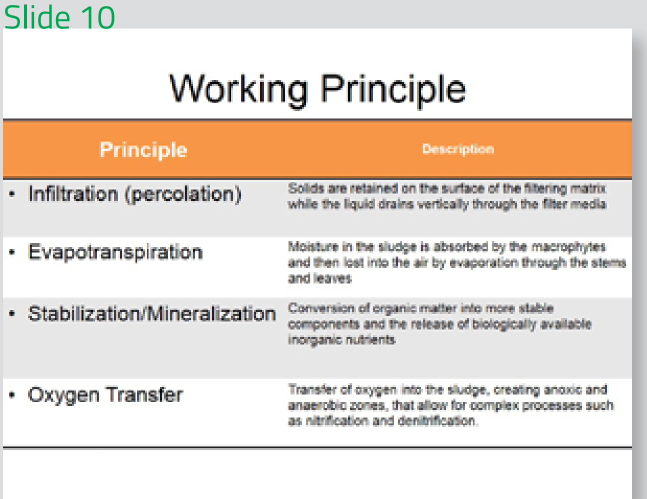
Few construction pictures of an unplanted drying bed.

Slide 9


A planted drying bed is a type of drying bed which uses plants (macrophytes) to stabilize and dewater the sludge.

Picture of an operational planted drying bed.

Slide 10



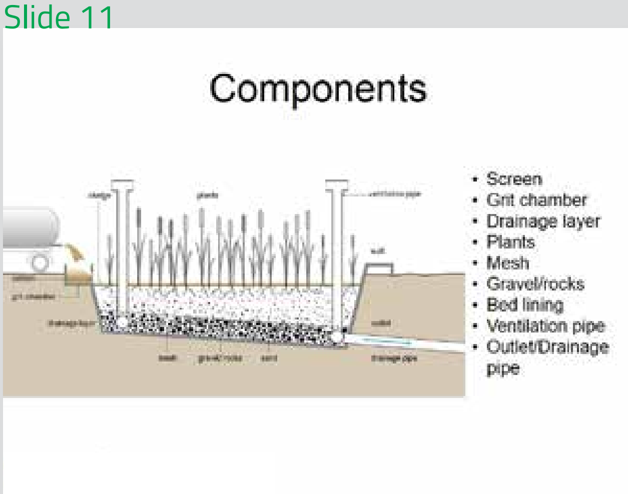
### Working Principle

| Principle | Description |
|---|---|
| • Infiltration (percolation) | Solids are retained on the surface of the filtering matrix while the liquid drains vertically through the filter media |
| • Evapotranspiration | Moisture in the sludge is absorbed by the macrophytes and then lost into the air by evaporation through the stems and leaves |
| • Stabilization/Mineralization | Conversion of organic matter into more stable components and the release of biologically available inorganic nutrients |
| • Oxygen Transfer | Transfer of oxygen into the sludge, creating anoxic and anaerobic zones, that allow for complex processes such as nitrification and denitrification. |

The PDBs perform multiple functions of dewatering (by percolation and evapotranspiration) and organic load reduction (by stabilization/ mineralization and oxygen transfer). The long retention time which PDBs provide, which is upto 3 years, creates an environment of pathogen removal.

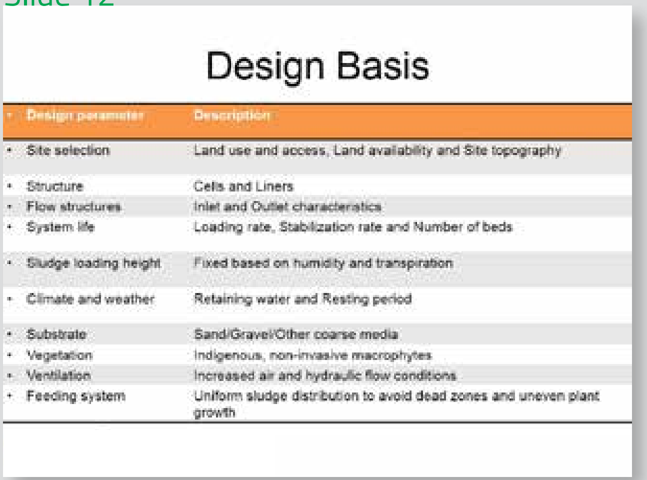
Thus, the PDB works perform many additional functions apart from dewatering.
For more details refer to FSM Book (Strande, Ronteltap, & Brdjanovic, 2014)

Slide 11




Various components of a planted drying bed.

### Slide 12

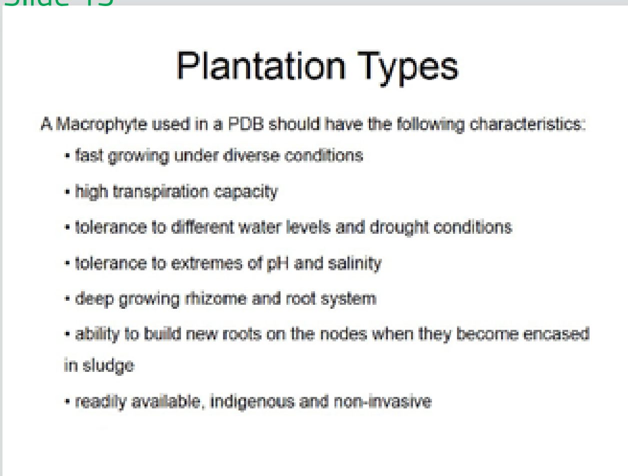


Design Basis

| Design parameter | Description |
|---|---|
| Site selection | Land use and access, Land availability and Site topography |
| Structure | Cells and Liners |
| Flow structures | Inlet and Outlet characteristics |
| System life | Loading rate, Stabilization rate and Number of beds |
| Sludge loading height | Fixed based on humidity and transpiration |
| Climate and weather | Retaining water and Resting period |
| Substrate | Sand/Gravel/Other coarse media |
| Vegetation | Indigenous, non-invasive macrophytes |
| Ventilation | Increased air and hydraulic flow conditions |
| Feeding system | Uniform sludge distribution to avoid dead zones and uneven plant growth |

Factors that influence the success of the design of planted drying beds.

### Slide 13



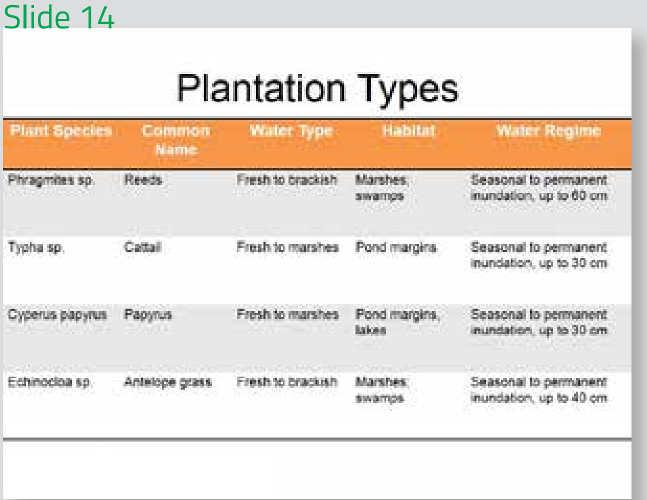
Plantation Types

A Macrophyte used in a PDB should have the following characteristics:

- fast growing under diverse conditions
- high transpiration capacity
- tolerance to different water levels and drought conditions
- tolerance to extremes of pH and salinity
- deep growing rhizome and root system
- ability to build new roots on the nodes when they become encased in sludge
- readily available, indigenous and non-invasive

Points to consider while selecting the plant for the planted drying bed.

### Slide 14



Plantation Types

| Plant Species | Common Name | Water Type | Habitat | Water Regime |
|---|---|---|---|---|
| Phragmites sp. | Reeds | Fresh to brackish | Marshes, swamps | Seasonal to permanent inundation, up to 60 cm |
| Typha sp. | Cattail | Fresh to marshes | Pond margins | Seasonal to permanent inundation, up to 30 cm |
| Cyperus papyrus | Papyrus | Fresh to marshes | Pond margins, lakes | Seasonal to permanent inundation, up to 30 cm |
| Echinocloa sp. | Antelope grass | Fresh to brackish | Marshes, swamps | Seasonal to permanent inundation, up to 40 cm |

Various types of plants, their characteristics and habitat summarized above.

### Slide 15


Pictures of the various stages of the operation of the planted drying beds.

## References

Strande, L., Ronteltap, M., & Brdjanovic, D. (2014). Faecal Sludge Management: Systems Approach for Implementation and Operation. London: IWA Publishing.

## Day 3 - Session 3

# Design of Planted Drying beds

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.

Day 3

Session 3

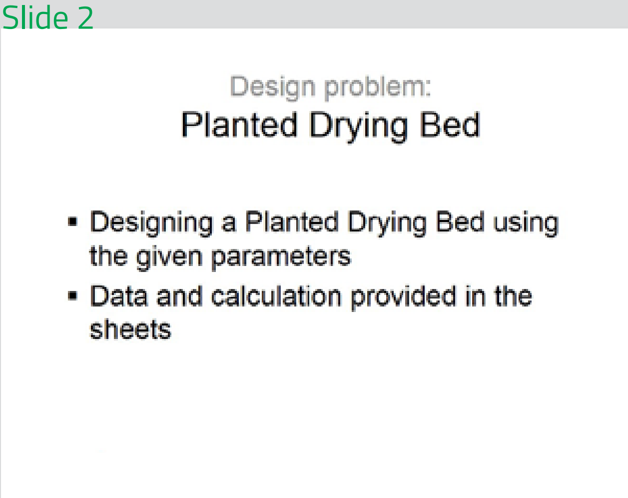
Outcomes

- Participants carry out preliminary design of the treatment module Sludge drying and planted sludge drying bed

# Objectives of the session

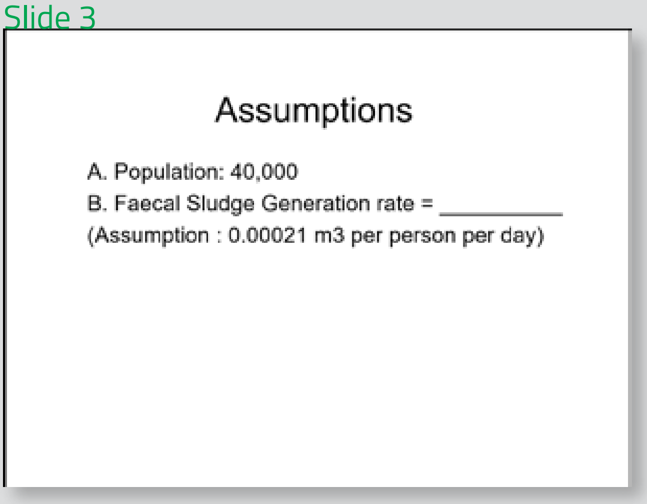
- Method of making calculations to arrive at the design estimates

Slide 2



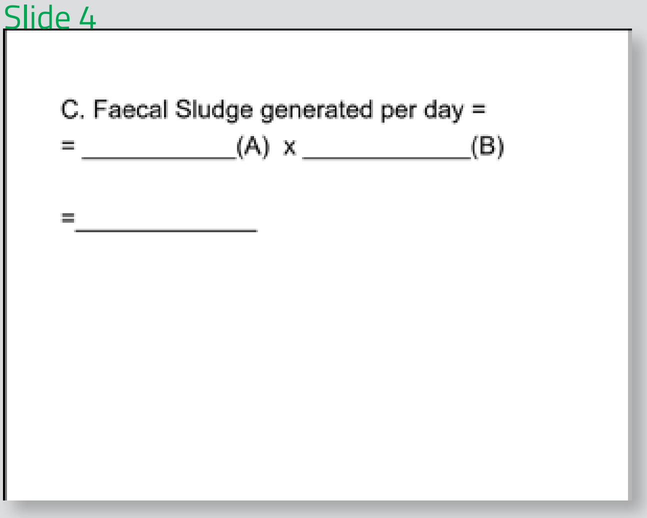

Refer to the activity sheet for the design problem and the parameters. The participants are expected to follow the steps according to the consequent slides.

Slide 3

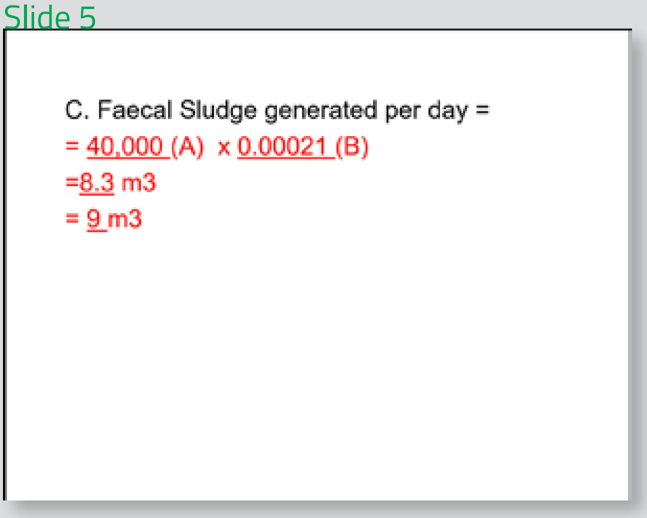



Assumptions made in order to calculate the amount of faecal sludge and the quality of faecal sludge

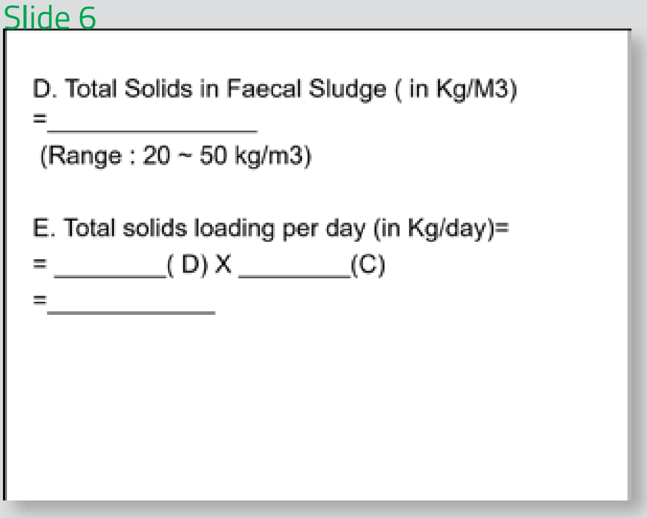
Slide 4



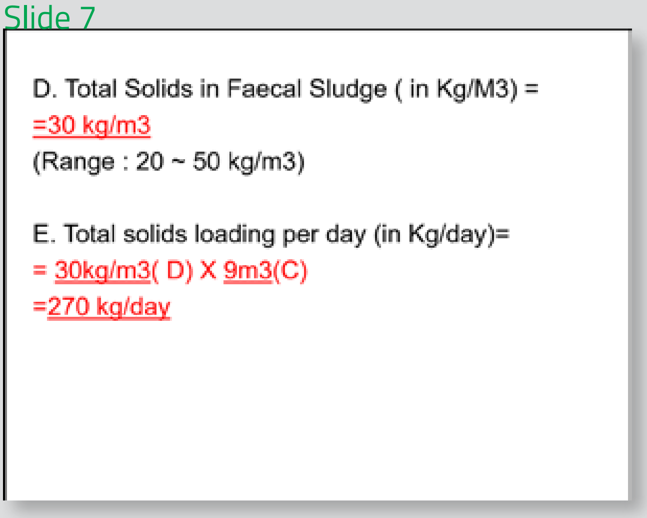

Slide 5




Slide 6




Slide 7



### Slide 8

F. Total Solids loading per annum ( in Kg/annum)

= __________(E) X ___________( 300 ~ 365 days)

= __________________

### Slide 9

F. Total Solids loading per annum (in kg/annum)

= 270 kg/day(E) X 300 Days( 300 ~ 365 days)

= 81,000 kg/annum

### Slide 10

G. Sludge loading rate ( in Kg Ts/annum/m2)
= ________________
(Range 150 – 250 Kg TS/m2/Annum)

H. Area required for drying beds (in m2) = F/G
=__________ (F) / __________(G)
=_____________

### Slide 11

G. Sludge loading rate ( in Kg Ts/annum/m2) =
=200 Kg TS/m2/Annum
(Range 150 – 250 Kg TS/m2/Annum)

H. Area required for drying beds (in m2) = F/G
=81,000 kg/Annum(F) / 200 kgTS/m2/Annum(G)
=405 m2

Slide 12

I. Drying time = ________Days)
(Assumption : Hot areas = 4-6 days, Cold areas 8-10 Days)

J. Area of each bed (in m2) = H/I

=____________(H)/(I)____________
=____________

Slide 13

I. Drying time = 6 Days
(Assumption : Hot areas = 4-6 days, Cold areas 8-10 Days)

J. Area of each bed (in m2) = H/I
=405 m2 (H) / 6 Days (I)
=67.5 m2
(L =9 m, B=7.5 m)

Slide 14

K. Number of beds = (I) x 2 + Beds for maintenance
=_________(I) X 2 +Beds for maintenance
= ______________________

L. Freeboard (in m) = _______
(Loading period 12-18 months ~ 1 metre. 18-24 months ~ 1.5 metre)

Slide 15

K. Number of beds = (I) x 2 + Beds for maintenance
=6 Days(I) X 2 + 2 Beds
=14 Beds

L. Freeboard (in m) = 1 m
(Loading period 12-18 months ~ 1 metre. 18-24 months ~ 1.5 metre)

Slide 16

## Day 3 - Session 4

# Treatment concept - Effluent Treatment

Feacal sludge treatment doesn't stop with just stabilizing the solids. The effluent/percolate has to be managed. For this purpose, natural treatment processes such as DEWATS which primarily employs anaerobic treatment are preferred.

This section provides information on suggestive treatment options for effluent/percolate and also provides the design specifications.

Day 3

Session 4

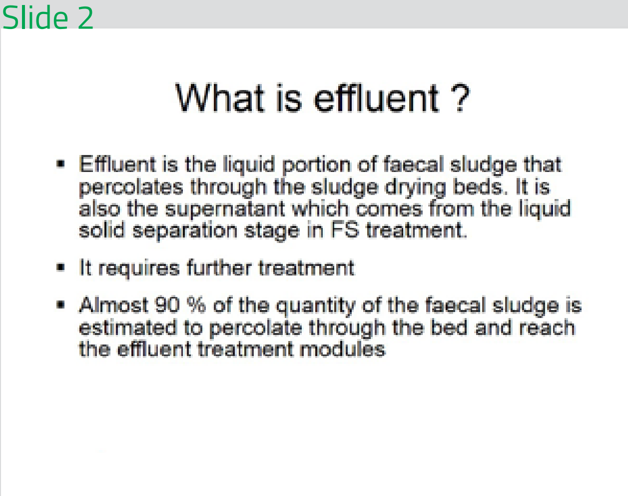
Outcomes

- Participants can list and understand the components of effluent treatment and design it

# Objectives of the session

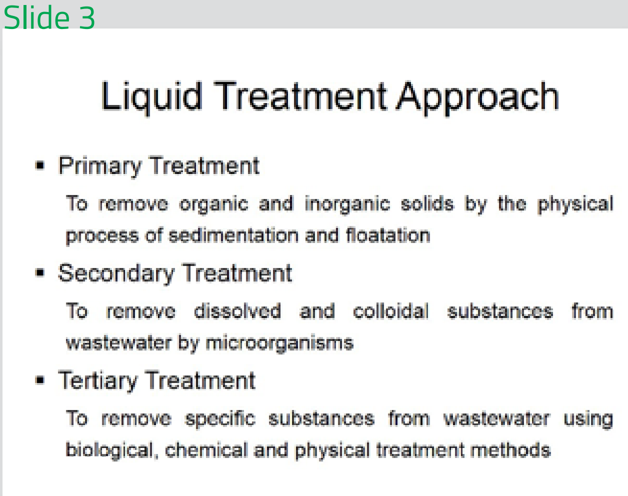
Characteristics of effluent
Treatment mechanisms for of effluent treatment

Slide 2



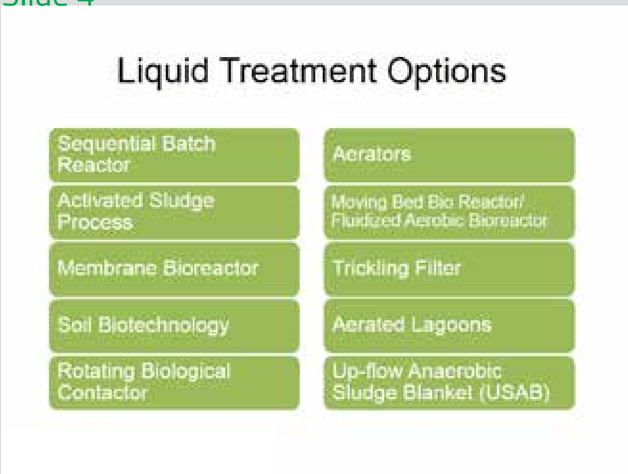

Effluent comprises of the liquid separated from the faecal sludge in the beginning and the leachate coming from the sludge drying bed.

Slide 3




The approach adopted to treat the effluent follows the conventional treatment stages, namely: primary, secondary and tertiary treatment.

Slide 4

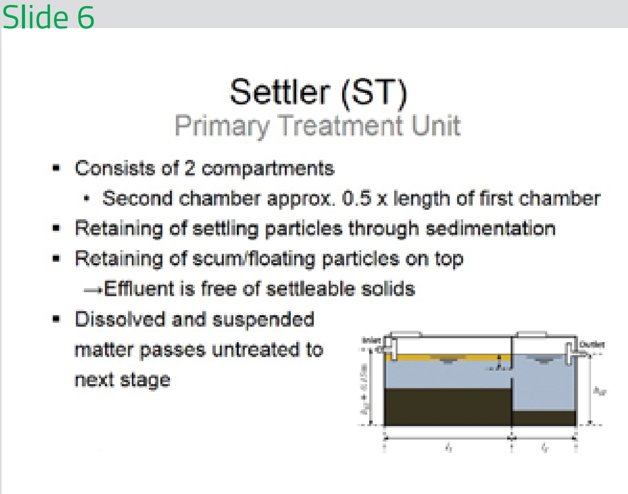



Summary of all the technology options for liquid treatment from the faecal sludge treatment plant.

Slide 5

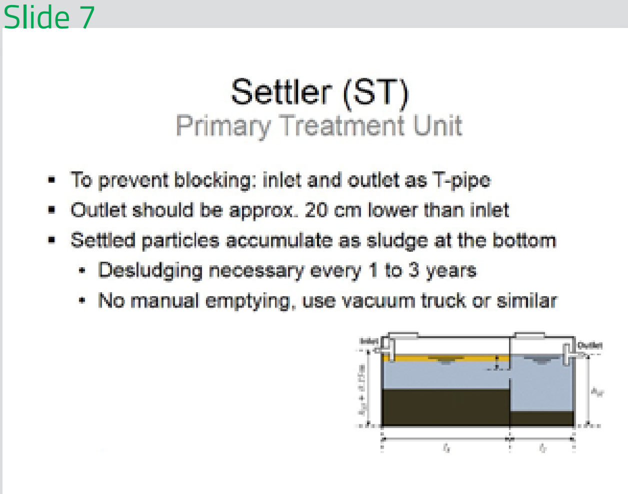

Settler or settling tank is a primary treatment unit of the effluent.

Slide 6



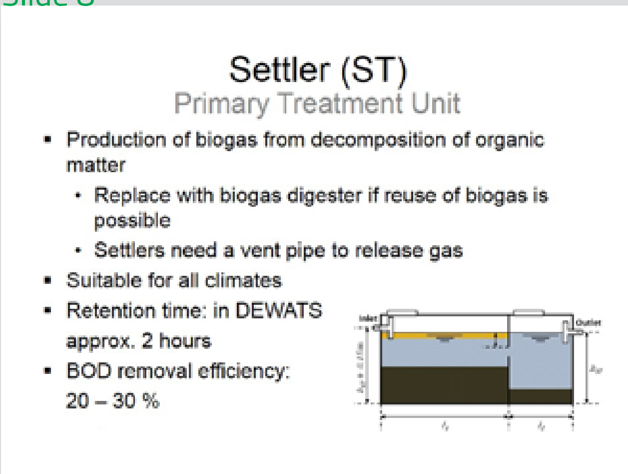

It usually has two compartments.
Settleable solids settle in first chamber, some solids move to second chamber and settle there.

Slide 7




When the settler is desludged, some sludge should be left in the settler as it contains beneficial microorganisms that support the treatment process.

## Slide 8




Even though, the design is similar to a stand-alone septic tank, there are differences:

- A septic tank has a longer retention time (up to several days)
- A settler is smaller because it is not a collection device (like septic tank) and there are further treatment modules following

BOD and COD removal is mainly due to settling of settleable solids.

## Slide 10

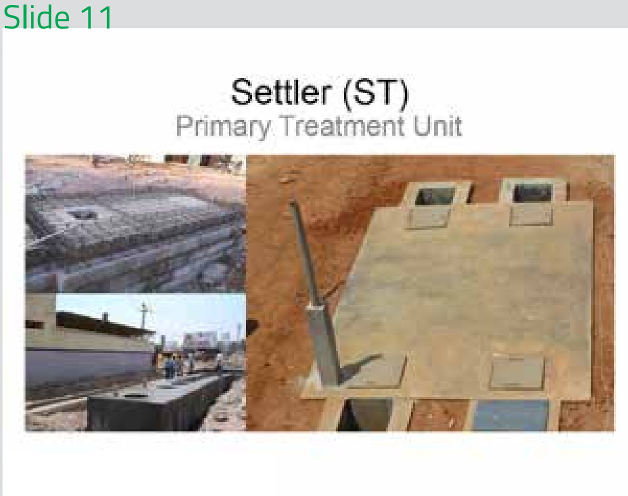

Left up:
Integrated settler + anaerobic baffle reactor
Right up:
Openings in settler divider wall
Right down:
Openings and gas vent pipe in divider wall
Left down:
Connection of inflow and outflow pipes (without T-pipe at this stage)

## Slide 9


A Settling tank or settler during construction.

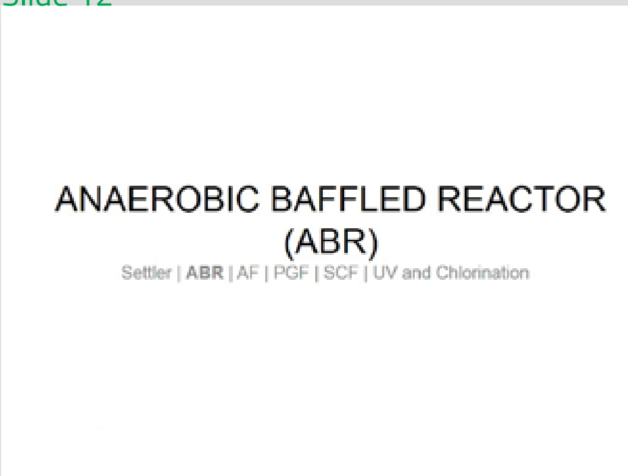
There are two settlers and a collection tank in the middle.

## Slide 11



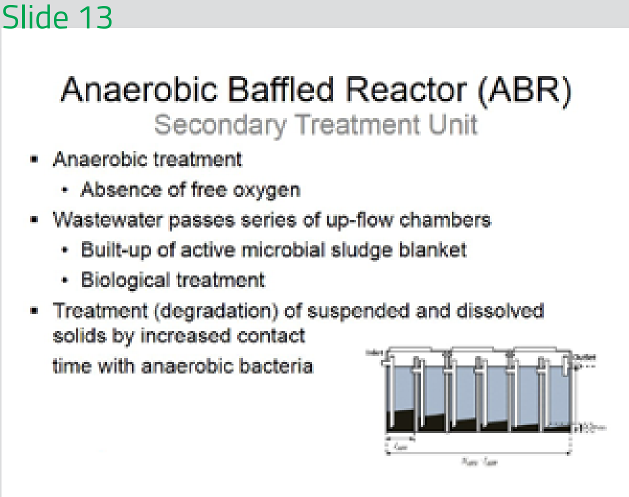

Left up:
Closing settler with cover slab during construction
Left down:
Finished settler with connections for gas vent pipe and missing manhole covers
Right:
Finished double settler with vent pipe and inlet and outlet register

Slide 12




Anaerobic baffle reactor provides secondary treatment of the effluent.

Slide 13



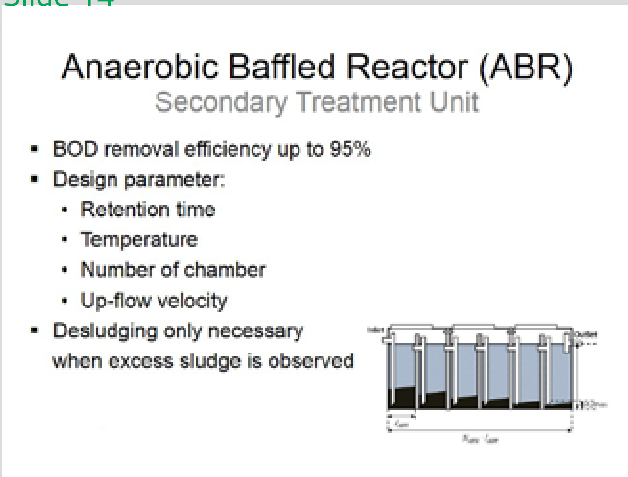

Anaerobic Baffle Reactors digests the organic matter in the effluent with the help of anaerobic bacteria. An ABR is a tank with a series of baffles which creates a continuous upward movement of effluent through a sludge blanket.

Sludge blanket will be lower from chamber to chamber due to decreasing organic load (=food for microorganims).

It will be higher at end of the chamber due to hydraulics (water comes in at front and displaces sludge to the rear of the chamber).

For more details, refer to (Participants Kit)

Slide 14

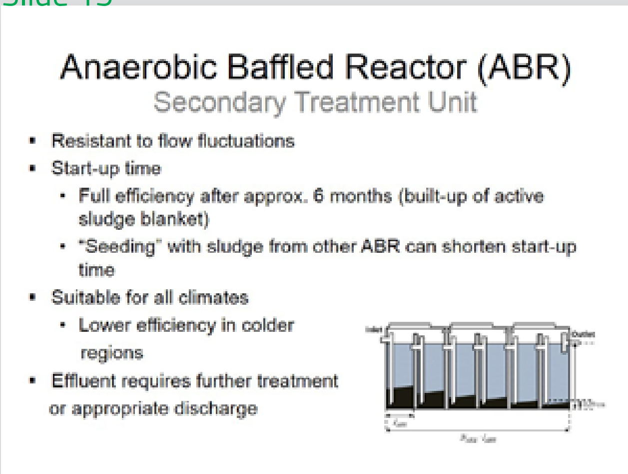



Digestion of the organic matter in the ABR depends on 4 key factors:

1. Hydraulic retention time (HRT): It is a measure of the average length of time that the effluent remains in the ABR. This is directly proportional to that of the contact time between wastewater and microorganisms.
2. Temperature determines efficiency of the treatment system. A temperature of 20-35 degree Celsius is favourable for microbial growth while a temperature outside this range reduces the efficiency.
3. Number of chambers is directly proportional to the HRT. More the chambers, more the HRT.
4. Up-flow velocity is fixed to be around 0.9 meter per second.

ABR requires desludging only after about 10 years. But, depending on sludge levels, mostly it is enough to take excess sludge (i.e. more than 50cm) from first chambers and put them into the last chambers. In that way, no beneficial microorganisms get lost for the treatment process. This reduces the need for desludging further.

Slide 15




ABR is resistant to shock loads due to increase HRT and baffled design.

An ABR, usually, reaches full efficiency after 6 months of its start because the active sludge blanket takes that much time to build up.

Slide 16

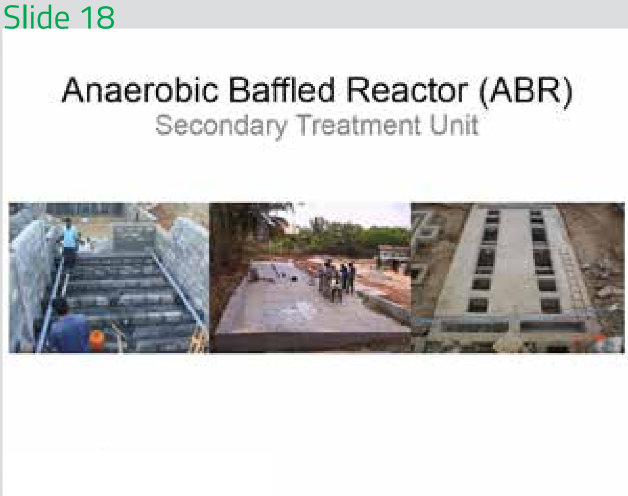

ABR (10 streets)

Red arrow indicates the flow direction.

Slide 17


Left up:
Two street ABR under construction
Right up:
Baffled pipes
Right down:
Fixing of outlet pipes
Left down:
First chamber with baffled wall instead of pipes for better flow distribution.

Slide 18



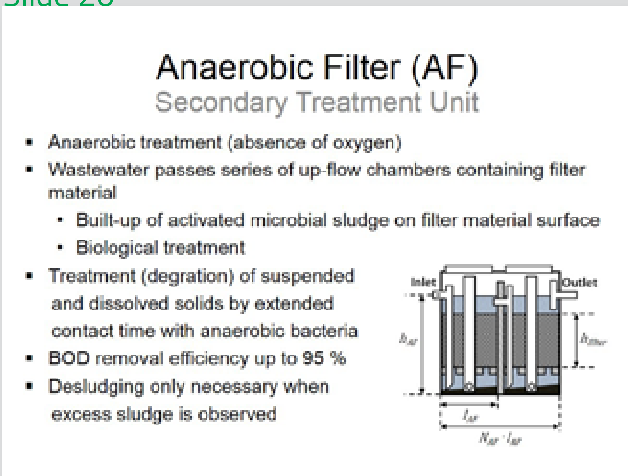

Left up:
Fixing of baffled pipes through the whole ABR. Use a long pipe and align it horizontally with a scale, then complete the baffle walls and cut the pipe at the end of construction.

Right down:
Two-street ABR with cover slab.

Slide 19


Anaerobic filter is also a type of secondary treatment which leads to organic load reduction by providing surface to the microorganisms to grow on filter surface.

Slide 20




Active microorganisms will grow on filter surface and porous filter material allows for enhanced contact to wastewater.
BOD and COD levels are reduced due to digestion of organic matter by microorganisms.

For more details, refer to (Participants Kit)

Slide 21

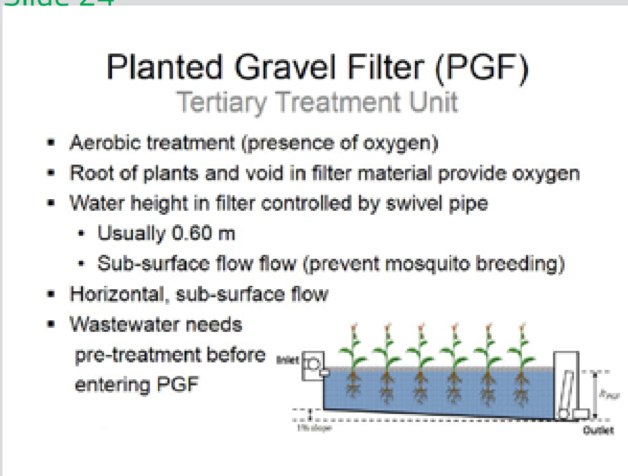

Slide 22


Left: Production of perforated slab
Right: Support for perforated slab

Slide 23


Planted Gravel Filter provides tertiary treatment to the effluent by means of removal of colour and odour.

Slide 24




The planted gravel filter enriches the effluent with oxygen, which penetrates into upper layers of water through the filter pores and the root system.

For more details, refer to (Participants Kit)

Slide 25


Left: PGF grounding during construction

Right: with side walls

Slide 26


Up - left: PGF with filter material (gravel)

Up - right: PGF freshly planted plants

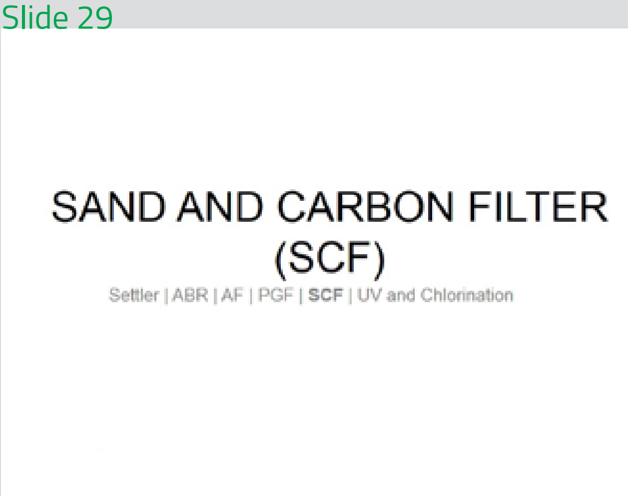
Slide 27


Some plants commonly used.

Slide 28

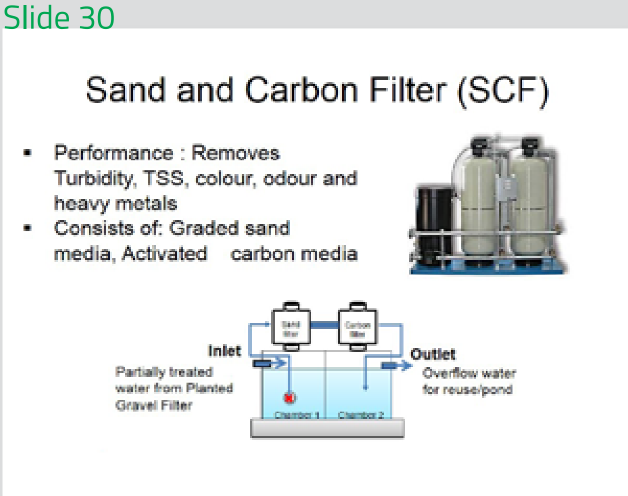

Fully grown PGFs.

Slide 29




Sand and Carbon Filter is another tertiary treatment mechanism to the effluent.

Slide 30

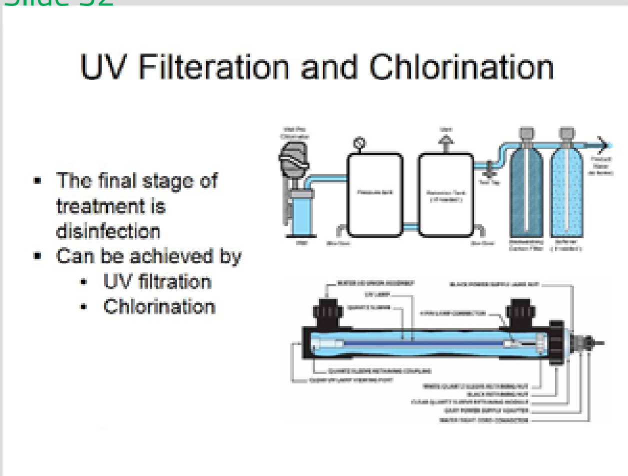



SCF is used to remove the turbidity, TSS colour and odour. A schematic explaining the working of sand and carbon filter is shown in the slide.

Slide 31


UV Filtration and Chlorination is the final step used for disinfection of the effluent.

Slide 32



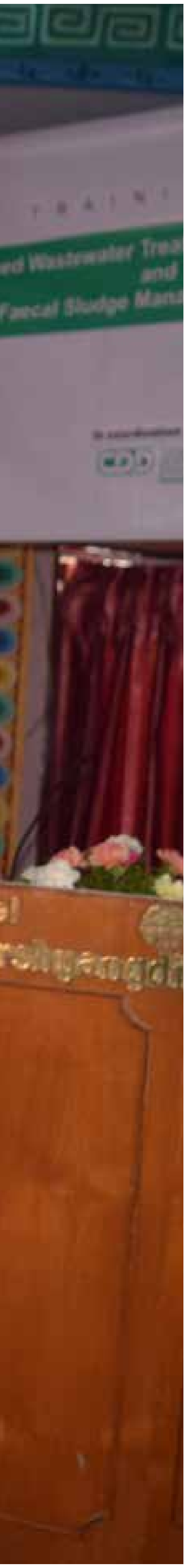

Final step in the treatment process is UV filtration and chlorination in order to ensure disinfection.

## References

Participants Kit. (n.d.). CDD Society .

Strande, L., Ronteltap, M., & Brdjanovic, D. (2014). Faecal Sludge Management: Systems Approach for Implementation and Operation. London: IWA Publishing.


DESIGN OUTPUT for HPGF
DESIGN OF TREATMENT PLANT
(LAY-OUT)
SETT-LER
ABR
FILTER
FILTER
Collec-TION
FIELD
TOTAL COST : 45,48,000.00
MATERIAL COST: 27,28,800.00
LABOUR COST: 18,19200.00
COMPONENTS:
1) SETTLER: 1 NO - 363840.00
2) ABR: 1 NO - 2728800.00
3) FILTER: 2 NO - 1091520.00
4) COLLECTION CHAMBER: 1 NO - 363840.00
LOTUS



## Day 3 - Session 5

# Design of a Treatment System

In most of the Faecal Sludge Treatment Plants(FSTP), ease of construction, capital cost and reuse infrastructure is taken in consideration in great significant in order to ensure a holistic approach to environmental sanitation. However, one should remember that a faecal sludge treatment plant that is operated and maintained efficiently has the potential to be productive and long lasting. Even well designed treatment technologies often fail because of poor operation and maintenance (O&M).

Operation and Maintenance tasks become crucial once the plant gets commissioned, it is observed from past experiences that the performance of treatment plant directly depends upon how well it is maintained and operated regularly. The day-to-day operational tasks are adopted for smooth functioning and upkeep of the treatment plant. The tasks are simple and require basic training.

This session provides information to participants in order for them to carry out the routine specific and critical tasks. It has been prepared focusing on the detailed operation and maintenance related activities which need to be carried out to ensure effective and efficient performance of all of different infrastructure related to faecal sludge treatment infrastructure.

Day 3

Session 5

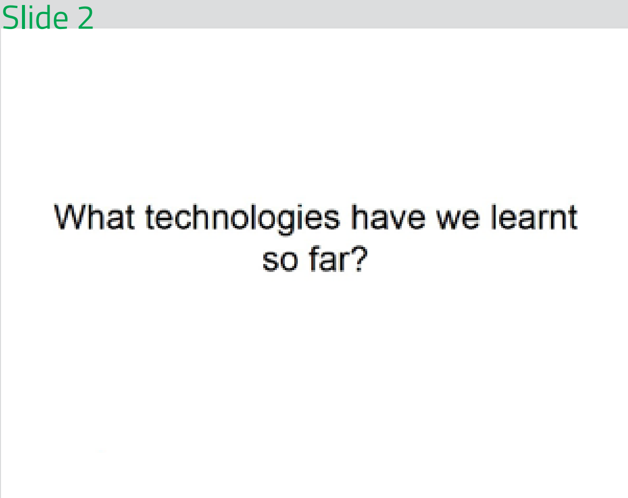
Outcomes

- Participants are aware of the various O&M requirements of the technology options discussed during the training

# Objectives of the session

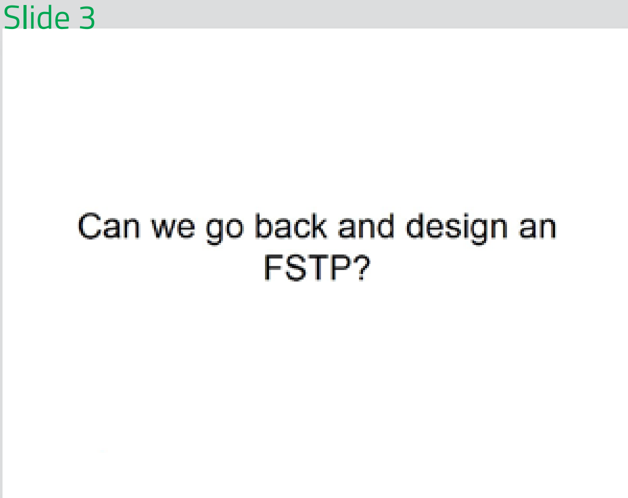
Activity based session to enable designing of a FSTP

Slide 2



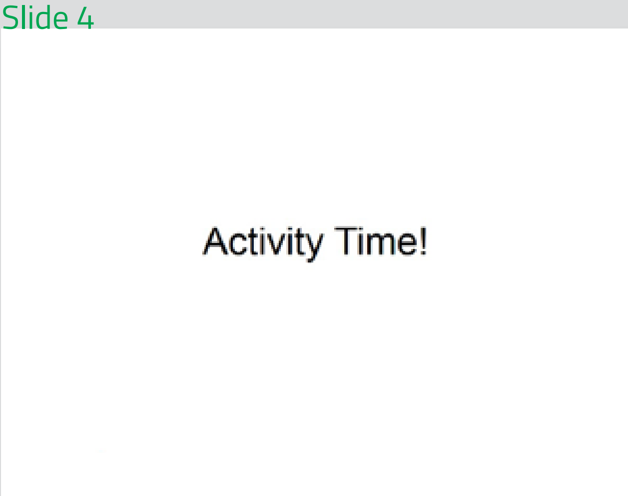

Recall the technologies learnt so far.

Slide 3

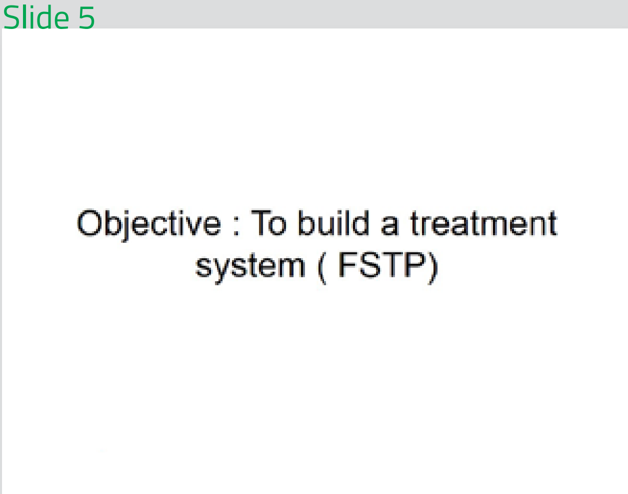



All the treatment modules discussed in the training need to be integrated based on the local context, the function of the module and treatment objectives.

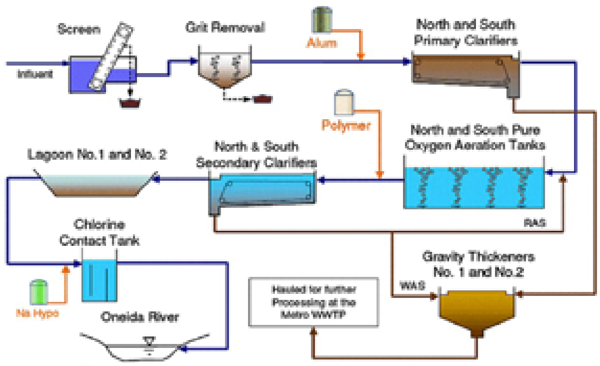
Slide 4




Slide 5



Slide 6




Slide 7

## Materials

- Chart
- Pictures of Modules
- Information on the modules
- Case requirement

Slide 8

## What you will need to do?

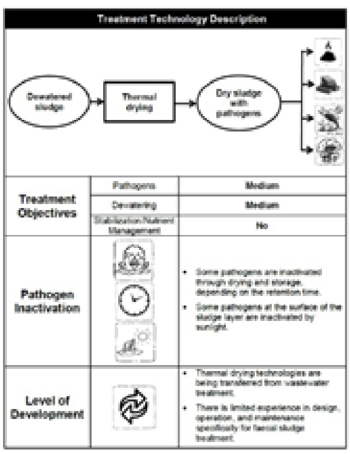
- Understand the requirement
- Select the modules
- Place them in the correct sequence
- Connect them – process flow diagram
- Present your work!

Slide 9

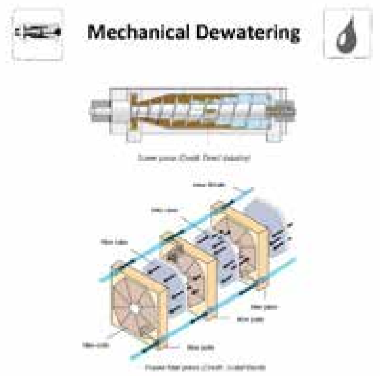
## Example

Slide 10


Slide 11

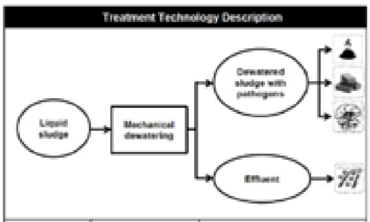


Slide 12




Slide 13

**Treatment Technology Description**




| | | |
|---|---|---|
| **Treatment Objectives** | Pathogen Inactivation | Low |
| | Dewatering | High |
| | Stabilization/Nutrient Management | No |
| **Pathogen Inactivation** | | • No information is available about pathogen inactivation for mechanical dewatering. |
| **Level of Development** | | • Mechanical dewatering technologies are being transferred from wastewater treatment<br>• There is limited experience in design, operation, and maintenance specifically for faecal sludge treatment |

Slide 14

**PRESENTATION**

Slide 15

## What will you present

1. What is the case requirement
2. What modules were chosen and why?
3. What is the end product?
4. What was the key learning from this experiment?

Time for each team : 2 minutes


2500
2000
1500

## Day 3 - Session 6

# O&M of Treatment technologies - Drying beds and its effluent

Detailed Project Report is the base-document for planning and implementing the Feacal Sludge Treatment Plant. It provides details for investment decision-making and helps the reader to understand the technical, economic and social details for the proposed faecal sludge management plan. It is a detailed document that guides an implementation process, it also expresses the rationale behind various assumptions and explains the method adopted to validate various parameters considered in decision making.

This session elaborates the components of a DPR document, the details that are encapsulated in each of the sections. Also this session helps the participants to learn and understand how to review a DPR that is submitted to the local decision making authorities for sewerage and feacal sludge management projects.

Day 3

Session 6

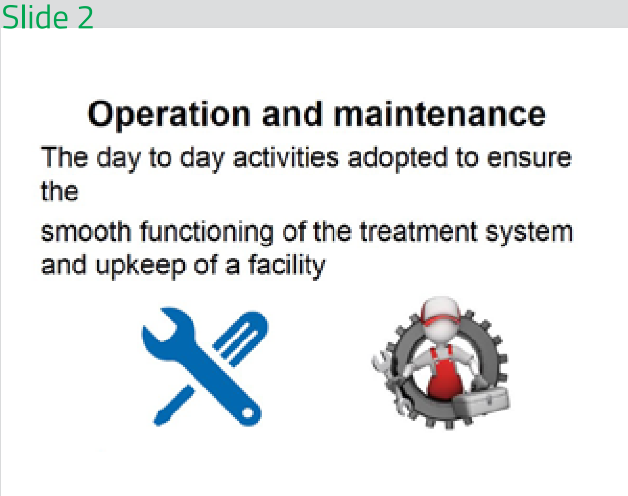
Outcomes

- Participants are aware of the various O&M requirements of the technology options discussed during the training.

# Objectives of the session

To familiarise with the operation and maintenance procedures of the FSTP

Slide 2




Definition of Operation and maintenance and the importance of O&M.

Slide 3

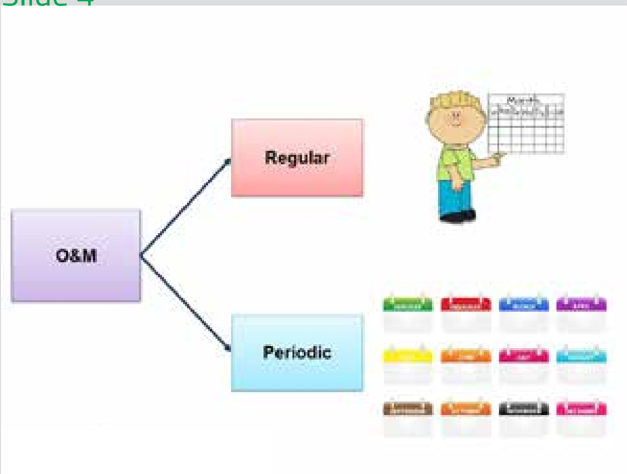

Operation are the activities that are required to ensure that a faecal sludge treatment technology delivers treatment services as designed

Maintenance are activities needed to avoid malfunction or breakdown of the plant. Maintenance activities are of two types:

- Planned or routinely performed activities
- Unplanned or activities performed during emergency situations to avoid breakdown.

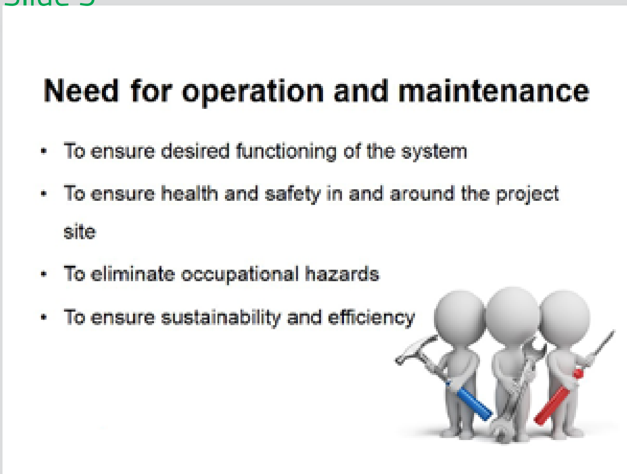
For more details, refer to (Participants Kit)

Slide 4



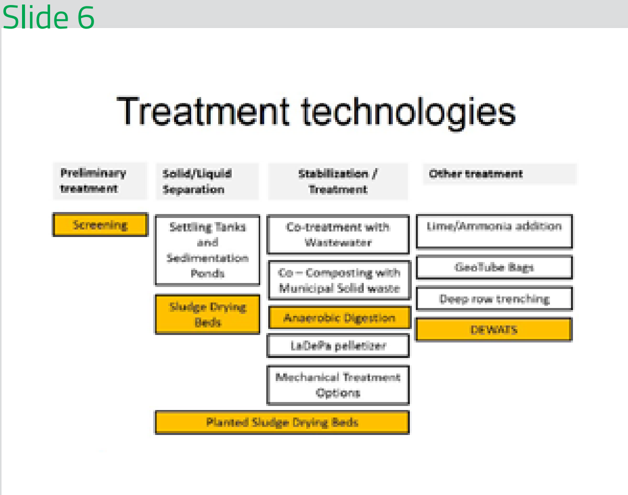

Planned O&M is further classified into two categories namely, regular and periodic.

Slide 5




Operation and maintenance procedures need to be strictly followed not only in order to ensure that the plant is functioning optimally, but also to eliminate occupational hazards. FSTP deal with human waste, which is a type of hazardous waste. Hence, it has to be handled carefully. The safety of those who are at the plant is of outmost importance. This includes not only the staff, but also the cesspool operators coming to dispose off at the plant, the visitors to the plant and anyone who is at the premises of the plant.

Slide 6




Activities which are part of O&M of feeding tank.

Slide 7

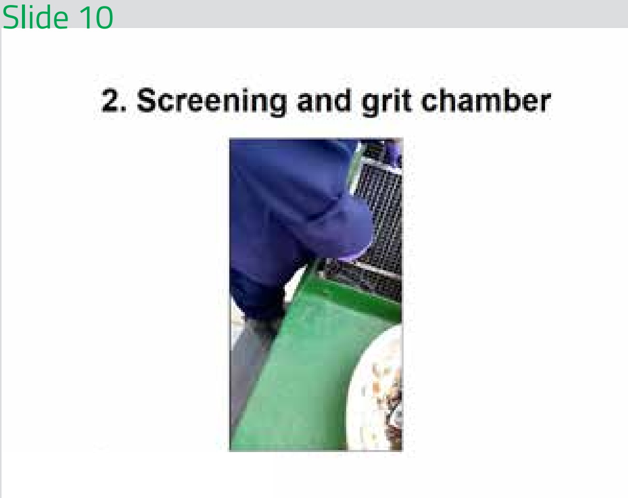

Activities which are part of O&M of Screening and grit chamber.

Slide 8


Slide 9

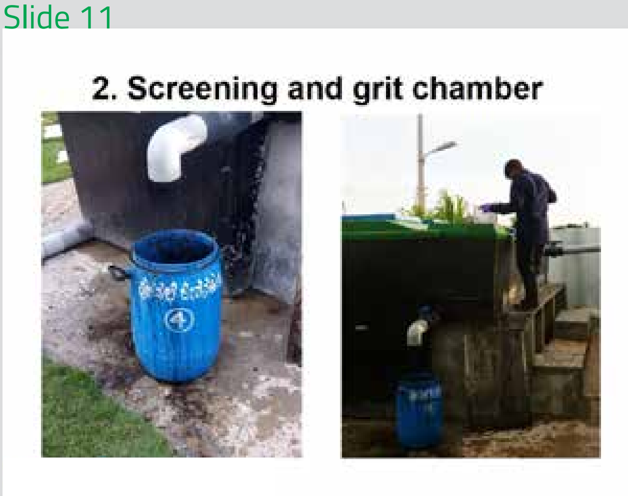

Activities which are part of O&M of screening and grit chamber.

Slide 10

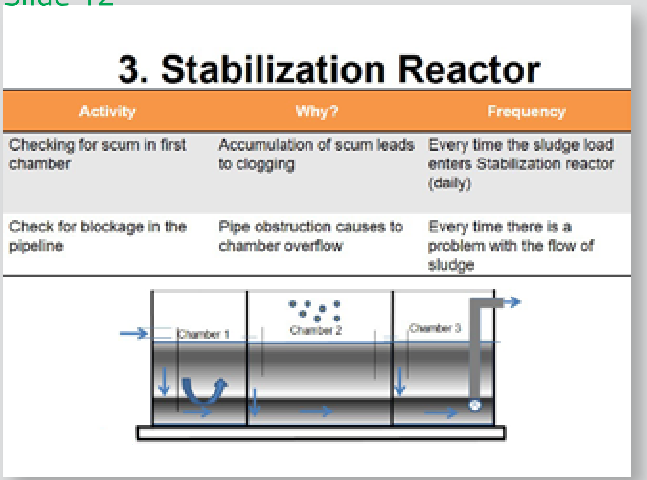



Activities which are part of O&M of Sludge drying bed.

Slide 11



Slide 12




| Activity | Why? | Frequency |
|---|---|---|
| Checking for scum in first chamber | Accumulation of scum leads to clogging | Every time the sludge load enters Stabilization reactor (daily) |
| Check for blockage in the pipeline | Pipe obstruction causes to chamber overflow | Every time there is a problem with the flow of sludge |

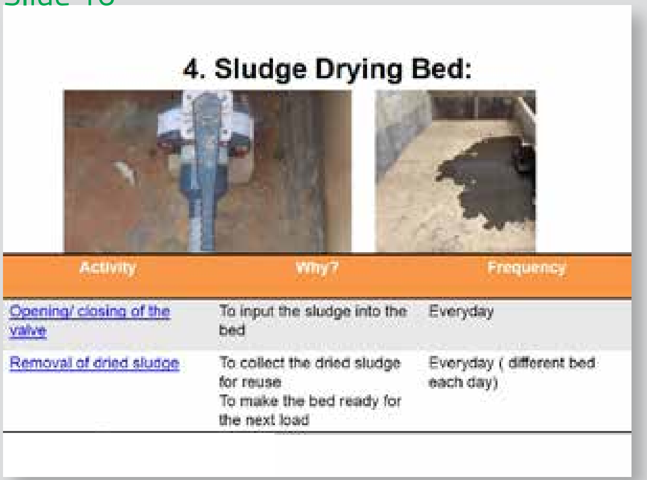
Activities which are part of O&M of at stabilization reactor.

Slide 13


Slide 14


Slide 15

Slide 16



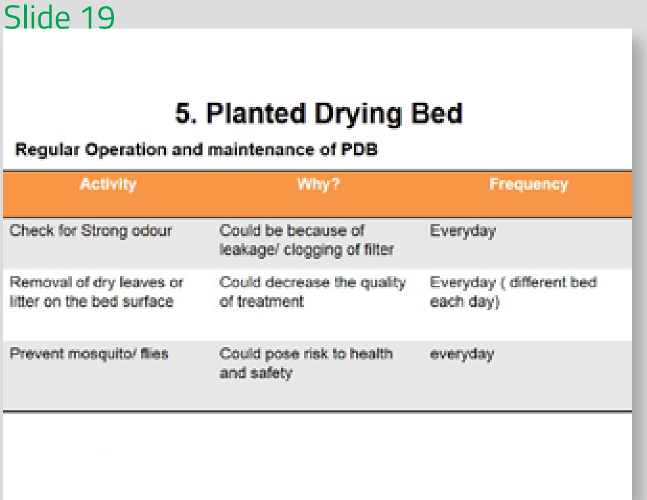

| Activity | Why? | Frequency |
|---|---|---|
| Opening/ closing of the valve | To input the sludge into the bed | Everyday |
| Removal of dried sludge | To collect the dried sludge for reuse<br>To make the bed ready for the next load | Everyday ( different bed each day) |

Activities which are part of O&M of sludge drying beds.

Slide 17


Slide 18


Slide 19

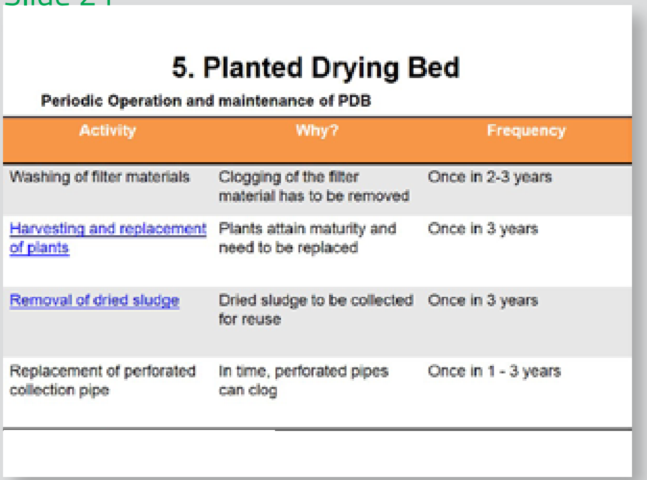



| Activity | Why? | Frequency |
|---|---|---|
| Check for Strong odour | Could be because of leakage/ clogging of filter | Everyday |
| Removal of dry leaves or litter on the bed surface | Could decrease the quality of treatment | Everyday ( different bed each day) |
| Prevent mosquito/ flies | Could pose risk to health and safety | everyday |

Activities which are part of O&M of planted drying beds (Regular).

Slide 20


Slide 21



5. Planted Drying Bed

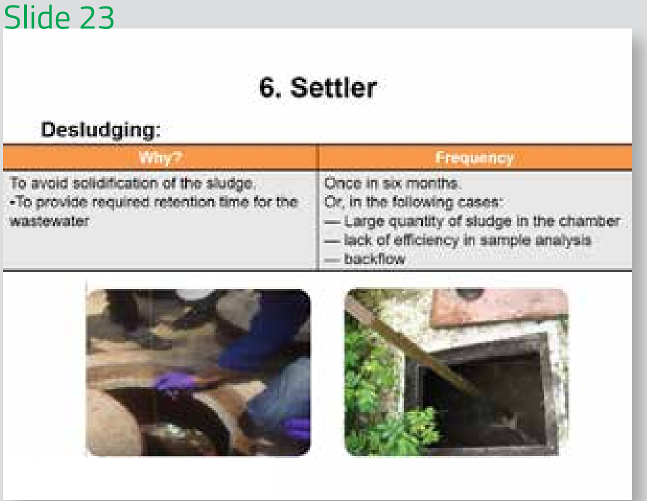
Periodic Operation and maintenance of PDB

| Activity | Why? | Frequency |
|---|---|---|
| Washing of filter materials | Clogging of the filter material has to be removed | Once in 2-3 years |
| Harvesting and replacement of plants | Plants attain maturity and need to be replaced | Once in 3 years |
| Removal of dried sludge | Dried sludge to be collected for reuse | Once in 3 years |
| Replacement of perforated collection pipe | In time, perforated pipes can clog | Once in 1 - 3 years |

Activities which are part of O&M of planted drying beds (Periodic).

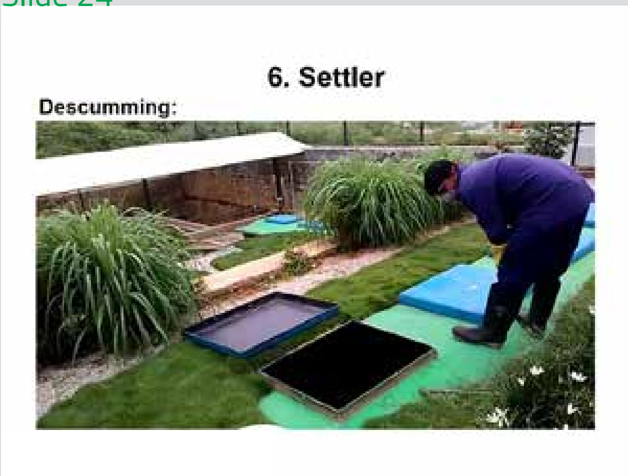
Slide 22


Slide 23



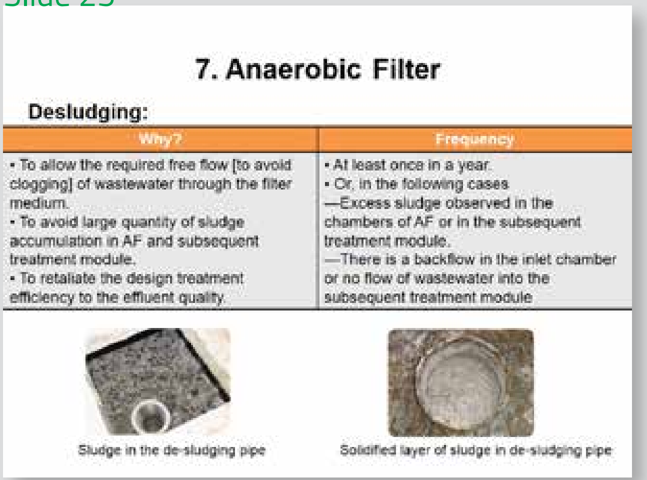

Activities which part of O&M of settler desludging.

Slide 24




Settler descumming.

Slide 25

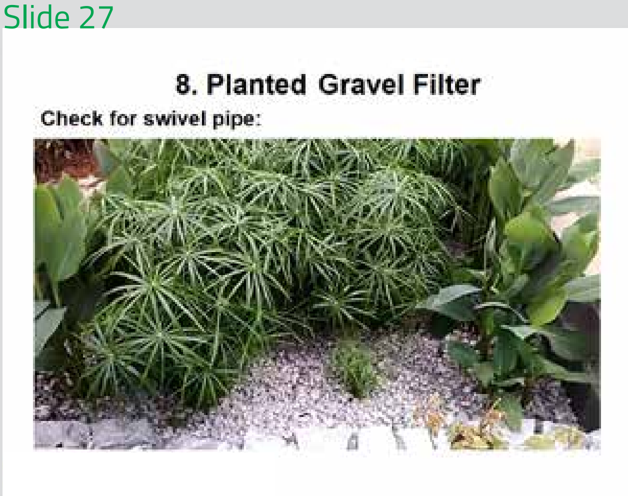



Desludging of Anaerobic Filter.

Slide 26


Checking for Swivel pipe of planted gravel filter.

Slide 27



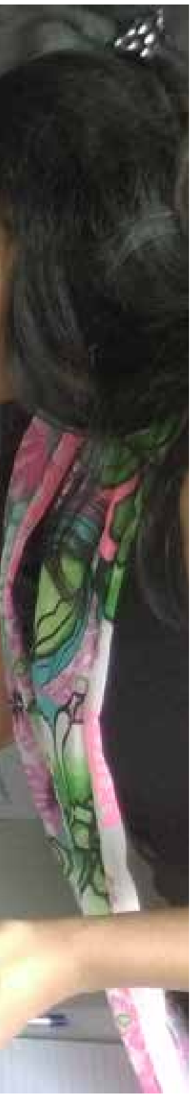
Slide 28


Removal of wearing of dead leaf litter and other litter at planted gravel filter.

## References

Participants Kit. (n.d.). CDD Society .


Maternal
under-nutrition
Use of food
Stability
Chronic
malnutrition
='Stunting'
Undernourishment
Malnutrition
Hunger
Under-nutrition
Lucas



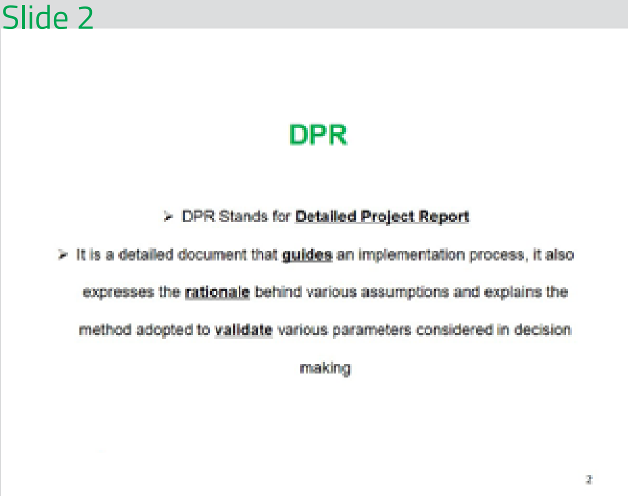
Day 3 - Session 7

# Components and Review of DPR

# Objectives of the session

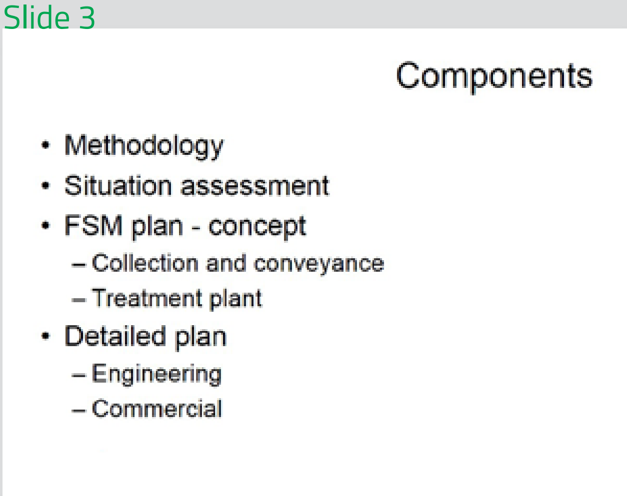
Components of Detailed Project Report
Activity based session to enable reviews DPR

Slide 2



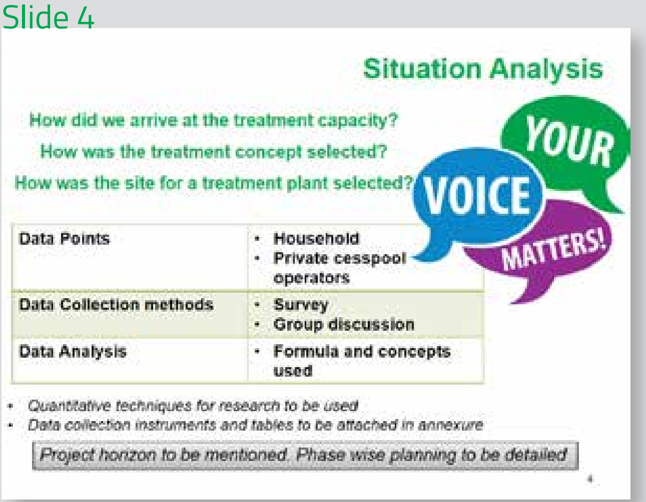

A detailed project report is an elaborate report which describes the existing situation, the problem and the solution. Since it is a very long document, the reviewer should be familiar with the framework of a DPR and the components to look for in it.

Slide 3



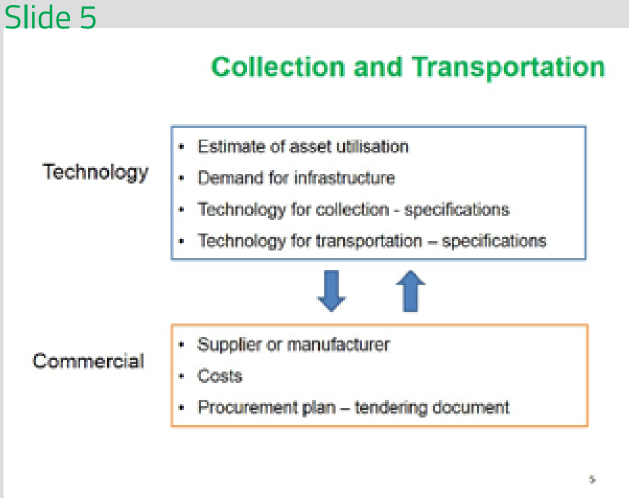

Components of a Detailed Project report.

Slide 4



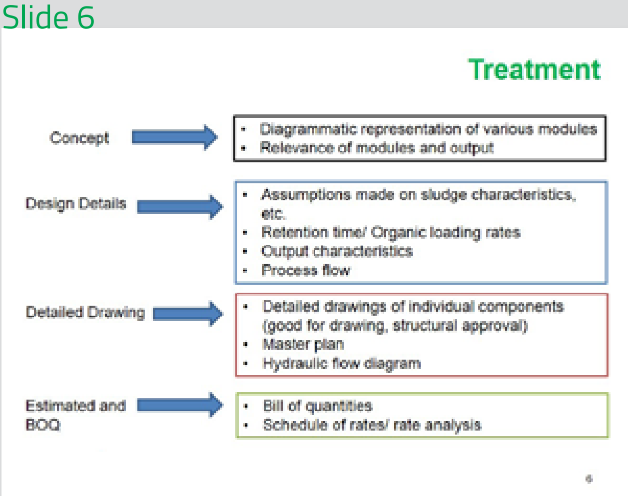

Situational analysis or baseline assessment is the key component of any DPR because it is a detailed analysis of the problem at hand.

Slide 5



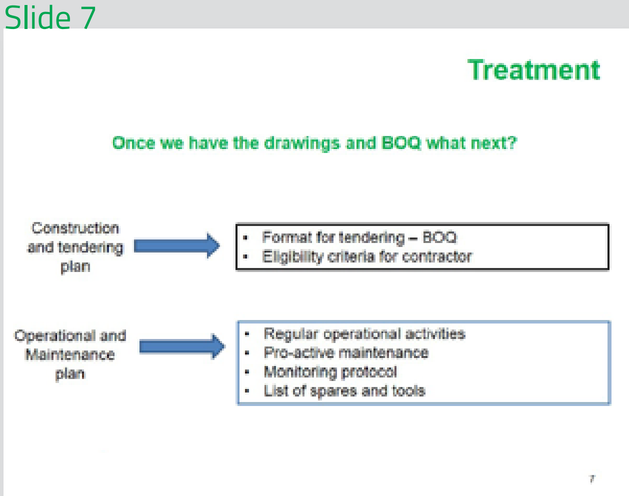

The solutions pertaining to collection and transportation section should be on the lines of the above mentioned items.

Slide 6




The solutions pertaining to treatment section should be on the lines of the above mentioned items.

Slide 7



Slide 8

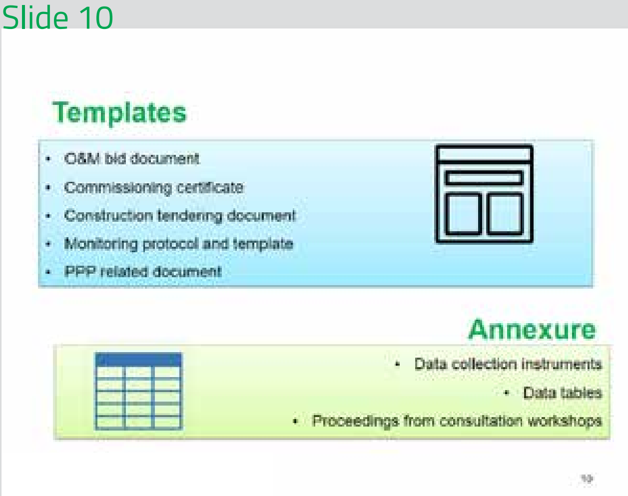

The solutions pertaining to treatment section should be on the lines of the above mentioned items.

Slide 9

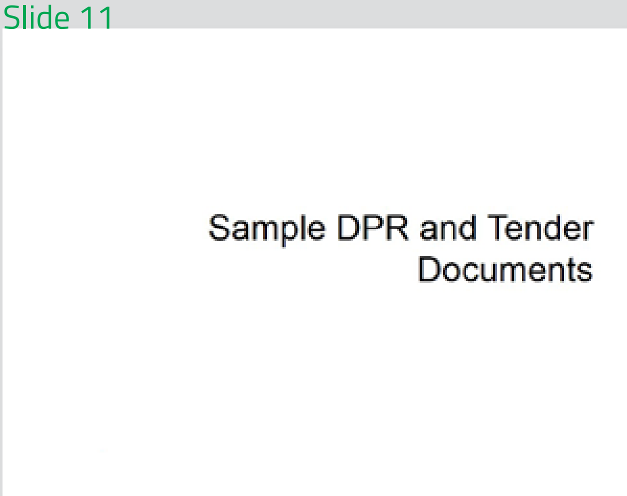

| Vertical | Short term ( > 5 years) | Long term ( 5- 10 years) |
|---|---|---|
| Infrastructure | Long desludging pipes and improved pumping mechanism | Small vehicles fit with modified desludging equipment |
| Financial | Soft loans for infrastructure | Taxation and polluter pay model |
| Capacity | O&M training of operator | Capacity building of ULB staff |
| Institutional | Additional duty for existing staff | Inclusion of FSM vertical |

For the listed verticals, action plans for short term and long term is summarized in the table above.

Slide 10




Slide 11




## References

Checklist for Assessment of Septage /Sewerage and Wastewater management DPRs. (n.d.). CDD Society. Checklist for Assessment of Septage /Sewerage and Wastewater management DPRs. (n.d.). CDD Society.

# Notes

## Notes

## Notes

National Institute of Urban Affairs

**National Institute of Urban Affairs**
1st and 2nd Floors, Core 4B, India Habitat Centre, Lodhi Road, New Delhi - 110003, INDIA
(+91 11) 24643284/24617517, (+91 11) 24617513 • niua@niua.org, www.niua.org, scbp.niua.org

ADVANCED TRAINING ON FAECAL SLUDGE AND SEPTAGE MANAGEMENT PART B - LEARNERS' NOTE