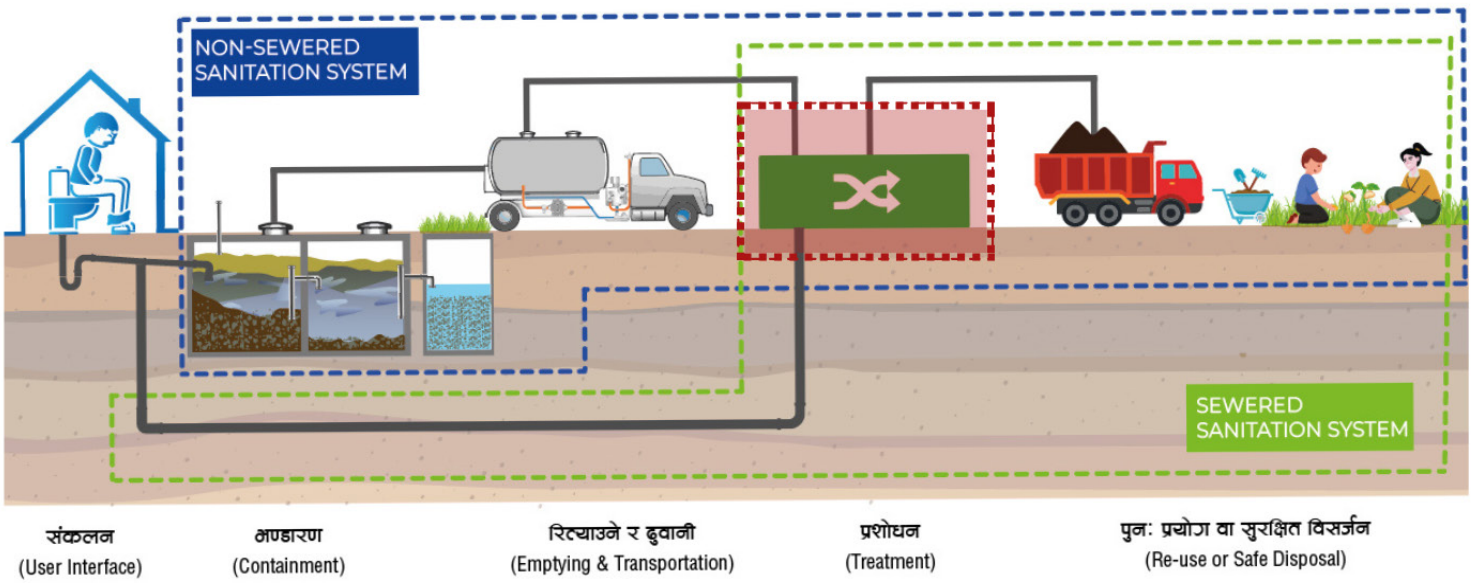
Government of Nepal
Ministry of Water Supply
National Water Supply and Sanitation Research,
Innovation and Capacity Development Center

Operation and Maintenance of Faecal Sludge Treatment Plant

Power Point Presentation Slide Note for Participants



2025

Material and Learning Application

Table of Contents

Introduction

This document, power point presentation with slide notes, is a supporting document for the trainers/ presenter to conduct the "Operation and Maintenance of Faecal Sludge Treatment Plant" training. This is a compilation of all the slides to be presented in the training along with the notes for the trainer as of what to describe while presenting the particular slide.

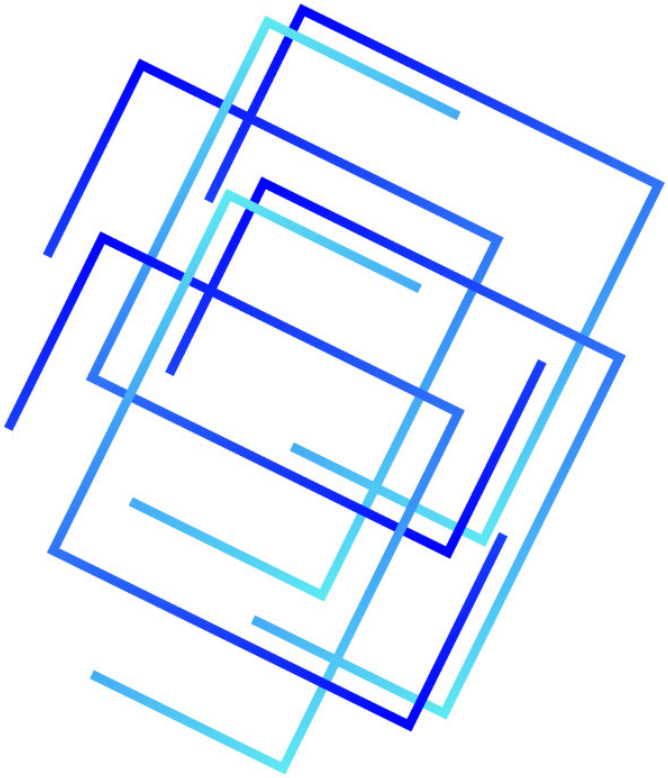
Objective

The main objective of the document is to guide the content that a presenter would be discussing on each slide. To this, it also provides a preview of all the slides contained in the training along with the slide notes.

How to Use ?

The document consists of slides from all session. Slide notes for each slide is presented just below the slide itself. The trainer or presenter cango through the notes and describe the slides as per the information provided in the slide notes.

For the effective use of the document, trainer or presented is recommended to use simultaneously with the 'Trainer Manual' with instructions.



Lesson Plan 1: Training Opening

Slide 1

Operation and Maintenance of FSTP

Training opening and Introduction

Resource Person

Government of Nepal
Ministry of Water Supply
National Water Supply and Sanitation Research, Innovation and Capacity Development Center

Slide 2

Setting the context

- After declaration of Nepal as open defecation free country Nepal's national targets, as driven by sustainable development goal 6, is to progress towards achieving total sanitation.
- With 80% of on-site sanitation, sustainable management of Faecal sludge will remain core task at hand in achieving total sanitation.
- However, with few cases from ground it's been realized that long-term functionality of faecal sludge treatment plants is real challenge in Nepal, especially in the context of skilled human resource base to operate such system to ensure long term functionality.
- In this regards, to address the issue, this training package on the operation and maintenance of FSTPs has been designed.

Slide 3

Training Introduction

Objectives

- Develop skilled human resources capable of effectively operate Faecal Sludge Treatment Plants (FSTPs), ensuring their long-term sustainability
- Understand the key knowledge required for smooth day to day operation and maintenance of FSTPs

Slide 4

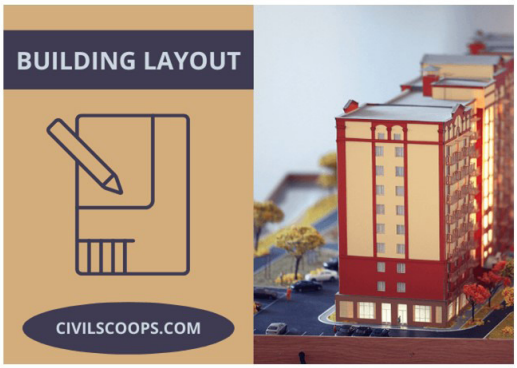
Training Structure

1 Training Opening
2 Overview on Sanitation Situation
3 Details on FSTP
4 Day to Day preparatory activities
5 Smooth System operation
6 Routine maintenance
7 Monitoring
8 Exposure Visit
9 Training Closing

Slide 5

Building Layout

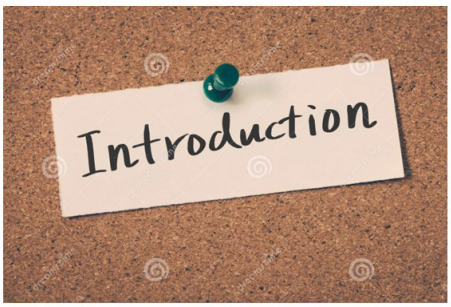
- Bathroom Location
- Emergency Exits
- First Aid



Slide 6

Introduction

- Distribute cards
- Pair with similar card
- Introduce with each other including Name, Organization, working FSTPs
- Introduce in large group



Slide 7

Learning Expectations

- One learning outcomes from each participant

Slide 8

Pre-test

5-10 minutes

Slide 9

Training Format and Agenda

- Experiential, hands-on and learn by doing
- Individual and group activities
- Case studies and learning from others' experience
- Open discussion, questions and answers
- Develop a sense of community and network within the group

Slide 10

Thank you!
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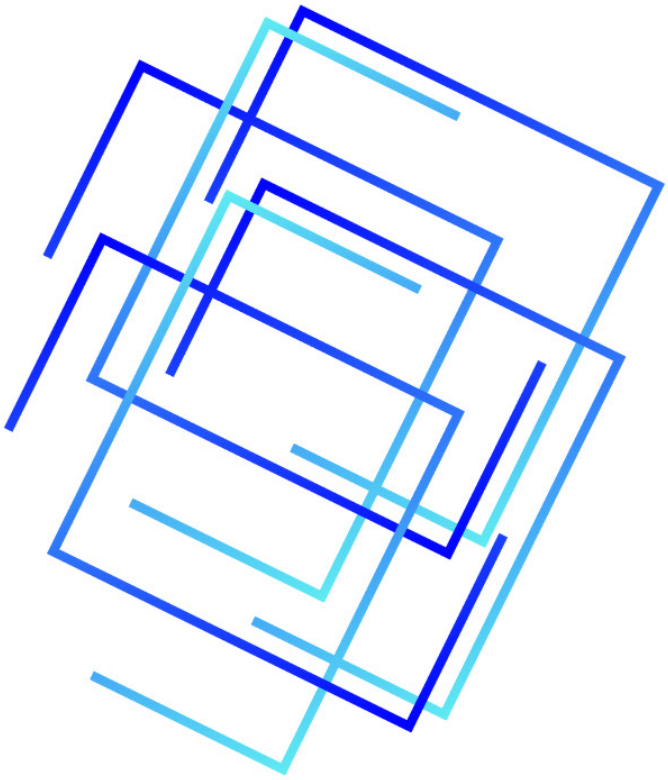


Lesson Plan 2: Overview on Sanitation Status

Slide 1

Operation and Maintenance of FSTP

Setting the context: Overview on Sanitation Situation

Resource Person

Government of Nepal
Ministry of Water Supply
National Water Supply and Sanitation Research, Innovation and Capacity Development Center

Slide 2

Before Starting …

- What is your main responsibility/ profession?
- Can you link yourself/ your profession with sanitation?
- **If Yes HOW???**

Start the training session by asking the questions in slides.
Expected answers:
to regularly operate the FSTP
Linking with the sanitation- Yes,
FS is already a part of sanitation and FSTP operation contributes in the treatment of FS which otherwise would end to the open environment and or water bodies

Slide 3

Introduction

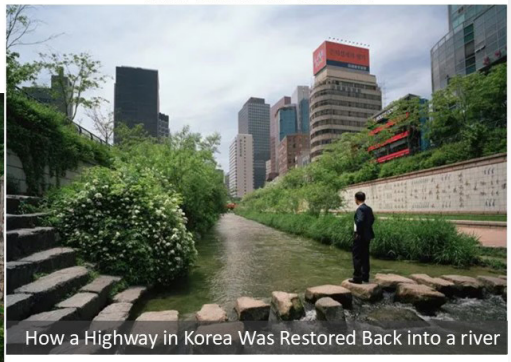
Understanding the status of today helps us to focus on what we need to do

WHERE WE ARE??

Sewage and rubbish choke Nepal's holy Bagmati river

Source: https://www.aljazeera.com/gallery/2022/8/17/photos-kathmandu-sewage-and-trash-choke-nepal-holy-bagmati-river

OUR ULTIMATE GOAL??



How a Highway in Korea Was Restored Back into a river

Source: https://settingmind.com/how-a-highway-in-korea-was-restored-back-into-a-river/

WAY FORWARD

Ask participants:
If they have any role or are their profession related to these pictures?
What and how?
Linking to the responses from the participants inform that the main role of the FSTP operators are to operate and maintain the FSTP so that the designated volume of waste could be treated and contribute as much as possible to achieve the status of the second picture from the first. However, to do this, it is always needed to understand the status of sanitation at current and focus on what one needs to do to achieve the ultimate goal.

Slide 4

Learning Outcomes

- Explain existing sanitation situation
- Explain the importance of FSTP and its contribution in circular economy

Slide 5

Training Structure

Slide 6

Presentation Outline

- Key definitions on sanitation
- Safely managed sanitation
- Nepal's Sanitation Status and targets
- Role of FSTP operators

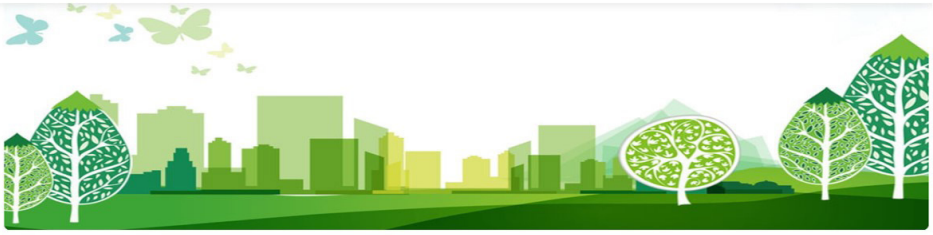
Slide 7

Key Definitions

Sanitation is access to, and use of, excreta and wastewater facilities and services that ensure privacy and dignity, ensuring a clean and healthy living environment for all.

Reference: UN-Water Decade Programme on Advocacy and Communication (UNW-DPAC)

Fecal sludge management refers to the handling of the contents of septic tanks and latrine pits, including emptying, conveyance and treatment.



KEY FOUNDATIONS FOR CLEAN AND GREEN CITY

Slide 8

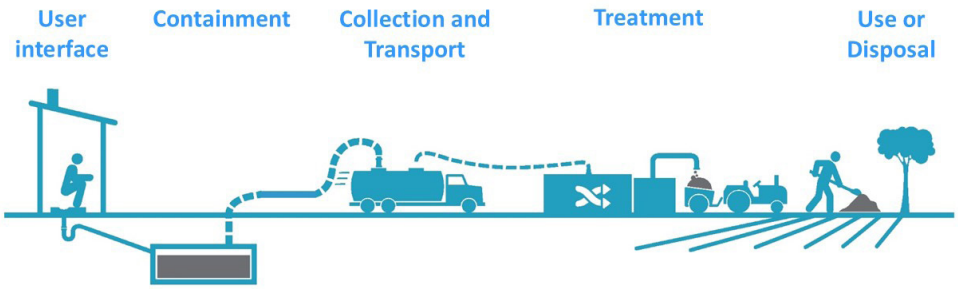
Sanitation Management

- **Safely Managed Sanitation:** Population using an improved sanitation facility that is not shared with other households and where excreta are safely disposed of in situ or treated off.
- **Improved sanitation facilities:** It includes flush/pour flush to piped sewer systems, septic tanks or pit latrines; pit latrines with slabs (including ventilated pit latrines), and composting toilets.

Slide 9

Sanitation Service Chain (SSC)

Entire stage of sanitation services from point of generation to final disposal of waste.

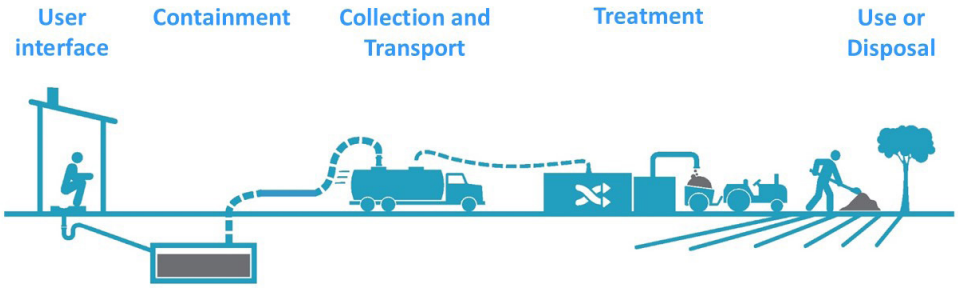


User interface: Toilet, slab, superstructure, latrine accessories (e.g., anal cleansing materials, a place to dispose of menstrual hygiene products, handwashing station). May also be called: User experience, toilet, or latrine.
Containment: On-site sanitation technologies need to include some type of pit, tank or chamber to safely collect and store excreta until it is removed. Treatment may or may not occur in the containment. May also be called: excreta storage.
Collection and transport: Manual or mechanical methods to remove faecal sludge and transport it (e.g., vacuum trucks)
Treatment: This refers to treatment after the fecal sludge is collected. It does not include the treatment that happens in the containment.
Use or disposal: May also be called end-use or resource recovery. Disposal is the return of fecal sludge to the environment, ideally in a way that poses less risk to the environment and public health. Disposal is sometimes described as the containment of fecal sludge on-site. This is not disposal – it is containment.

Explain that that sanitation service chain is also called other names, like sanitation system or s anitation chain.

Slide 10

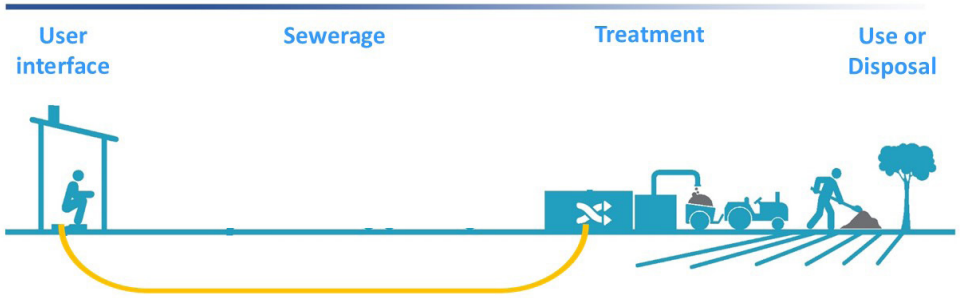
Sanitation Systems



- What is a non-sewered sanitation system?
  - ➢Human waste is collected and stored at point of generation which is periodically emptied and transported off-site for treatment. It is also called on-site sanitation.

Slide 11

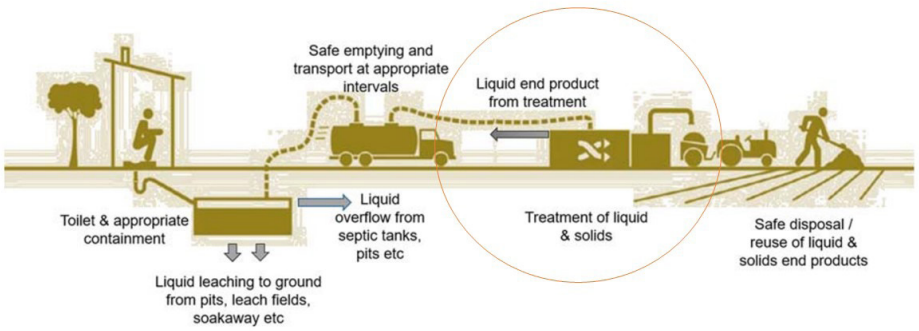
Sanitation Systems



- What is a sewered sanitation system?
  - ➢Human waste is collected and discharged into sewer pipe which is continuously conveyed for treatment. It also called off-site sanitation.

Slide 12

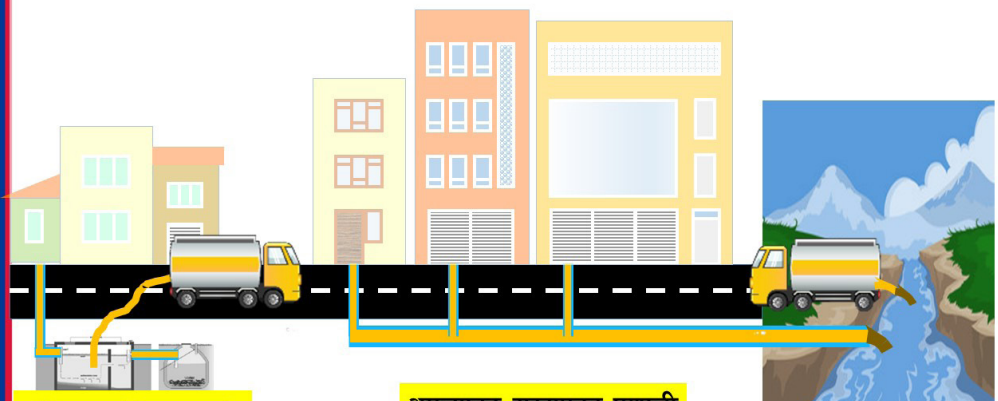
Sanitation Service Chain



Source:Gates Foundation

Slide 13

Current practice of sanitation system



In general, there are two types of sanitation systems: on-site and off-site sanitation systems. In on-site sanitation systems, the sludge is collected in containment and is desludged. For off-site sanitation, wastewater is transported through a sewer network. In either system, waste should be treated before disposal. However, due to lack of treatment systems, the common practice of on-site sanitation is desludging and disposal of fecal sludge, and flushing and forgetting the wastewater.

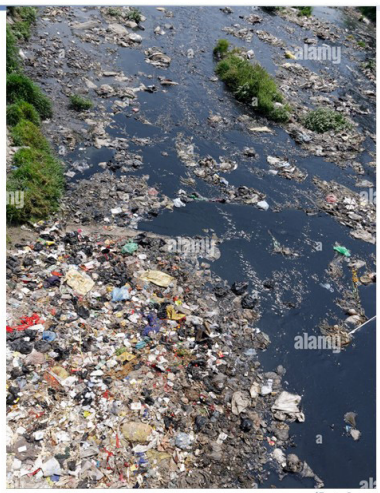
Slide 14

Sanitation Situation of Nepal

89% HHs with on-site sanitation

11% HHs with Sewer connection

2.1% Status of treatment



(Data Source: UNICEF-GoN MICS, 2019)

Slide 15

Open Defecation to Open Disposal

Open defecation and **Open disposal** -both have serious public health and environmental consequences, including the spread of disease, contamination of water sources, and pollution of the environment

Brief on Nepal declaration on open defecation free country
Regardless our country is declared as ODF country, the country is moving from open defecation to open disposal.
Explain why we are openly disposing the FS, the main reason is unavailability of enough treatment plant. In next slide we discuss on FSTP that are present in Nepal.

Slide 16

FSTPs in Nepal

Total FSTPs in Nepal: 17

No. of FSTPs operating: 8

Go to the link :https://enpho.org/map/

Slide 17

FSTPs of Nepal

Kakarbhitta FSTP

Slide 18

FSTPs of Nepal

Lubhu FSTP

Waling FSTP

Slide 19

What Faecal Sludge Treatment Plant is?

- Facility designed to receive, treat and safely managed faecal sludge collected from onsite sanitation systems such as septic tanks, pit latrines.
- Faecal sludge is transported to the plant by vacuum trucks or manual desludging operators from sources like households, public toilets or institutions.
- Upon arrival, the sludge is directed to pre-treatment units, including screening chambers that remove grit, plastic and inorganic materials.

Slide 20

What Faecal Sludge Treatment Plant is?

- The sludge then moves to solid liquid separation units where solid fraction is separated from liquid portion for further processing.
- The solid component is treated through composting, converting it into nutrient rich compost for agricultural use.
- The liquid portion undergo appropriate liquid treatment technologies resulting in an effluent safe for reuse, particularly for irrigation purpose.

Slide 21

Importance of FSTPs

- Prevent direct discharge of untreated wastewater into environment thereby minimizing pollution risk.
- Helps control contaminating the drinking water sources and spread of water borne diseases.
- Supports local government in achieving national sanitation standards and aligning with the sustainable development goals
- Enables resource recovery by converting treated sludge into useful by-products such as:
  - Dried sludge used as compost or soil conditioner,
  - Biogas for cooking or generation of electricity and
  - Treated wastewater for non-potable uses like irrigation and landscaping.

Slide 22

FSTPs contributing to the circular economy

- Treated sludge is rich in nutrients such as nitrogen and phosphorus, which can be used to produce organic compost for agriculture.
- Anaerobic digestion in FSTPs can produce biogas, that can be used as renewable energy source.
- The treated effluent can be reused for irrigation.
- Reusing of byproducts from FSTPs reduces the dependency on chemical fertilizers, fossil fuels and fresh water sources.

Slide 23

Although Faecal Sludge Treatment Plant offers numerous benefits- including contributions to environmental protection and public health, they are often found to be non-functional or under performing.

Having said the above, inform participants we will discuss the reasons of non functionality of FSTPs in another session?

Slide 24

FSTPs of Nepal (under performing)

Tikapur FSTP

Charali FSTP

Slide 25

Reasons for non functionality of FSTPs (Nepal)

- Absence of responsible person or limited institutional ownership
- Lack or insufficient finance/ financial planning
- Strict rules and regulations
- Design default
- Absence of regular monitoring
- Lack of skilled manpower
- Inadequate operation and maintenance
- Irregular sludge collection

Slide 26

Reasons for non functionality of FSTPs (Nepal)

- Common practice of “Built and forget”
- FSTPs often do not receive sufficient quantity of FS as per the design
- Lack of consistent fund flow for continuous operation and maintenance
- Lack of systematic standard operating procedure
- Limited skill of **FSTP operator/Caretaker** for immediate repair incase of failure to operate

Slide 27

Who is responsible for functionality of FSTPs?

Slide 28

Thank you!
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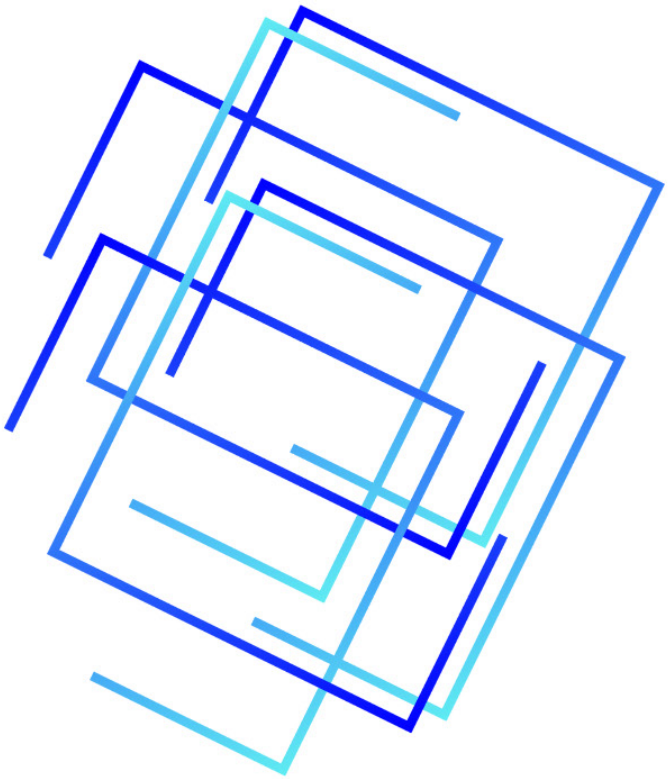


Lesson Plan 3.1: Components of FSTPs

Slide 1

Operation and Maintenance of FSTP

Components of FSTPs

Resource Person

Government of Nepal
Ministry of Water Supply
National Water Supply and Sanitation Research, Innovation and Capacity Development Center

Slide 2

Before Starting …

- Identify the different components of FSTP and sequentially arranging them as per their operations

4 Groups
5 minutes

Preparation- Print out 4 sets of different components of FSTP including arrows.
Instruction: Divide the participants into groups, ask them to identify each of the components and ask them to arrange as per their work flow

Slide 3

Learning Outcomes

- Explain types of treatment process involved in FSTPs and how they are achieved via treatment units
- Explain about nature-based treatment and mechanical treatment
- List the components of faecal sludge treatment plants

Slide 4

Training Structure

Slide 5

Presentation Outline

- Information on faecal Sludge Treatment Plant
- Nature based FSTP and Mechanical FSTP
- Treatment objectives
- Treatment processes (explaining different treatment units)
- Highly technological FSTPs
- Layouts of units of FSTPs; case of:
  - Lubhu FSTP
  - Waling FSTP

Slide 6

Objectives of FS management

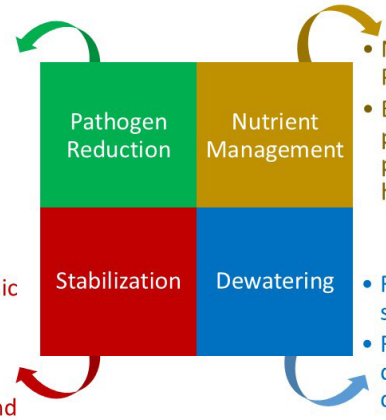
- To convert unpleasant and potentially harmful faecal sludge into **inoffensive products**
- To protect public health and environment from harm of FS
- To easily handle FS

Mention that the diagram here shows the most simple organization of the units under Faecal Sludge Treatment System

Slide 7

Treatment Objectives

- Reduce pathogens from the liquid effluent
- Reduce pathogen concentrations in sludge



- Nitrogen, Phosphorus and Potassium and others
- Bio-solids : Improve productivity of soil, stimulates plant growth, increase water holding capacity

- Degradation of organic matters
- Reduces biological oxygen demand
- Reduces pathogen and odour

- Reduce water content in sludge
- Fresh sludge - difficult but digested sludge - easy to dewater

Slide 8

General types of units used in FSTPs

Slide 9

FSTP Units

केन्द्रीकृत दिसाजन्य लेदो प्रशोधन प्रणालीहरू

Slide 10

Nature Based Units

What is nature-based systems ?

- Relies on **natural elements like plants, soil, bacteria, and porous media to remove pollutants**
- Do not require special skill for operation and maintenance

Example: Sludge Drying Bed, Planted Gravel Filters, etc.

Source: https://www.dutchwatersector.com/news/fifth-faecal-sludge-treatment-plant-in- Birendranagar municipality Nepal; SNV

Picture here, shows planted sludge drying bed (which we will learn later) from FSTP constructed by SNV at Birendranagar muicipality

Slide 11

Hi-tech mechanical Units

What is hi-tech/mechanical system?

- Uses energy intensive equipment
- Uses complicated physical, chemical and biological processes
- Require specific skill for operation and maintenance

Dewatering Screw Press - Butwal

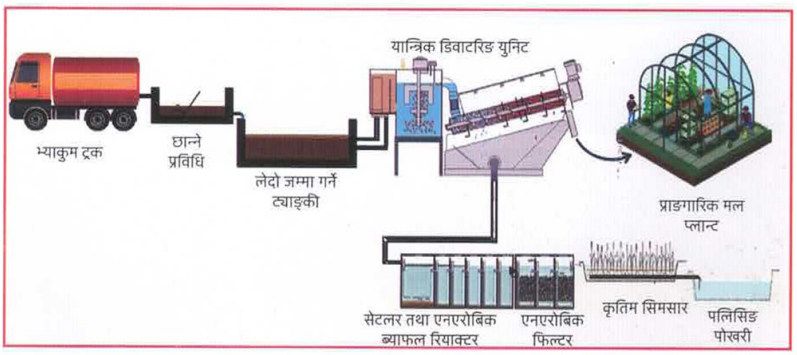
Janicki Omniprocessor

Generally, while designing FSTP, nature based units and mechanical units are combined together as per the treatment objective and financial criteria.
Picture included here is of Highly technological FSTP, Janicki Omniprocessor

Slide 12

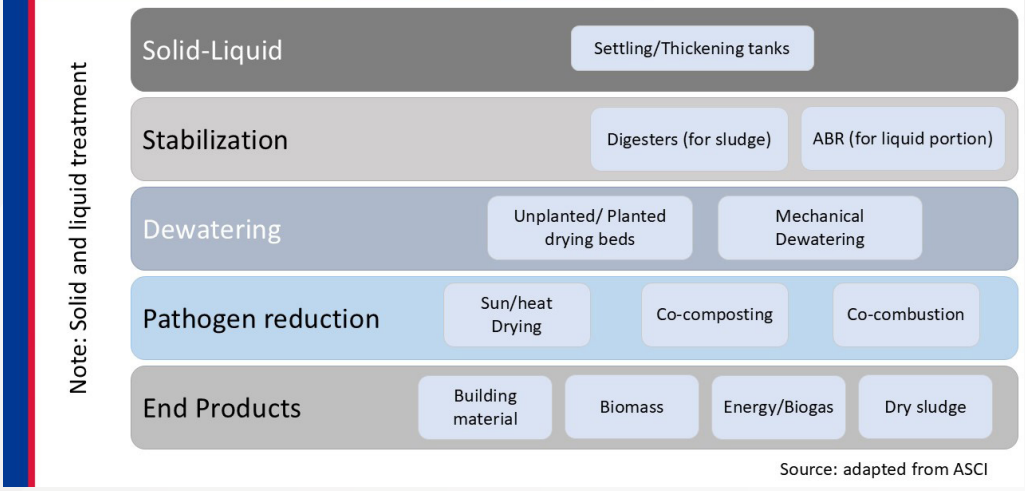
Hybrid FSTP

- Nature Based Units and Mechanical units work together in a system.
- In the example shown below, de-watering unit is used while most of the other units are nature based.



Slide 13

Treatment Process and the Components



Source: adapted from ASCI

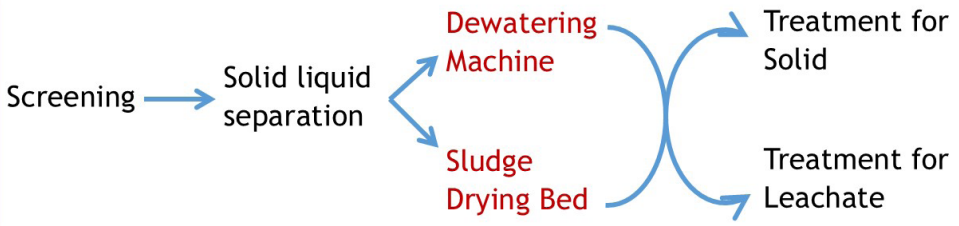
Slide 14

Treatment Processes

1. Reception and preliminary treatment
2. Solids-liquid separation
3. Liquid treatment
4. Solid dewatering
5. Treatment to allow safe end use

Slide 15

Treatment Processes



- Safe reuse or safe disposal to the environment

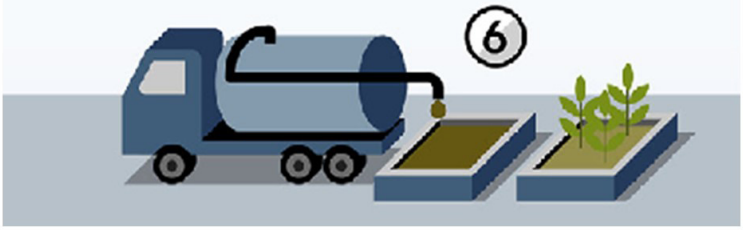
Slide 16

Reception and Preliminary Treatment

Slide 17

Reception and Preliminary treatment

- Every treatment plant must include provision for reception of incoming material
- **Coarse screening to remove large objects** such as trash and textiles is also essential

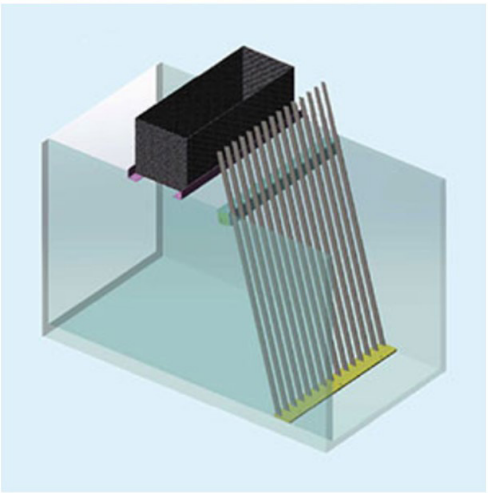


Removal of large objects is essential since such objects might otherwise cause down-stream blockages and/or damage downstream treatment processes.

Slide 18

Screen, Grit removal

- The screen and grit chamber is a basin to trap large solids (rags, paper, and metals)
- For settling of grits (sand, gravel, etc.)
- The solids collected in this chamber needs to be removed regularly and disposed safely



Ask participants what is it and how does it work? Collect a response and present.

Slide 19

Screen, Grit removal

Passing through a barrier, Screening- solids are screened by various barriers depending on the size of the solids.
Coarse material, such as rocks, sticks, leaves, plastics and other debris, should be removed because they could damage pumps or settlers. Screening devices such as bar racks and screens are recommended for this kind of pre-treatment.
Figure on the right shows, creative ways of using locally available material as screen – done at … (Nepal)

Slide 20

Solid Liquid Separation

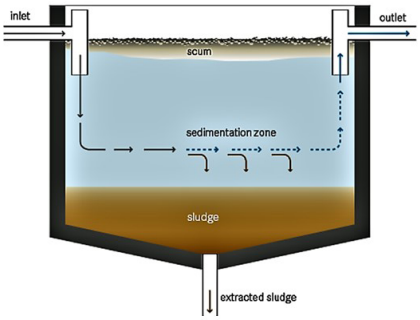
Simple process to separate out heavier content from the sludge

Slide 21

Solid Liquid Separation

Settling tanks

- Ensure maximum settling of solid particles
- The retentions time is generally for **4 hours**
- Also act as equalization tank
- The settled sludge from the tank enters into sludge treatment unit while supernatant liquid fraction enters into liquid treatment unit



Ensure maximum settling (gravity settling or forced settling through addition of lime) of solid particles

Also act as equalization tank to ensure uniform discharge of sludge into subsequent unit

Slide 22

Photos

Settling tank at Lubhu FSTP

Slide 23

TO BE CONTD .. In Session 3.2

Slide 24

Thank you!
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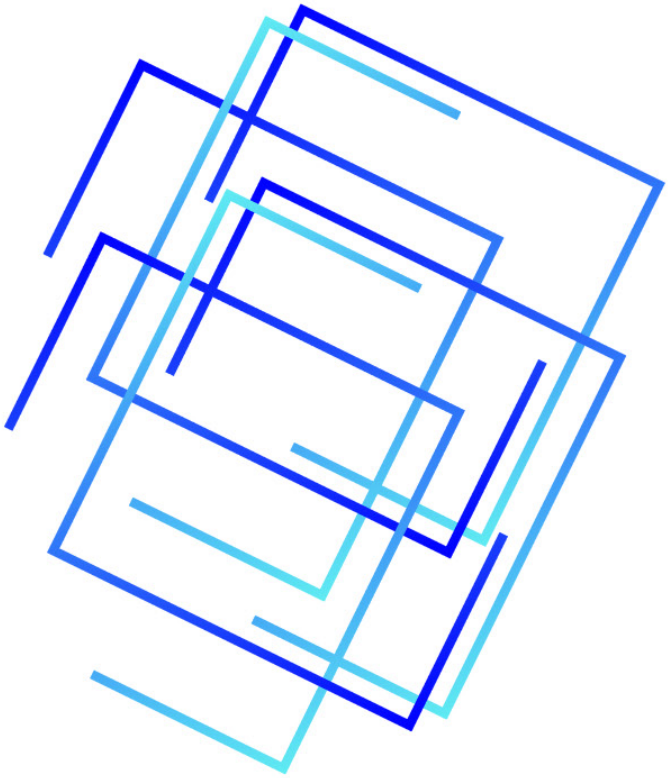

Lesson Plan 3.2: Components of FSTPs

Slide 1

Operation and Maintenance of FSTP

Components of FSTPs (Contd..)

Resource Person

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Ministry of Water Supply
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Slide 2

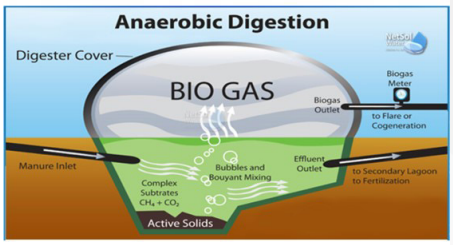
Sludge Stabilization

- It is a process that reduces sludge odour and putrescence (i.e. decay), and level of pathogenic organisms.
- This is generally achieved either chemically or biologically.
- It is achieved through combination of series of treatment units
- In Nepal, anaerobic digestion through biogas digester is used for sludge stabilization

Slide 3

Biogas Digester (Solid and liquid stabilization)

- Anaerobic digestion
- Digestion results in reduction in sludge volume
- Increases the dewaterability of the sludge
- This process produces biogas, an excellent energy source.
- **The sludge retention time (SRT) is maintained for 30-33 days (Nepal) inside the digester**
- The stabilized sludge enter dewatering units



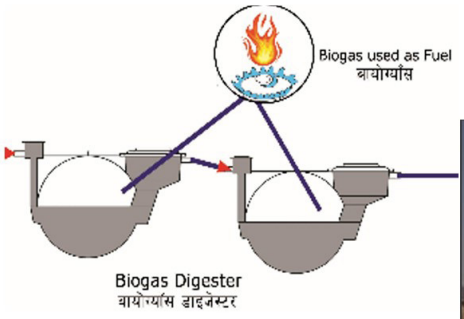
Other Benefits

- Clean energy production
- GHG reduction

- Anaerobic digestion through the use of biogas digestor,
- undertakes fermentation process to stabilizes the sludge by reducing chemical oxygen demand, reducing pathogen, reducing odor.
- Digestion results in reduction in sludge volume. It increases the dewaterability of the sludge.
- This process produces biogas which is about 55-70% methane (the primary component of natural gas) and therefore an excellent energy source.
- The sludge retention time (SRT) is maintained for 12-15 days inside the digester
- The stabilized sludge enter into dewatering units

Slide 4

Biogas digester



Layout of biogas digester at Lubhu FSTP

Ouagadougou, Burkina Faso, Industrialized Biogas for the treatment of Faecal sludge and organic waste

Biogas digester at FSTP Lubhu, and industrialized biogas from digestion of organic component of solid waste and faecal sludge at Ouagadougou, Burkina Faso.
The limiting factors for implementation in anaerobic digester is that it requires monitoring on a daily basis and skilled persons for operating the treatment unit
It is to be noted that: The limiting factors for implementation in anaerobic digester is that it requires monitoring on a daily basis and skilled persons for operating the treatment unit

Slide 5

Solid Dewatering

Sludge dewatering separates sludge into liquids and solids for waste minimization.

A. Natural Dewatering

B. Mechanical Dewatering

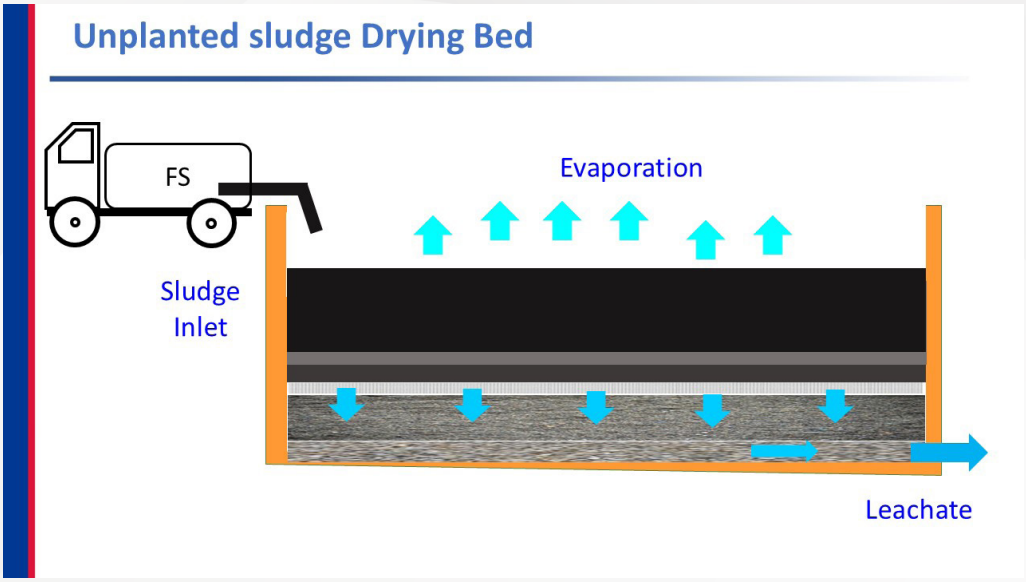
Slide 6

Natural Dewatering

Sludge Drying Beds

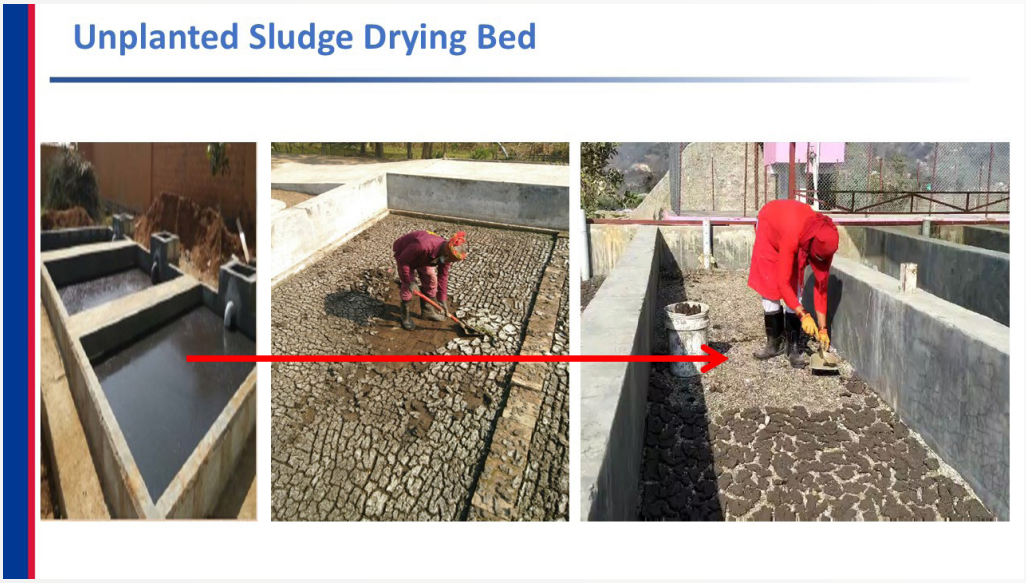
- One of the simplest and oldest technologies for sludge dewatering.
- A simple, permeable bed that, when loaded with sludge, collects percolated leachate and allows the sludge to dry by evaporation.

Slide 7



When the sludge is applied at the top, the dewatering process occurs by filtration from filter bed where solid retains and leachate is drain out from drainage pipe at the bottom. Besides filtration, evaporation also plays important role in dewatering Dried sludge is obtained from this treatment technology

Slide 8



Example of the unplanted sludge drying bed

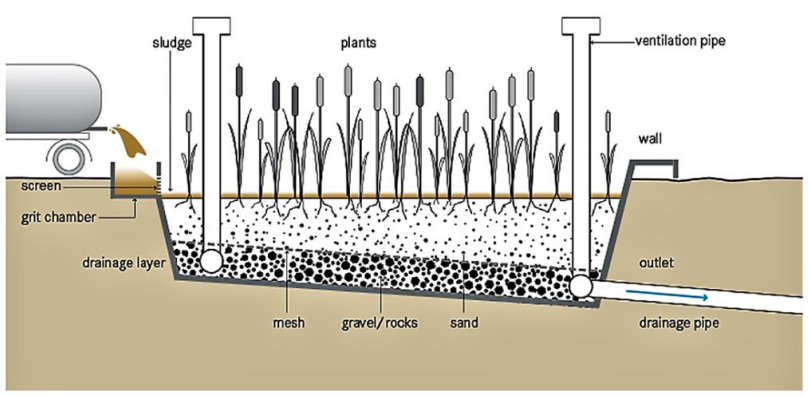
Slide 9

Planted Sludge Drying Bed

- Depth and characteristics of filter media same as unplanted drying bed
- Plantation of reeds, canna, cattails, bulrushes, etc on filter media
- sludge dewatered by filtration, evaporation and evapo-transpiration
- Liquid fraction flows vertically downwards through media and is collected at bottom and treated separately
- Sludge retention time is 2-3 years depending on sludge loading rate TS

Slide 10

Planted Sludge Drying Bed

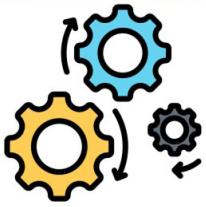


Schematic of a planted drying bed. Source: TILLEY et al. (2014)

Slide 11

Mechanical Dewatering Units

- Filter Press
- Screw Press
- Centrifuge

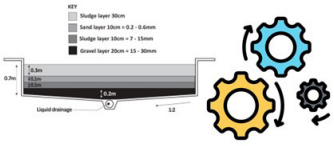


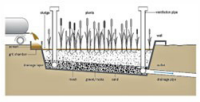
- Advantage of mechanical treatment options include compactness and speed of the process
- Limitation of mechanical treatment options include high investment costs, O&M and electricity requirement
- At this phase, **none of the FSTPs in Nepal uses them**, but they have potential in Nepal's FSM sector

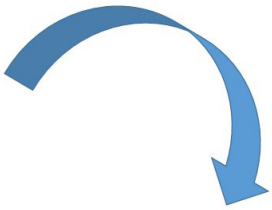
These mechanical dewatering units are also used to treat wastewater sludges. Belt Filter Press was planned for the new FSTP planned for Mahalaxmi Municipality

Slide 12

Dewatering







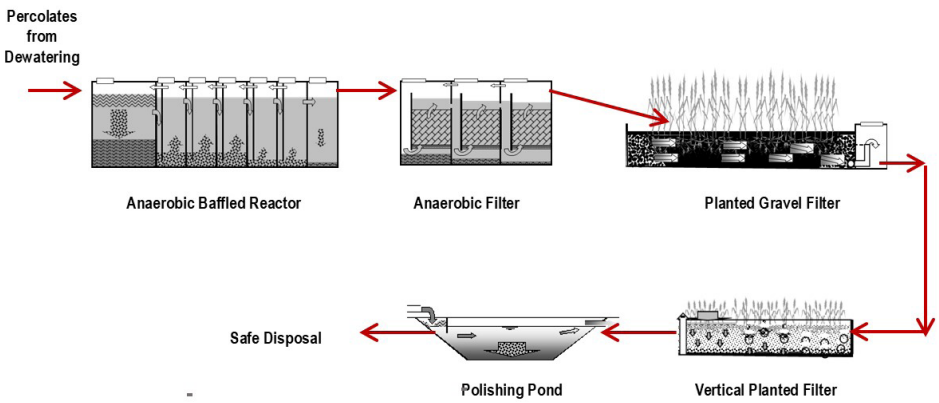
Effluent water from the dewatering units is further treated with the liquid fraction of the sludge (from the settling unit)

Slide 13

Liquid treatment

Slide 14

Liquid treatment system



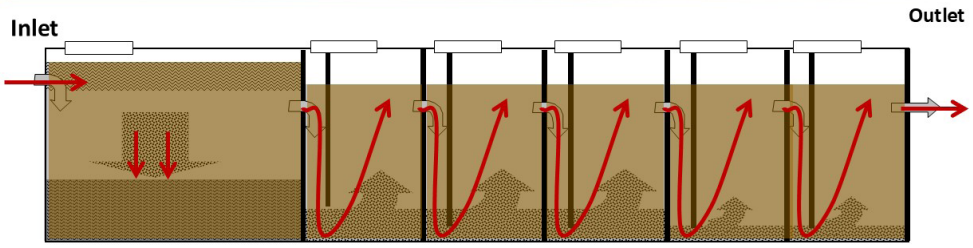
Slide 15

Anaerobic Baffle Reactor

Anaerobic treatment (in the absence of oxygen)
Wastewater passes a series of up-flow chambers
Bacteria mass (activated sludge) at bottom of each chamber
Further treatment (degradation) of suspended and dissolved solids by anaerobic bacteria
Efficiency 75%- 85%
Desludging is needed only if excess sludge is generated

Slide 16

Anaerobic Baffle Reactor



- This is Secondary treatment unit consisting series of up-flow chamber
- It functions under anaerobic digestion
- Liquid comes in contact with the activated sludge (bacteria mass) and dissolved/suspended matters undergoes into degradation by anaerobic bacteria

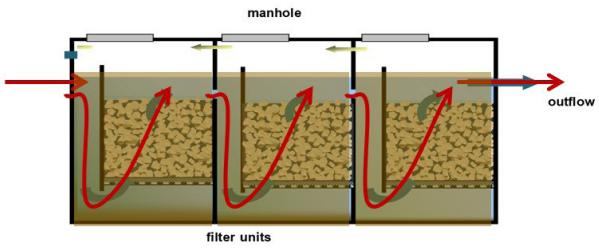
Slide 17

Anaerobic Filter

- Anaerobic treatment (in the absence of oxygen)
- Wastewater passes in a series of up-flow chambers with carrier material (filter material)
- The filter is made out of gravel, slag or plastic elements
- To avoid plugging pre-treatment (sedimentation) is necessary.
- Efficiency 75%- 90%
- Desludging is needed only if excess sludge is generated

Slide 18

Anaerobic Filter



- This is Secondary treatment unit consisting series of up-flow chamber embedded with filter media
- Filter media is made up of gravel, slag, plastic materials
- To avoid clogging of filter bed, pre-treatment unit is necessary before it

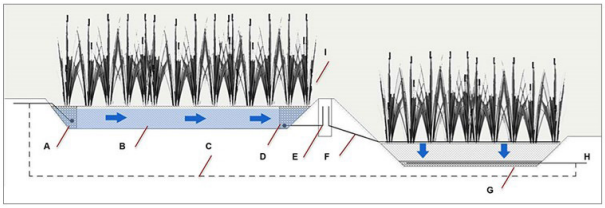
Slide 19

Treatment to allow safe end use/disposal

Slide 20

Polishing of liquid fraction

1. Horizontal Planted Gravel Filter



2. Vertical Planted Gravel Filter

Photo, PGF of Ama Ghar

Slide 21

Constructed Wetland

Constructed wetlands are treatment systems that use natural processes involving wetland vegetation, soils, and their associated microbial assemblages to improve water quality.
Wetland plants also foster the necessary conditions for microorganisms to live there. Through a series of complex processes, these microrganisms also transform and remove pollutants from the water.
Picture source: (Sketch- https://www.frtr.gov/matrix/Constructed-Wetlands/)
https://upload.wikimedia.org/wikipedia/commons/1/1b/S_Koirala_Hospital_Constructed_Wetland_%284975034182%29.jpg

Slide 22

Disinfection of liquid fraction

Polishing pond (for liquid fraction): Use of solar radiation to destroy the pathogens

Disinfection: Use of chlorine to destroy the pathogens

Slide 23

Composting / Co-composting

Co-composting is process in which Faecal sludge is composted along with municipal solid waste. We have to know about composting before going to co-composting
Composting: Decomposing of organic matter under controlled predominantly aerobic condition. It is basically of two types: open composting and closed composting. Open composting is cheaper and requires lots of space. Closed composting are windrow method and box composting where the space is minimized

Slide 24

To be noted

- In Nepal, mostly low energy requirement systems are used than the hi-tech systems which require high energy and skilled HR
- Combination of the above units is tailored as per the context

Slide 25

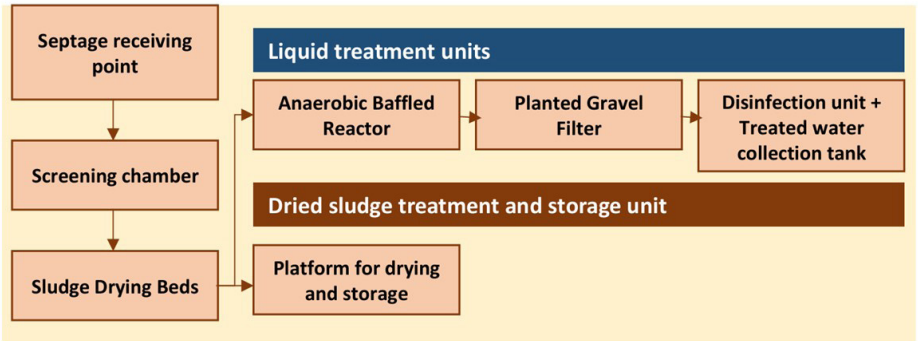
Video Break

- https://www.youtube.com/watch?v=fElLQ7JRaTk (Waling)

This video gives digital tool of FSTP at Waling municipality. Before the video ask the participants to be attentive on how the different components leaned ahead in this session are combine to form the treatment system/plant.
After watching the video, get some interactive perspective of participants like:
What are the different components observed that was discussed earlier in this session ??

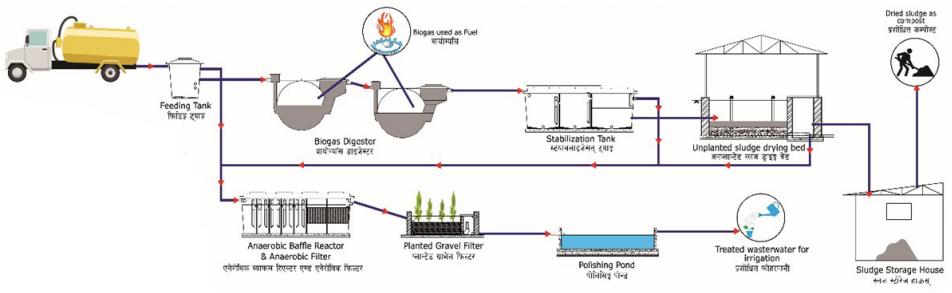
Slide 26

Schematic representation of FSTP's process



Slide 27

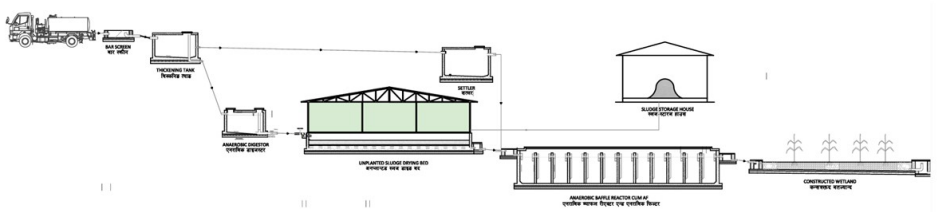
Lubhu FSTP



Please note that how different units learned earlier are brought together to form the system

Slide 28

Waling FSTP



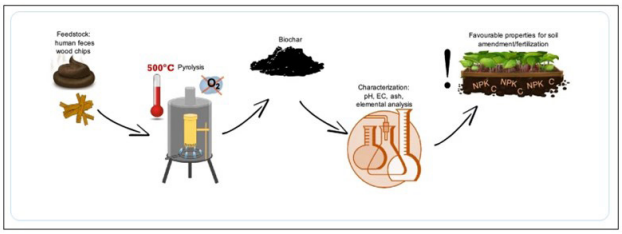
Please note that how different units learned earlier are brought together to form the system

Slide 29

High Technology Treatment

Slide 30

Thermal treatment - LaDePa (Latrine Dehydration and Pelletisation)



Pyrolysis not only eliminates pathogens within the sludge but produces biochar as an end product which has the potential as a soil amendment to increase crop yield

These are some of the hi-tech technologies used for FSM, LaDePa and Pyrolysis are both thermal treatment.

Slide 31

Omniprocessor

(https://www.youtube.com/watch?v=bVzppWSIFU0)

Slide 32

Group Activity

- Rework on the same exercise (in same groups) on identifying the different components of FSTP and sequentially arranging them as per their operations.
- Each of the group to present their work

10 minutes

Preparation- Print out 5 sets of different components of FSTP including arrows. Divide the participants into groups, ask them to identify each of the components and ask them to arrange as per their work flow.

Slide 33

References

- Manual for Operation and Maintenance of Faecal Sludge Treatment Plants (https://cwas.org.in/resources/file_manager/O%26M%20manual%20for%20FSTP.pdf)
- Sustainable Sanitation and Water Management Toolbox (https://sswm.info/)
- Anaerobic Filter (AF) Design Considerations for Faecal Sludge (https://dqo52087pnd5x.cloudfront.net/posters/docs/gatesopenres-197555.pdf)
- ASCI training modules

Slide 34

Thank you!
धन्यवाद !

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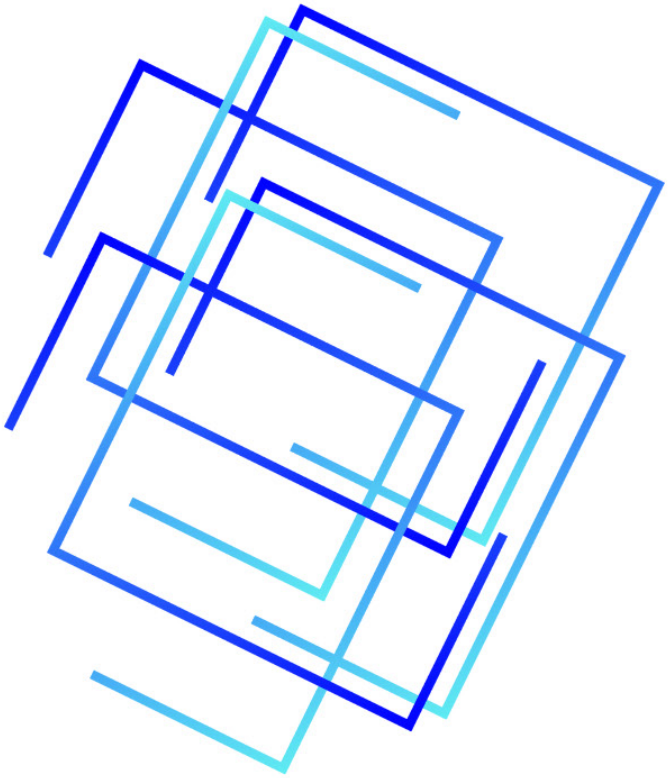


Lesson Plan 4: Day to Day Preparation

Slide 1

Operation and Maintenance of FSTP

Day to day Preparation for smooth operation

Resource Person

Government of Nepal
Ministry of Water Supply
National Water Supply and Sanitation Research, Innovation and Capacity Development Center

Slide 2

Before Starting …

Charge battery
Recharge the balance
Install/ uninstall apps

Similarly,
Resources
Day to day preparation and O&M

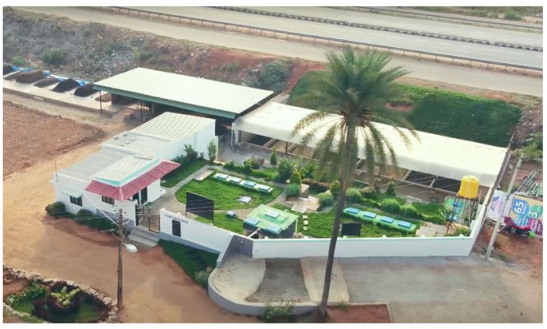
Ask participants, if they all have their mobile phone? Expected answer: yes
What do they with their mobile phone on daily basis? Expected answer: make calls, surf the internet, use various app
For these things, you do certain activity like charging mobile, recharging the balance, downloading apps and etc.
Link: these are some things that we do on daily basis for the operation of our mobile phones. Similar to our phones, the FSTPs also needs resources and day to day preparation and operation and maintenance.

Slide 3

Introduction

No O&M

With proper O&M



Compare how important O&M by comparing these two picture. Both are FSTPs

Slide 4

Introduction

- **Low O&M** has been understood for **No O&M**
- Thus, lack proper O&M planning from the inception phase of FSTP designing

Unfortunately, in our work of line in sanitation, low O&M has been almost understood as No O&M and that's where the harm is being done. Most of the time O&M is never planned from the begening during FSTP design inception phase but rather considered only after it starts operating, and only one care taker is assigned with limited capacity and mostly with no training.

Slide 5

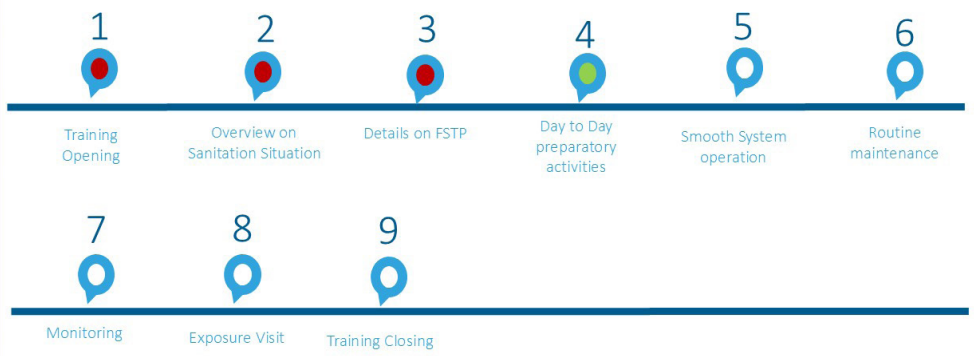
Learning Outcomes

- Explain day to day preparation work that is required at FSTP to ensure smooth operation and maintenance
- List good housekeeping at FSTP and explain why it is important

Explain that this session is the first session on O&M, where we enter into the world of operation and maintenance. Before this session it was just a background setting to bring all the participants into similar understanding level.

Slide 6

Training Structure



Slide 7

Presentation Outline

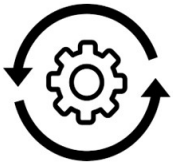
- Setting Context for O&M
- Importance of O&M
- Components of O&M
- O&M Plan
- HR in O&M
- Preparatory activities
- Housekeeping at FSTP
- Insurance of Human resources and FSTP

Slide 8

Setting Context for O&M

- Operation and maintenance (O&M) typically includes **all day to day as well as the regular maintenance activities** necessary **for running a system.**

Operation refers to all the activities that are required to ensure that a FSTP delivers treatment services as designed



Maintenance refers to all the activities that ensure long-term operation of equipment and infrastructure (Braustetter, 2007)

Operation focuses on using the asset to achieve its intended purpose.
Maintenance involves activities to preserve the asset's condition and functionality.

Effective O&M ensures the asset's longevity, efficiency, and safety.

Slide 9

Group Activity

3-5 groups

Discuss- Importance of O&M of FSTPs

5 minutes

5 minutes for presentation and discussion

Slide 10

Importance of O&M

Some voices from participants

- O&M activities ensure that the FSTP is sustainable over a long-term
- Allows for the correct provision of services and benefit to end-users
- Prevents the collapse of FSTP which could create environmental and health hazards
- Proper O&M of FSTP will ensure compliance to environmental norms
- Must be considered as an integral component of the full life cycle costs of a facility

O&M plan must be prepared at the time of design and thoroughly reviewed

Training and capacity building is essential for the operator

Slide 11

O&M Plan

Ideally, costed O&M plan should be in place which incorporates:

- engineering drawings and FSTP specifications;
- for purchased equipments - manufacturer's literature and equipment operation guidelines;
- responsible person for each task;
- frequency of each activity;
- Standard operation procedures and tools required to perform the task;
- safety measures required; and
- information that is to be monitored and recorded.

Slide 12

Human Resource for O&M

Initiate engaging discussions with the participants on What they think could be the preparatory activities at FSTP once the faecal sludge is delivered and before it enters into the treatment systems? Collect their response in metacards and

Slide 13

Who does O&M? (Human Resource)

As per the standard, FSTP needs to have set of HR for robust functioning:

1. **Plant superintendent**
2. **Plant engineer**
3. **Plant operator**
4. **Plant maintenance technician**
5. **External contracts**

Please note that, this is in ideal case and good to have such HR structure in big FSTPs. However, in case of Nepal, mostly there is one care taker at the site as the volume/ size of FSTPs are small.
HR plan and finances to accommodate, this should be planned during the FSTP design and planning phase
In the practical context of Nepal, care taker as plant operator is there and other's come in as per the requirement.
Plant superintendent: Oversees day to day management of FSTP including staff management
Plant engineer: Oversees technical aspects of system functions
Plant operator: Responsible for carrying out the day to day technical aspects of plant operations
Plant maintenance technician: Responsible for routine and emergency maintenance and repairs on plant facilities, pumps, engines, motors, etc.
External contracts: For the maintenance of equipments that require specific skills Or unskilled labour during certain time of workload like harvesting of plants (Planted drying beds/PGF)

Slide 14

Roles of Plant operator/Care taker

Responsible for day-to-day operations

- performing equipment inspections, monitoring operations, and collecting samples in order to verify system performance in collaboration with laboratory employees;
- operating pumps, blowers, generators, compressors, and other machinery/equipment;
- keeping records of operational activities, degradations and failures;
- preparing field and office reports summarising the records and providing recommendations for optimising the system; and
- assisting in site environmental investigations, field surveys, and cleanups as required.

Collect responses from participants, as much as new points are being added, and present the information on the slides.

Slide 15

Roles of Plant Maintenance technician

- Performing routine maintenance on mechanical equipment (greasing, oil changes, etc.).
- Maintaining infrastructure, including buildings, roads, and grounds.
- Replacing worn-out parts and conducting repairs on motors, bearings, seals, etc.
- Inspecting installed mechanical and hydraulic equipment for contract compliance.
- Monitoring and repairing leaks or malfunctions in facilities and equipment.
- Logging maintenance activities, repairs, and preparing summary reports

Plant operator and plant maintenance technician could be one person in case of small FSTPs.
If care taker's skill is limited then plant maintenance technician could be on contract
checking, adjusting and maintaining mechanical equipment including greasing of moving parts, changing oil, and performing other routine maintenance activities;
maintaining buildings, roads and grounds;
replacing worn parts and performing routine and emergency service and repairs including replacing motors, bearings, flanges, seals and other equipment components;
inspecting mechanical and hydraulic equipment being installed under contracts to ensure compliance with contract requirements;
monitoring facilities and equipment in order to identify and repair leaks or other malfunctions;
keeping records through the logging of maintenance activities and repairs, and preparing reports summarising the main activities, malfunctions and recommendations.

Slide 16

O & M of FSTP aligning with 4 KPIs of Sanitation

- **Accessibility**
  - FSTP services to be accessible for all
  - Consistent FSTP operation be maintained to support regular desludging services in all areas including marginalized communities.

- **Safety**
  - O & M must prioritize health, safety and environmental compliance.
  - Regular inspection and repair of units
  - Ensure proper handling, treatment, and disposal of sludge and effluent as per national standards
  - Equip staff with proper PPE

Slide 17

O & M of FSTP aligning with 4 KPIs of Sanitation

- **Inclusiveness**
  - Ensure affordable and accessible desludging schedules
  - Employ gender-sensitive workforce policies and inclusive facilities at the FSTP
  - Set up an inclusive grievance redress system to receive feedback from underserved groups.

- **Sustainability**
  - Develop and implement a business plan including tariffs, cost recovery, and service contracts.
  - Promote resource recovery (e.g. compost, biogas, treated water reuse)
  - Monitor energy usage for resource optimization

Slide 18

Preparatory Activities

Initiate engaging discussions with the participants on What they think could be the preparatory activities at FSTP once the faecal sludge is delivered and before it enters into the treatment systems? Collect their response in metacards and

Slide 19

Preparatory Activities for FS Delivery

Once the desludging service providers get a request from households:

1. The truck driver should call and alert the FSTP operator/site in-charge about the number of requests and time of arrival
2. The FSTP operator should confirm whether the FSTP is ready to take a load
3. Specify expected waiting time at the FSTP to discharge the load

Coordination between truck and FSTP operators is essential for smooth operation of FSTP

Slide 20

Delivery of FS at the treatment site

What should a FSTP operator do during the delivery of FS at treatment site?

2 to 3 responses

- FSTP operator should guide the truck driver to properly position and park the truck near the discharge point

Ask participants to answer:
What should a FSTP operator do during the delivery of FS at treatment site?
Collect a response or two from participants and present the answer.

Slide 21

Checking the readiness of sludge receiving point

After the confirmation by truck driver about arrival of load, FSTP operator should:

1. Check clearance of any kind of obstruction in area where vehicle will be parked while unloading the sludge into the treatment system
2. Check for any kind of blockage in the inlet pipe
3. Arrange sampling equipment

Slide 22

Before we start….Know your sludge

- Name of the desludging vehicle operator
- Location of the sludge collected (i.e. HH/CT/PT)
- Volume of sludge to be received at the FSTP
- Collection of sample from the tanker (Once a week for testing)
- Testing of sludge samples for pH, TSS, BOD & COD at regular interval

Maintain logbook for daily collection of fecal sludge, vehicle details, quality test results.

Understanding the source of sludge of essential as FSTP are designed to take in only domestic sludge which is mostly organic in nature, it wont be able to treat sludge from the industries which uses chemicals.

Slide 23

On-site sludge check

It is recommended to have certain testing equipment within the premises of FSTP with small lab set-up.

1. Equipment required for sampling: (Beakers, Imhoff cone)
2. Portable pH, electrical conductivity, and TDS meters
3. Moisture probe, hygrometer and thermometer

Moisture probe:
Hygrometer: Measures humidity of the air of gas

Slide 24

Plan for Quick Tests

- FSTP operator should **conduct on-site check for certain crucial parameters** to understand the sludge

Parameters	Accept the FS truck load only if these criteria are met
pH	Should be within the range of 6.5 to 8
Electrical conductivity	Should be within the range of 2.5 to 4 milli siemens
Color	Blackish, brownish, dark greenish black, yellow. Reject the load if white or other color confirming chemical effluent is noticed
Odor	Strong pungent and rotten egg smell (if acidic or chemical fumes are noted, reject the load)
Oil and grease	No presence of oil or grease (if present, reject the load)
Temperature	Acceptable range of 25-35° C

Slide 25

Sampling for on-site check

- Operator should instruct the truck driver to open the valve to half open position
- Collect the sample – 3 times (at the beginning, in between and at the end)
- Sample to be collected in the proper sampling bottles and imhoff cone

Ask participants if they practice this activity? If yes, do they carry it in every load of FS delivered to the plant or when do they collect it.
If no, ask why?

Slide 26

Screening for Acceptance or Rejection

- As mentioned earlier, operator at FSTP should conduct on-site testing
- **If the sample passes the on-site check**:
  - Instruct the operator to empty the complete load into FSTP
  - If failed to clear onsite check, reject the FS load and send the truck to STP or another designated disposal site
  - Approximately 5 to 10 minutes for on-site test

Inform the participants that: Reject the sludge from industry or hospital

Slide 27

Connecting hose of truck to inlet pipe

- Once truck is parked, ensure the hose is clamped to the inlet pipe
- FSTP operator and truck driver should wear proper PPE

Slide 28

Examples of different inlet arrangements

Inlet Chamber at Small Scale FSTP

Pneumatic Value Arrangement at Mechanized FSTP

Photo on the left slide is from Butwal, which shows the innovative yet simple inlet arrangement, photo on the right show a bit complex inlet arrangement (from India)

Slide 29

After Emptying the Truck Load

- Operator should check for leakage or spill near the ramp
- If found, clean the ramp by flushing with water
- If major spill occurs, sprinkle lime or bleach on the spill and let it dry
- Once dried, the area needs to be swept and flushed with water before next load arrives at the FSTP

Take a response or two from participants before presenting the slide

Slide 30

Key points to remember

- Without a hose connection, spillage of FS around discharge point is likely
- Sampling and on-site check should be mandated
- As most FSTP are designed with biological treatment, thus chemical effluents should not be accepted
- Truck driver and operator must wear proper personal protective equipment (PPE)

Slide 31

Housekeeping at FSTP

Housekeeping can be defined as “a provision of Clean, comfortable and safe environment”,

Initiate engaging discussions with the participants on What is housekeeping?? Get some answers from the participants and click to show the definition. Also ask them what housekeeping works do they think could be required at FSTP? Collect their response in metacards and read few of them. This could be good starting point for this section.

Slide 32

Why Housekeeping at FSTP ??

- FSTP is high risk zone and highly prone to accidents.
- Unkept, messy and dirty FSTP can make the FSTP look neglected; these conditions may lead to incidents such as:
  - ➢Tripping over loose objects on floors
  - ➢Slipping on greasy, wet or dirty surfaces
  - ➢ Hurting yourself against projecting sharp tools
  - ➢Falling of poorly stacked items or misplaced materials

FSTP is high risk zone and highly prone to accidents. Thus, proper housekeeping activities at the FSTP is crucial to control or eliminate workplace hazards and ensure proper operation of the treatment plant.

Slide 33

Housekeeping at FSTP

- Good housekeeping makes good sense because it helps prevent fires and accidents
  - ➢Keeping the workplace neat, clean, and safe is everyone's responsibility;
  - ➢Keep alert to housekeeping hazards while you work;
  - ➢Eliminate or report any hazards you identify anywhere in the facility
- To avoid hazards, a schedule of housekeeping activities should be maintained which are to be taken out regularly (daily/weekly/monthly).
- It must be ensured that every worker follows this schedule and fulfill his duty along with cleaning his workspace before the end of his shift.

Slide 34

Daily Routine of housekeeping at FSTP

- Keeping the FSTP area including office area clean
- Maintaining sanitary condition (eg. Keeping the toilets clean, restocking the required supplies)
- Weed removal and trimming of plants
- **Infection control**
- **Maintaining tools and equipments**
- **Management of solid waste at FSTP**
- **Pest Control**

Inform the participants that we will discuss more on the highlighted points as they are important. The diagram to the right summarizes essential components that house-keeping refers to : Donning PPE, Be caution of fire and electric hazards, etc. (maintaining proper garden and landscaping)

Slide 35

Infection Control

FS, by its nature is infectious material. It often carries disease-causing bacteria, viruses or other pathogens.

Infection control procedures include:

- use of appropriate PPE to protect skin from contact with faecal material;
- washing hands prior to eating or after coming in contact with faecal material;
- no eating or drinking in areas where FS or chemicals are stored or processed;
- reporting illness to plant supervisors immediately;
- prohibition against smoking, an activity that can transmit pathogens via the fecal oral route of entry.

Slide 36

Proper Hand washing steps

Slide 37

Maintaining tools and equipment

Source: CDD society, Handbook on FSTP Operation and Maintenance (Internal Publication)

After every use

1. Clean tools and equipment after each use
2. Return and store the tolls and equipment at its designated place
3. Replace/repair the tolls which have loose handles, screw or detachable parts
4. Remove any residual grease or lubricant on the handles of tools used for electrical maintenance
5. Ensure the floor cleaning tools are dried before storing in the rack

Slide 38

Management of Solid Waste at FSTP

- Collect solid waste generated in a dustbin and dispose it regularly
- Ensure the collected solid waste are safely stored and out of reach from stray dogs and pests
- Use a proper waste collection bin with lid to prevent flies.
- Separate bin for disposed gloves, mask and wrapper sheets, napkins and sanitary waste removed from FS load received

Source: CDD society, Handbook on FSTP Operation and Maintenance (Internal Publication)

Maintainance: Daily or weekly as per the municipal arrangement

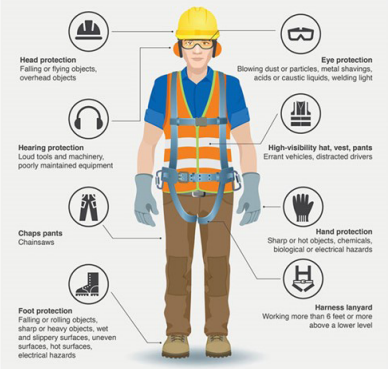
Slide 39

Pest Control

Exclusion	Reduction	Destruction
• Seal any gaps in the drain with covers • Seal gaps in the base of gate, door and windows • Ensure proper closing of access points	• Reduce food sources for pests • Store the dried/ treated sludge and compost in clean and dry place. • Store the gunny bags away from walls • Remove excess weeds around the site	• Use sticky papers/ boards, screens and electronic insects killers to trap insects • Use pesticides to kill pests • Alternatively, contact pest control agencies

Slide 40

Ensure Safety of Staff Performing Housekeeping Activities



- Wear proper protective gear while cleaning
- Keep the cleaning tools and detergents at a designated; clean and dry place
- Wash your hands thoroughly after any cleaning activity
- Update the daily, weekly and monthly logbook
- Follow the report structure for reporting
- Handle harmful chemicals carefully

Slide 41

Insurance of Human resources

- **Health insurance** covering for illness, injuries or hospitalizations. It also include routine checkups and vaccinations.
- **Accident and disability insurance** covering injuries or death during work.
- **Life insurance** compensating family members in case of fatal incidents on duty.
- **Personal protective equipment** coverage including insurance or fund for timely provision and renewal of safety gears.

Explain the above with significance.

Slide 42

Insurance of FSTPs

- **Asset insurance** covering physical infrastructures, mechanical and electrical equipment.
- **Machinery breakdown insurance** covering damages due to internal failures of mechanical/electrical equipment
- **Fire and natural disaster insurance**

Explain the above with significance.

Slide 43

Group work: Exercise

List 3 things that you learnt from this session. Why is it important? What will happen if its not taken into considerations?

Around 20 minutes

15 minutes for group work.
5 minutes presentation from each group

Slide 44

References

- USAID – DWSSM Faecal Sludge Management Training Package
- Faecal Sludge Management: System Approach for Implementation and Operation (Chapter 11: Operation, Maintenance and Monitoring of Faecal Sludge Treatment Plant) (https://www.researchgate.net/publication/264357136_Faecal_Sludge_Management_Systems_Approach_for_Implementation_and_Operation)
- Manual for Operation and Maintenance of Faecal Sludge Treatment Plants (https://cwas.org.in/resources/file_manager/O%26M%20manual%20for%20FSTP.pdf)

Slide 45

Thank you!
धन्यवाद !

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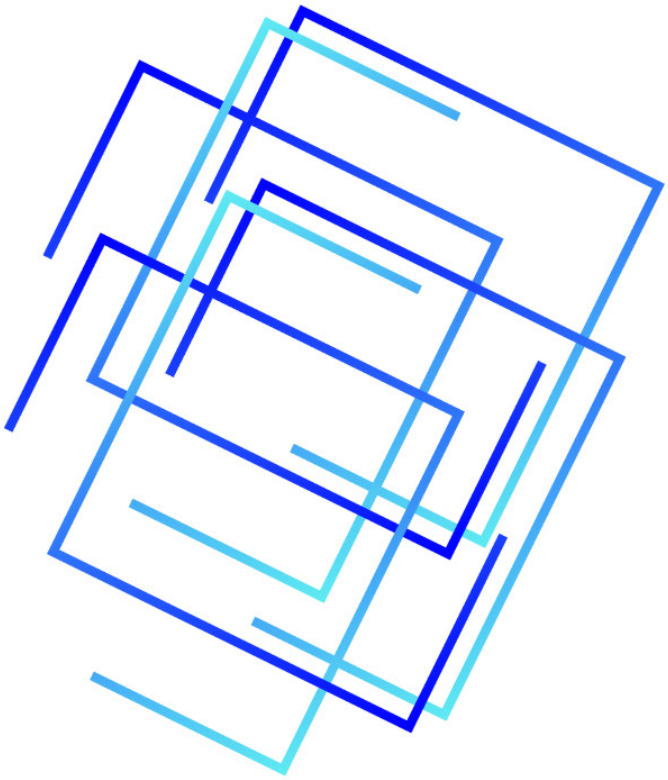


Lesson Plan 5: System Operation

Slide 1

Operation and Maintenance of FSTP

System Operation

Resource Person

Government of Nepal
Ministry of Water Supply
National Water Supply and Sanitation Research, Innovation and Capacity Development Center

Slide 2

Before Starting …

- https://www.youtube.com/watch?v=dHn24PBKCsQ

Tell the participants, we are going to see one video (only 5 minutes) before going ahead into the session also ask for apologies first, since the video is not in our language but in hindi.

Slide 3

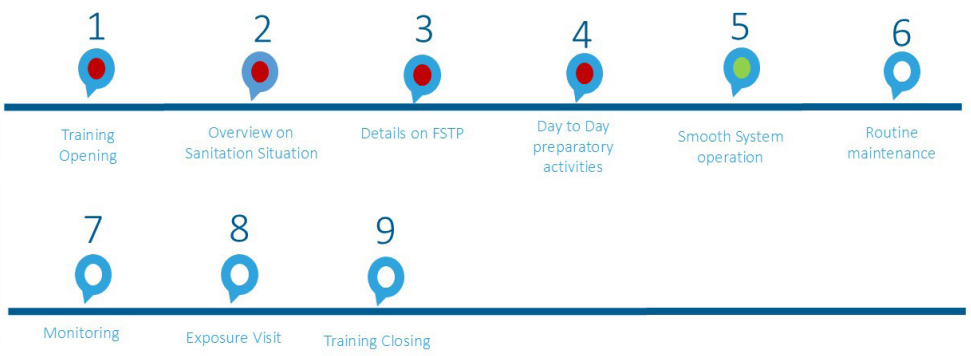
Learning Outcomes

- Explain how as an operator, ensure each of the units of FSTP operates smoothly
- List the things to consider while operating FSTP
- Explain challenges of FSTP operation and discuss possible solutions for the same

Explain that this session is the first session on O&M, where we enter into the world of operation and maintenance. Before this session it was just a background setting to bring all the participants into similar understanding level.

Slide 4

Training Structure



Slide 5

Presentation Outline

- Definition of Operation
- Step by step operation of components at FSTP
- Tools used in FSTP operations and maintenance
- Challenges in FSTP operations and maintenance

Slide 6

FSTP Operation in context of Nepal

- **Operation** refers to all the activities that are required to ensure that a FSTP delivers treatment services as designed.
- FSTPs constructed till date in Nepal, is with low maintenance and do not require high skill.

Simple training can develop operator's skill, ensuring smooth operation

Slide 7

Step by step operation at FSTP

Ask the participants what was the first step of the FSTP

Slide 8

OPERATIONS:

Preliminary Treatment

Slide 9

Before any operating procedures, operator should wear **complete PPE (gloves, boots, face mask and protective clothing)**

Slide 10

Screen Chamber

A voice or two

Ask: What should one check for in the screen chamber?
Collect a response or two and present.

Slide 11

Screen Chamber

While FS truck is unloading at receiving station, operator should check the screen chamber for:

- Solid waste clogging the pipe for screen
- Obstruction at the truck inlet
- Check that the screen is securely placed and not damaged.
- Confirm that downstream treatment units (e.g., grit chamber, settling tank) are functional.
- Allow faecal sludge to pass through the screen chamber.

Ask: what should be done while FS truck is unloading at receiving station? Or What should one check for in the screen chamber?
Collect a response or two and present.

Slide 12

OPERATIONS:

Solid Liquid Separation

Slide 13

Settling Tank

- Check for any kind of blockage or leakage in inlet and outlet pipes.
- Ensure that sludge stays for retention time of 2 to 3 hours.
- The thickened sludge and the liquid supernatant leaves the tank either through gravity by opening valve or by pump.
- Scum to be removed manually by shovel or using mechanical equipment.
- Start the inflow of faecal sludge at a controlled rate to prevent turbulence

Ensure both, the thicken sludge and the liquid supernatant leaves the tank as per the plan, through the system provided (either through gravity by opening valve or by pump).
Scum can be removed manually by shovel or mechanical equipment if the FSTP is large. It does not need to be removed daily, but only after substantial scum is deposited.

Slide 14

OPERATIONS:

Sludge Stabilization

In Nepal, anaerobic digestion through biogas digester has been used for sludge stabilization and we will be discussing only that unit.

Slide 15

Operation at Biogas Digester

Source: CDD Society

- Check that the digester structure is leak-proof and all valves are functional.
- Ensure the inlet, outlet and gas pipes are clear of blockage.
- Gradually introduce faecal sludge in small batches to prevent shock loading.
- Release the accumulated moisture through water trap operation
- Regularly check the T-Connection in the outlet for scum particles and remove scum during loading
- Check gas flow rate in the flow meter

Take responses from participants before presenting the points to make it participatory and also to validate their feelings/experiences.

Slide 16

OPERATIONS:

Solid Dewatering

In Nepal, anaerobic digestion through biogas digester has been used for sludge stabilization and we will be discussing only that unit.

Slide 17

Sludge Drying Beds

1. **Initial inspection before loading the beds**
   - The sand surface should be leveled
   - Clear all debris/waste/unwanted materials from the surface of bed
   - Make sure a splash pad/plate is in place where the sludge enters the bed

2. **Start flow of liquid sludge** into allocated bed. **A strainer should be used** at the outlet point of the pipe while emptying the liquid sludge from the truck on to the splash pad of the SDB to prevent the entry of solid waste on the drying beds.

3. **Stop flow** when the liquid is approximately **around 20cm** deep throughout the bed that is denoted by a red line marking.

Slide 18

Sludge Drying Beds

4. **Remove dried sludge from the bed when it is visibly dry**
   - moisture content less than 50%,
   - sand layer is visible through cracks and can be easily handled.
   - When sludge is dry (normally 8-12 days or more depending upon weather conditions and depth of sludge load applied)
   - remove the sludge using shovel or shovel and plastic/ metal bowls.
   - Make sure a splash pad/plate is in place where the sludge enters the bed

5. **After the sludge is removed,**
   - inspect the bed,
   - rake the surface of the sand to level it and
   - remove any solid waste/ unwanted materials and
   - add makeup sand to the required depth if necessary.

Slide 19

Examples

Levelled sand surface of SDB
Source: Ner, Amravati FSTP

Splash pad to avoid disturbance of filter media
Source: Maharashtra FSTP

Slide 20

Examples

Facilitating flow of sludge on to splash pad
Source: C-WAS

Sludge to be filled up till red marking
Source: C-WAS

Slide 21

Planted Drying Beds

Source: CDD Society

- Similar to that of unplanted drying beds
- Ensure the right bed is loaded (providing resting period of beds as per design)
- Ensure uniform loading of FS on the bed
- Check the distribution pipes in the PDB for any clogging or obstruction in flow

Repeat the process of collecting the points/ ideas from participants (2 to 3) and present the points.

Slide 22

Operation of Planted Drying Beds

Source: https://a.storyblok.com/f/191310/26b530a2e6/2-constructed-wetland-faecal-sludge-treatment-tech-in-practice-bangladesh.pdf

Slide 23

OPERATIONS:

Liquid treatment

Slide 24

Anaerobic Baffled Reactor / Anaerobic Filter

- **The flow from the SDB into the ABR is by gravity** (preferably). If not by gravity, the pump discharge should match the design discharge to avoid sludge washout.
- **An ABR requires a start-up period of several months** (generally 3 to 6 months) to reach full treatment capacity since the slow growing anaerobic biomass first needs to be established in the reactor.
- **Scum and sludge levels need to be monitored** with appropriate measuring device to ensure timely de-scumming and desludging of excess sludge.

Slide 25

Anaerobic Baffled Reactor and Anaerobic Filter

- Check for sludge level in all chambers
- If the level in first chamber of ABR is above 75% of the total depth:
  - ➢Prepare for desludging into the sludge drying beds (SDB)
  - ➢While desludging the chamber, mixing using a rod or stick might be required to ensure continuous flow to SDB
  - ➢Sludge height measurement on daily basis after each load is accepted
  - ➢Check for blockage between chambers and at the desludging valve

Slide 26

Examples

Checking sludge levels
Source: Angul FSTP O & M manual (CDD society)

Desludging first chamber of ABR unit
Source: C-WAS

Slide 27

OPERATIONS:

Treatment to allow safe end use/disposal

Slide 28

Planted Gravel Filter (Liquid Treatment)

- Flow of water from the ABR unit should be distributed equally in each PGF bed
- Flow from the PGF is to be monitored to keep the water in the PGF beds at an optimum level.
- The gravel or other material should be free of silt and clay (fines) that could clog the pores
- **Inspection** to be done on a weekly basis to check
  - ➢ the color of water at the inlet and outlet of PGF
  - ➢ there are no leakages from the piping arrangements or the PGF bed

Slide 29

Example

Slide 30

Co-composting

Operations

- The raw materials -dry leaf litters, treated FS and municipal organic waste (MOW) -were taken in 0.4:1:2 ratio respectively.
- The **most common composting is windrow composting**, The bulking materials are first placed on the platform, then the treated FS is laid onto the leaf litters and covered with MOW. The same sequence of layering is carried out until the windrow reaches 6 feet of height.
- The **first turning** is carried out after **15 days**. The retention period allows the microbes to stabilize.

Interval

- Post the 15 days, the pile is turned **once a week**. To ensure an optimum of 50-60% moisture in the bed, water is sprinkled onto the compost heap during turning. The final matured compost is then sieved and bagged.

Skill and intervention required

- Unskilled labor with proper training should be able to handle operations

Source: https://cddindia.org/wp-content/uploads/2017/10/Findings-from-Co-Composting-Operations-FSTP-Devanahalli.pdf

Show the compost sample to the participants to have some understanding on compost from FS

Slide 31

Examples

Windrows which have been turned manually (left) and mechanically windrow turning (right)

Source: https://sswm.info/sswm-university-course/module-6-disaster-situations-planning-and-preparedness/further-resources/%28co-%29-composting-%28large-scale%29

Slide 32

Other day to day operations

Inform the participants that all the pictures of tools are taken from net. Its adaptated from USAID and DWSSM's Faecal Sludge Management Training Modules

Slide 33

Sludge Storage Facility

What are some points that you consider?
2-3 responses

- Sludge removed from SDB will have **sand sticking** to it.
- Operator shall **place the sludge cake on plastics sheet**
- Allow it to dry for a day or two and **manually dust the sand** on the sheet. (This helps in reducing sand loss in the drying beds
- Finally**, put back** the sand on the bed and cake on the storage area.
- Ensure the crumbles of sludge cakes are not on the foot path or access roads. (As they become sticky once stamped by foot, they will attract flies.

Take responses from participants and present and discuss.

Slide 34

Storage and Packing of dried FS

Source: CDD society (Pictures from Devanahalli FSTP)

Slide 35

Sludge Storage Area

- Sludge storage area **depends on the quality of bio-solids** produced from the treatment facility.
- Materials should not be stored in manner that will result in **contamination of ground or surface waters**.
- Storage area should be constructed and sited **to prevent run-on and runoff of liquids.**
- Care should be taken **not to contaminate the solids** with oil, grease, gas, rocks and litter.
- The area needs to be **secure to prevent access by the public**, domestic animals or wildlife.

Slide 36

Stock Management

Stock List of Consumables

Stocks list	Daily Consumables	Replaceable items
☐ Daily Consumables	☐ Disposable gloves	☐ Bulb
☐ Replaceable Item	☐ Mask	☐ Trays
☐ Stationery and Office materials	☐ Tissues	☐ Tubes and hoses
☐ Tools and equipment	☐ Hand sanitizer	☐ Apron
	☐ disinfectant and soap	☐ Face shield
	☐ Towel	☐ Goggles
	☐ Bleach and chorine	☐ Other electrical fixtures
	☐ Sample bottles	☐ First Aid kit

Slide 37

Responsibility of FSTP operator in Stock Management

- FSTP operator should make **regular checks** on the essential consumables required for FSTP and office
- **Shall communicate the requirements** of stock inventory checklist to the plant/site in-charge
- Shall **communicate with plant manager or the plant engineer** by raising a formal request to spend from the O&M budget
- FSTP operator and site-in-charge should **also check and replace the consumables** that has expiry based on date of manufacturing

Take responses from participants on their take for the responsibility of FSTP operators.

Slide 38

Group Activity

3-5 groups
Discuss on the various tools used in FSTP and their purpose
5 minutes for group work
5 minutes for presentation and Discussion

In this activity, once the group has completed their work, ask one of the group to present, let the members of other group add any other points from their group which was not included during the discussion.

Slide 39

Tools for FSTP operation

Inform the participants that all the pictures of tools are taken from net. Its adaptated from USAID and DWSSM's Faecal Sludge Management Training Modules

Slide 40

Tools Required for FSTP Operation

Rake

Broom

Used for cleaning the bars of screen chambers and other areas of FSTP

Trowel for removing the trash from screens and bars

Used for collecting trash and water

Gums for working on SDB and while handling dried sludge

Shovels for moving and cleaning filter materials and removing dried sludge from the drying beds

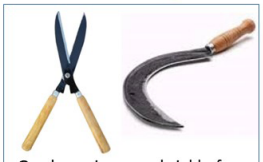
Wheel barrow for transferring dried sludge from drying beds to storage house

Plastic sheet used in the process of cleaning

Steel wire used for removing any obstruction in the pipe

Slide 41

Tools Required for FSTP Operation

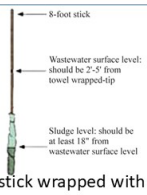


Garden scissor and sickle for timming, harvesting and removing weeds from drying beds, landscaping, etc.

Measuring tape for checking any levels

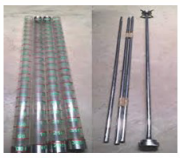
Long steel sieve for removing any obstructions in the pipe

Water pipe for flushing any area with pressurized water



Long stick wrapped with white cloth to check sludge level in septic tanks and other units

L – Brush for checking any blockages in pipes (vent pipes)



Glass tube samples for measuring sludge level and taking out samples

Sludge pumps used for desludging the bottom of treatment units

Slide 42

Tools Required for FSTP Operation

Set of screw driver for various purpose in the plant

Wheel chocks for stopping the vehicle from moving when parked

Fully stocked first aid kit should be available at any time

Ice box and sampling equipments like sampling bottles for collecting FS sample for laboratory tests

Personal protective equipments should be used during O&M activities

Slide 43

Group work

- List the challenges that they faced while operating FSTP
- 3-4 groups
- 5-7 minutes

If there are fresh operators without prior experiences, you may ask to think about the possible challenges that they might face while operating FSTP.

Slide 44

Challenges in FSTP operations

- Technological
- Institutional
- Unforeseen

Slide 45

Technical Challenges

- Over designing of the FSTP – due to which design flow to the FSTP is not achieved resulting in poor performance
- Limited timely technical back stopping
- Repair of mechanized parts often gets delayed as service needs to be hired for such repairs

Possible way-out/ solutions

After presenting/ summarizing all the technical challenges, make sure to discuss the possible way-out or solutions for such challenges in the large group by taking responses from participants.

Slide 46

Institutional Challenges

- Reduced plant utilization rate - lack of support from private operators in delivering FS on regular basis
- Insufficient human resource
- Unavailability of additional labour in timely manner for scheduled maintenance
- Limited fund flow for operation and maintenance of FSTP (Low-cost recovery)
- Delay in mobilizing funds from Municipality for retrofitting FSTP infrastructure (Incidental causes)

Possible way-out/ solutions

Slide 47

Unforeseen

- Climate hazards – related challenges; which comes abruptly.
- Untimely wearing out of equipments and supplies due to poor quality

Possible way-out/ solutions

Ask the participants for any other unforeseen that they have come across?? Engage in a bit of discussion along with how they overcame through such issues/ challenges

Slide 48

Video

- https://enpho.org/aiovg_videos/3d-visualization-of-faecal-sludge-treatment-plantfstp-as-per-dpr-of-lamahi-municipality/ (Lamahi)

Video on FSTP tour of Lamahi Municipality. Before we watch the video prepare participants on what to observe:

- to see how different components of FSTP functions.
- to observe how each component works (and as an operator your role as discussed in the session)

After the video go to the next section on the exercise, on next slide.

Slide 49

Group work: Exercise

5 groups

15 minutes

List of activities	Tools required	Safety measures

Group work: Divide the participants into 5 groups (1. Sludge Reception Area, 2. Settling Tank, 3. Sludge Stabilization, 4. Drying Bed, 5. Anaerobic Baffled Reactor)
Each group: (In tabular form)

- List of operations (need to be done by operator) in each unit
- Tools needed
- Safety measures required

15 minutes for group work.
5 minutes presentation from each group

Slide 50

References

- USAID – DWSSM Faecal Sludge Management Training Package
- Faecal Sludge Management: System Approach for Implementation and Operation (Chapter 11: Operation, Maintenance and Monitoring of Faecal Sludge Treatment Plant) (https://www.researchgate.net/publication/264357136_Faecal_Sludge_Management_Systems_Approach_for_Implementation_and_Operation)
- Manual for Operation and Maintenance of Faecal Sludge Treatment Plants (https://cwas.org.in/resources/file_manager/O%26M%20manual%20for%20FSTP.pdf)
- Sustainable Sanitation and Water Management Tookbox (https://sswm.info/sswm-university-course/module-6-disaster-situations-planning-and-preparedness/further-resources/%28co-%29-composting-%28large-scale%29)
- Video on O&M case study of Philippines (https://www.youtube.com/watch?v=vlPIyxFNP2M&t=53s)

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Thank you!
धन्यवाद !

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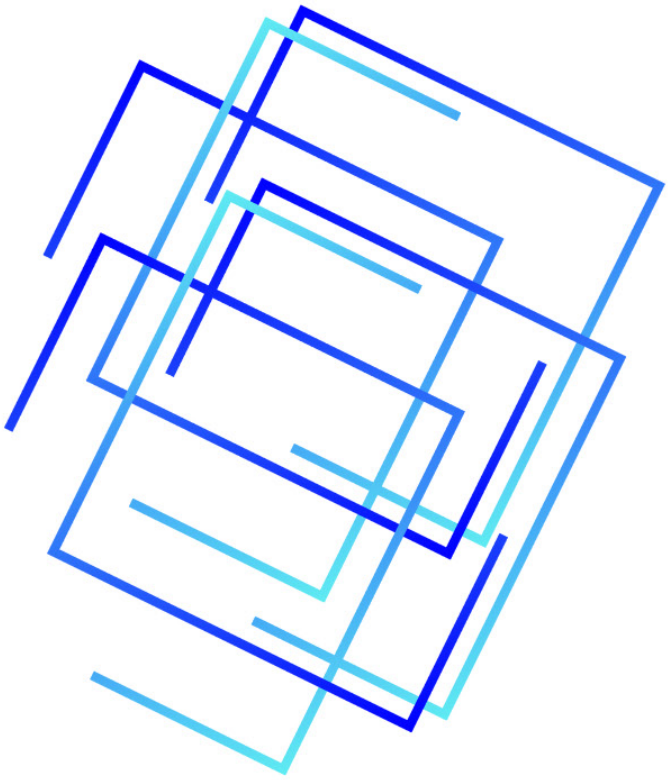
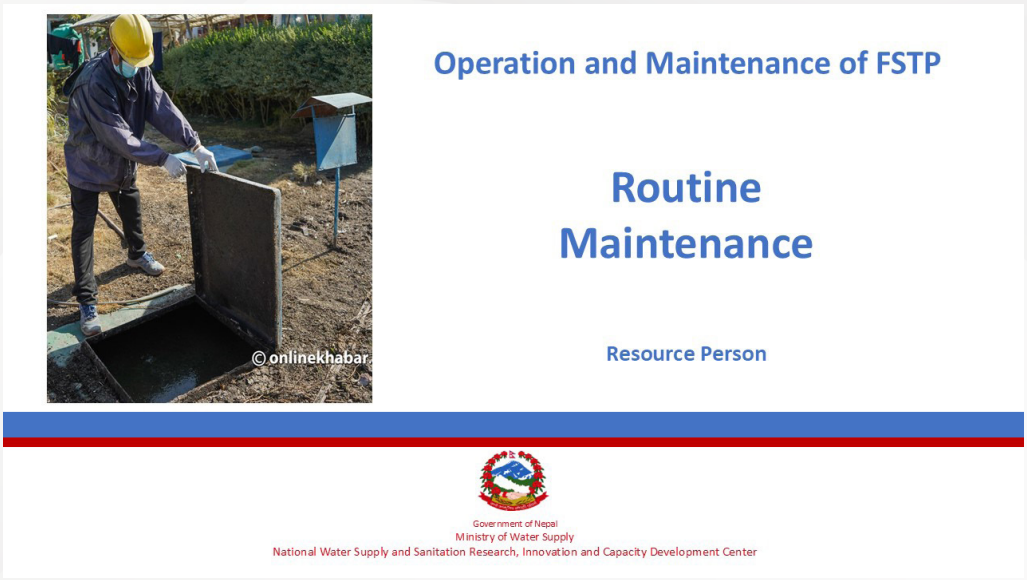
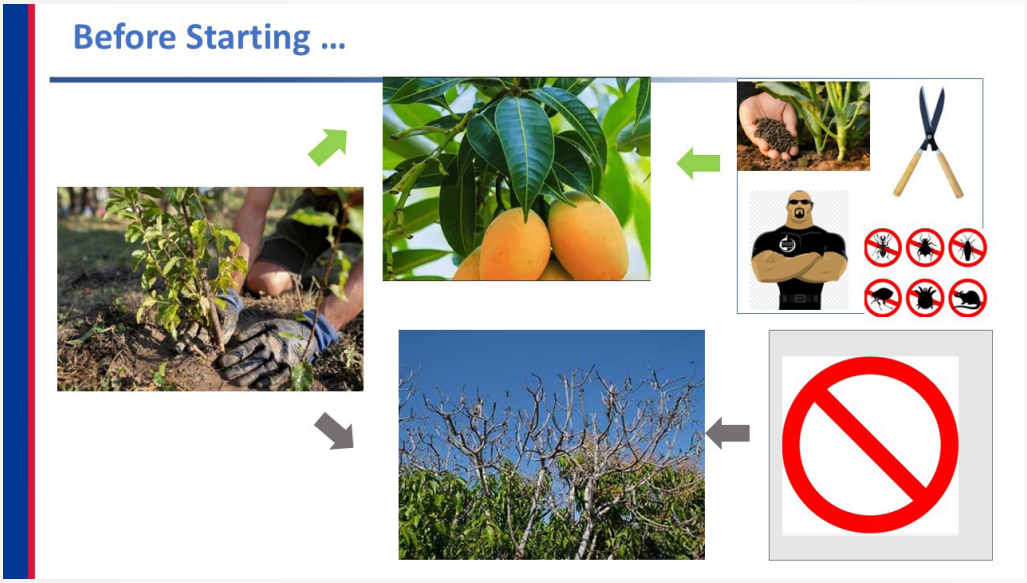


Lesson Plan 6.1: Routine Maintenance

Slide 1

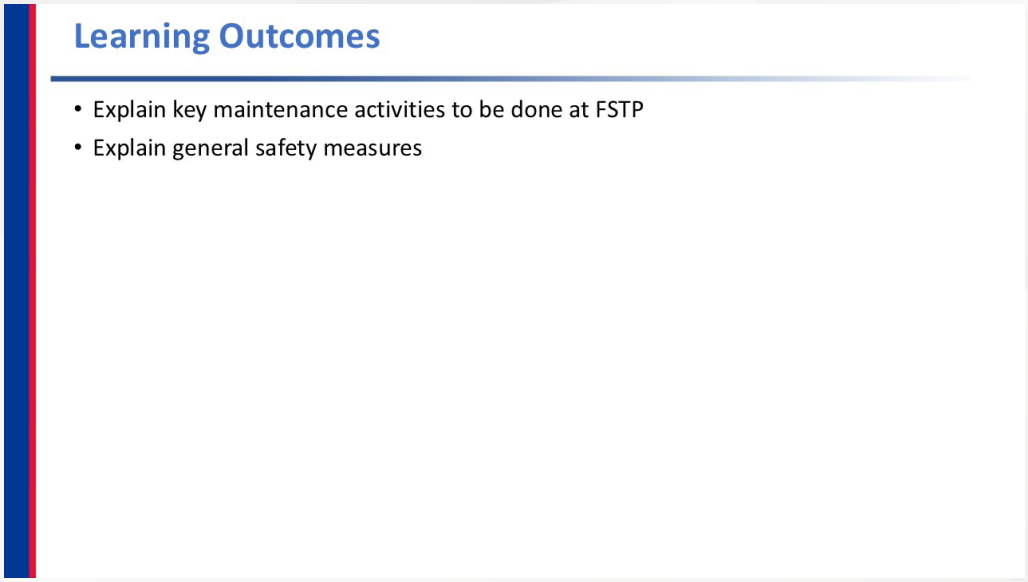


Slide 2



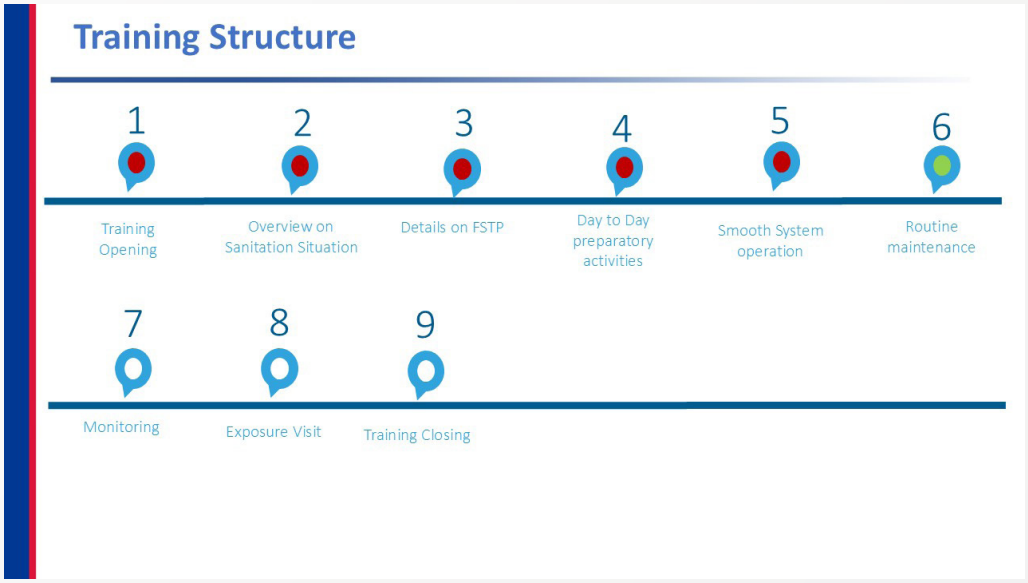
Let me tell you story of two sisters, both had a big gardens, and one day both went to market and got themselves a mango sapling each. Click to show them the photo of sapling being planted. They planted the same in their respective gardens. Years gone by, but wait lets see how their trees are now. Click and show them the photos of two trees; one bearing ripe, juicy with beautiful color Mango. But the other one is in the verge of death, barely any leaf let alone a fruit, dried branches, very very sick looking tree. Now ask them what went right and what went wrong here respectively. Try to connect with maintenance as much as possible. After getting some answers, click and show what all the maintenance activities went into the first one – Fertilizer, timely pruning, pests control and guarding against anyone picking mangoes. Click and show what went in the other one – absolutely nothing. It was neglected. Emphasize the importance of maintenance here. And share that in this session we will talk about maintenance activities required in FSTPs.

Slide 3



Explain that this session is the first session on O&M, where we enter into the world of operation and maintenance. Before this session it was just a background setting to bring all the participants into similar understanding level.

Slide 4



Slide 5

Presentation Outline

- FSTP Maintenance
- Equipment Repair and Maintenance
- Periodic FSTP maintenance
- Routine Inspection
- General Safety Measures

Slide 6

FSTP Maintenance

- The process of preserving a condition or the state of being preserved.
- The technical meaning of **maintenance** involves functional checks, servicing, repairing or replacing of necessary devices, equipment, machinery, building infrastructure, and supporting utilities in industrial, business, and residential installations
- Maintenance refers to all the activities that ensure long-term operation of equipment and infrastructure (Braustetter, 2007)

Add on further that as discussed in earlier session, the maintenance of the mobile will be Software updates, battery replacements, screen /screen cover repairs, cleaning the device and etc.

Slide 7

Types of Maintenance

Proactive Maintenance

- Also known as preventive maintenance
- Involves planned activities to prevent failures and prolong equipment life.
- Generally, more cost-effective and helps ensure consistent treatment performance.
- It includes:
  - Daily checks of pumps, valves and mechanical parts
  - Greasing and lubrication of mechanical components
  - Cleaning of screens and grit chambers
  - Regular testing of effluent quality

Slide 8

Types of Maintenance

Reactive Maintenance

- Also known as breakdown maintenance
- Carried out after the failure of the equipment.
- Unplanned and often more expensive due to downtime and emergency repairs.
- It includes:
  - Replacing a burned-out motor after pump failure
  - Fixing leaking pipe, broken valves
  - Emergency cleaning of a clogged screen or filter

Slide 9

It is to be noted..

- FSTPs in developing countries like Nepal is relatively small and the equipment used are simple nature-based system.
- Thus, maintenance is not so complicated and generally simple housekeeping works mostly take of the majority of maintenance works.

Slide 10

Equipment Repair and Maintenance

- Screens
- Gas flow meters
- Valves
- Electrical fixtures and lights
- Roof of sludge drying beds

- 5 groups
- A topic to each group
- Maintenance activities on each equipment
- 5 minutes

We will be discussing only key equipments commonly used in Nepal.

For the group work, as per participants comfortability on writing, you may either provide newsprint and markers to note or they can just discuss in their respective groups and present verbally.

Slide 11

Equipment Repair &Maintenance

Screen

- Should be scoured minimum once in a week
- Exposure of FS to mild steel would result in rusting, hence, use stainless steel
- Do not allow solids to overflow/escape from the screen
- Ensure no large gaps are formed due to corrosion of the screen
- Replace corroded/unserviceable screen immediately

Source: CDD Society

Ask group with same topic to present and summarize the points with slides

Slide 12

Equipment Repair & Maintenance

Source: CDD Society

Leakage Test in Gas Flow Meter

- Prepare a soap solution by mixing water and liquid soap (3:1) Or water and detergent powder (1 cup water: 1 teaspoon detergent powder)
- Keep supply of biogas ON by turning all the inlet and outlet valve to open condition in the biogas meter
- Apply soap/detergent solution on exposed pipes and pipe joints using a paint brush
- If bubbles are formed, get defective portion repaired by applying adhesive solution provided at site or replacement of faulty pipes.

Slide 13

Equipment Repair & Maintenance

Electrical fixtures and Lights

Source: CDD Society, Handbook on FSTP Operation and Maintenance (Internal Publication)

- Frequency of maintenance: once a month
- Check the electrical fixtures like switch and plug points for any loose connection
- Replace if malfunctioning fixtures are found
- Check the lights in the storeroom, office room, inside the plant access area
- Identify and replace the light bulbs with dim luminescence of flickering issues
- Also ensure that light bulbs and holders are cleaned

Slide 14

Equipment Repair & Maintenance

Valves used in FSTP

Location	Types of valve
Inlet of FS receiving point	Ball valve (PVC)
Outlet of Feeding tank – liquid stream	Ball valve (PVC)
Outlet of feeding tank – solids stream	Gate valve / plug valve (Cast iorn / galvanized iron)
Outlet of Anaerobic sludge stabilization reactor (ABR) (Gravity flow)	Butterfly valve (MS)
Inlet of sludge drying bed	Ball valve (PVC)
Inlet of planted sludge drying bed	Ball valve (PVC)

Slide 15

Equipment Repair & Maintenance

Valve trouble shooting

Types of valves	Issues	Maintenance
PVC – Ball Valves	Continuous exposure to sunlight make them brittle Could break due to brittle nature	• Check for blockage of flow • Check for leakage at closed position • Check for brittle handles • Check for resistance to movement of valve • Check for broken handles • Replace the valve with new one if any of the above issues were noticed
MS – Butterfly valves	Rusting and corrosion Frequent clogging and leakages	• Check for blockage of flow • Check for leakage at closed position • Check for rusted parts • Check for resistance to movement of valve • Check for poor closure of valve due to solids accumulation • If any of the issues were found, replace the valve of take preventive measures to control corrosion/rust

Slide 16

Equipment Repair & Maintenance

Valve trouble shooting

Types of valves	Issues	Maintenance
Gate / Plug valve (cast iron or galvanized iron	Worn out bush/water seal Rusting due to continuous exposure to moisture Leaky valve due to corrosion	• Check for blockage of flow • Check for obstruction preventing the full closure of valve • Check for leakage at closed position • Check for resistance to movement of valve handle • Check for leakages at the shaft • Check for torn casket between the flanges • If any of the above issues is noticed, dismantle the valve from the flanges ➢ Clear the blockages and remove silt accumulated inside the valve ➢ Replace the gasket, bush, worn-out water seal ➢ If issues still exist after maintenance. Replace with new valve

Slide 17

Equipment Repair & Maintenance

Roofs of Sludge Drying Beds

- Clean roof once a month to remove accumulated dust
- Check for loose joints, bolts, or purling holding the roofing sheets together
- Check for leaks through the joints while cleaning the roof by water sprinkling
- Use adhesive or sealant to close the gaps / leaks identified
- Close louvers during the off-sunshine hours to prevent humid air from entering
- If any punctures or holes are identified, replace the portion of the polycarbonate sheet
- Apply sealant periodically

Slide 18

Frequency of Equipment Maintenance Activities

Equipment	Issue	Maintenance activity	Frequency
Screens	Rusting and corrosion	Replacing screen	Once every two years
Gas Flow meter	Leakage	Testing and fixing leak	Weekly
Valve	Clogging and rusting	Clearing blockages, rust-proof painting, greasing	Quarterly / monthly / as required
Exhaust and ventilation	Dust accumulation and drop in efficiency	Clearing dust and greasing exhaust fan	Monthly
Sludge Drying Bed roof	Leaking and dust accumulation	Checking for leaks and applying sealant/replacing the patch	Monthly

Slide 19

TO BE CONTD in Session 6.2

Slide 20

Thank you!
धन्यवाद !

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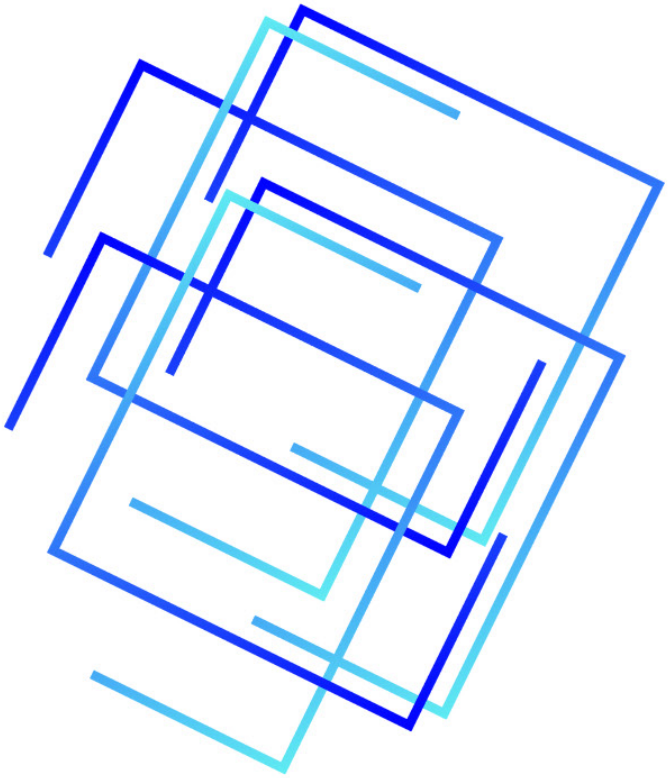


Lesson Plan 6.2: Routine Maintenance

Slide 1

Operation and Maintenance of FSTP

Routine Maintenance

Resource Person

Government of Nepal
Ministry of Water Supply
National Water Supply and Sanitation Research, Innovation and Capacity Development Center

Slide 2

Periodic Maintenance of FSTP

- Removal of scum
- Replacement of screen
- Cleaning of vent pipes
- Desludging of settler
- Desludging of ABR and AF
- Replacement of filter media (SDB and PDB)
- Cleaning of filter media (AF and PGF)
- Replacing broken pipes
- Fixing damaged structures
- Disposal of treated wastewater (liquid portion)

What are some of the activities for periodic maintenance of FSTPs

(Responses from participants)

Before presenting the information, take responses from participants and note it on white board or newsprint paper.

Slide 3

Periodic Maintenance of FSTP

Unplanted sludge Drying Bed

What	How	When	Equipment Needed
Harvesting of sludge	• Arrange for additional labor require for transferring sludge to storage house • Remove the sludge from the SDB by hands • Remove the sludge using a shovel (if a stable support like perforated tiles are used) • Sweep the floor to remove the residual sludge in the beds	15-20 days in hot climate; 25-30 days in cold climate)	PPE, shovel
Replacement of filter media	• Take out all the dried sludge, if any remaining, from the beds • Remove sand layer from the bed using shovels • Transport and safely dispose off removed sand • Replace filter media using sand free from silt and clay; if these are present • Once sand is free from silt and clay, place sand on drying beds to 150 mm thickness	Once every 5 years	Shovel, plastic sheet, brush, gum boots

Slide 4

Harvesting of sludge in SDB

Ready to harvest:

Harvesting of sludge

Conditions for sludge harvesting

•Visual observation on dryness of the sludge
•Depth of crack and shrinkage in sludge cake
•Check by picking sludge cake at multiple points of the bed

Slide 5

Unplanted Sludge Drying Bed

Replacement of media and installation of perforated bricks

Source: CDD Society

Slide 6

Periodic Maintenance of FSTP

Planted sludge Drying Bed

What	How	When	Equipment Needed
Harvesting of plants	• Plants should be periodically harvested to maintain proper treatment efficiency; it should be done based on the height of plant growth • Plants root should not be damaged • Harvest the plant close to the surface of the filter media	Once in 4 – 6 months	Sickle, gum boots
Harvesting of sludge	• Dried sludge shall be removed only after underlying sand layer is visible through cracks • Emptying shall be avoided during the monsoon season • Depending on the accessibility – one can choose between manual or mechanical emptying • Re-plantation of plant species and refilling sand media lost shall be done after emptying	Only after the resting period (3-6 months)	PPE, gumboots, gloves, mask

Emptying of shall be avoided during the monsoon season as it will be difficult to reduce the moisture and achieved desired dryness

Depending on the accessibility – one can choose between manual or mechanical emptying of dried and stabilized sludge

Re-plantation of plant species and refilling sand media lost shall be done after emptying

Slide 7

Periodic Maintenance of FSTP

Planted sludge Drying Bed

What	How	When	Equipment Needed
Replacement of filter media	The process is similar to unplanted sludge drying beds • Take out all the dried sludge, • Remove sand layer from the bed using shovels • Transport and safely dispose off removed sand • Replace filter media using sand free from silt and clay • Once sand is free from silt and clay, place sand on drying beds to 150 mm thickness	Once every 5 years	Shovel, plastic sheet, brush, gum boots, (Appropriate vehicle or equipment as per requirement)

Appropriate vehicle or equipment as per requirement: Example some huge beds require JCB

Slide 8

Harvesting of sludge in Planted Sludge Drying Beds

Slide 9

Periodic Maintenance of FSTP

Anaerobic Baffled Reactor, Anaerobic Filter

What	How	When	Equipment Needed
Removal of Scum	• Check the cover slab • Check for the presence of scum and solids inside the chambers • Use the fishnet mesh and remove the scum and collect it in a plastic tray • Transfer the collected scum in the plastic bin • Place the cover slab back over the manhole	Once a week	Fishnet sieve/mesh, plastic bowl, plastic bin
Desludging of chamber 1 and 2	• Check level of sludge in both chambers of the tank • Connect flexible pipe to delivery portion of the submersible sludge pump • Switch on the pump and keep open the valve of the SDB • Wait until flow stops (float provided for auto shutoff of pump) • If desludged by truck: After the truck is full, discharge the sludge on the SDB • Close the valve and remove the flexible pipe from the SDB	Once a year	Gum boots, flexible pipe, gloves and mask, submersible pump

Slide 10

Periodic Maintenance of FSTP

Anaerobic Filter

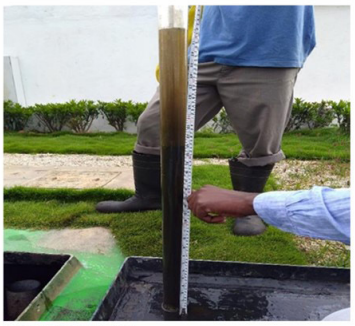
What	How	When	Equipment Needed
Cleaning of Filter Media (All the chambers of anaerobic filter	• Open the manhole covers • Use a pump, force water above the filter materials through jetting action • Use sludge pump to dewater the filter chamber through the desludging pipe • If the quality of water is still poor, take the media and wash it again on a plastic sheet • Repeat the steps 3 or 4 times till you pump out clear water • Place the maintenance cover back over the manhole	Once every 5 years	Desludging pump, L-shovel, straight shovel, trowel, hose pipe, pressure washer, PPE

Slide 11

Periodic Maintenance of FSTP

Desludging of Anaerobic filter module

Measuring sludge height in AF



Source: CDD Society

Desludging of AF chamber

Slide 12

Periodic Maintenance of FSTP

Cleaning of filter media in Anaerobic Filter

Washing of Filter Media

Source: CDD Society

Reloaded Filter Media After Cleaning

Slide 13

Periodic Maintenance of FSTP

Planted Gravel Filter /Constructed Wetland

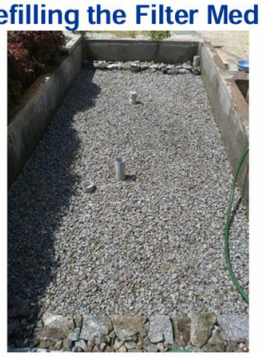
What	How	When	Equipment Needed
Cleaning of filter media	• Harvest the crops in the planted gravel filter • Remove the dried leaves on the filter media • Excavate the gravel media from the PGF using shovel and place it on plastic sheet • Once the gravel media is emptied, clean the sediments using a pump of desludging truck • Wash filter media 2-3 times repeatedly until the clear water is observed • Fill the media back into PGF and plant new plants	Once every 5 years	Desludging pump, L-shovel, straight shovel, trowel, PPE, hose pipe, pressure washer

Slide 14

Periodic Maintenance of FSTP

Maintenance of Planted Gravel Filter

Refilling the Filter Media



Source: CDD Society

Replanting the Plants

Slide 15

Periodic Maintenance of FSTP

Polishing pond

What	How	When	Equipment Needed
Maintenance of polishing pond	• Empty treated water present in polishing pond • Use brush to clean interior walls and floor • Remove all weeding and litter manually	Once a month or whenever needed	Rake, trowel, shovel, bucket

Slide 16

Periodic Maintenance of FSTP

Cleaning of vent pipes (All the units/modules with vent pipes)

What	How	When	Equipment Needed
Cleaning of vent 	• Remove the cap of the vent pipe • Use torch light to see the inside of the vent pipe • If any obstruction are found, use the L-brush to clear it • If the pipe is damaged / broken from anywhere inform to replace it	Once a week	Mask, L-brush, torch, gloves

Slide 17

Periodic Maintenance of FSTP

General : Replacing of broken pipes, Fixing of damaged structures

What	How	When	Equipment Needed
Replacing broken pipes (All units)	• Check for any damaged / broken pipes • If there are any pipes broken, notify the supervisor or whoever in charge • Replace the damaged pipe with a new pipe of the same diameter and specification • Follow the drawing in fixing important pipes	Once a month	wrench
Fixing damaged structures (All units)	• Check for any damaged structures • If there are any structures damaged, notify supervisor or whoever is the in-charge • Repair the damaged structure with necessary civil work. Replace if needed • Ensure that modules/units, working platforms and ramp near receiving station free of cracks or weak structure.	Once a month	wrench

- Check for any damaged / broken pipes (can be visually identified with any leakages or smell)
- If there are any pipes broken, notify the supervisor or whoever in charge
- Replace the damaged pipe with a new pipe of the same diameter and specification
- Follow the drawing in fixing important pipes
-
- Check for any damaged structures (can be visually identified with any leakages of smell)
- If there are any structures damaged, notify supervisor or whoever is the in-charge
- Repair the damaged structure with necessary civil work. Replace if needed
- Ensure that modules/units, working platforms and ramp near receiving station free

Slide 18

Routine Inspection

- Routine inspection of equipment and periodic calibration and adjustments are required to avoid breakdown of equipment
- A good routine inspection program will help in:
  - ➢Better scheduling and utilization of personnel
  - ➢Reduced overtime for emergency repairs
  - ➢Better coordination between departments, especially if equipment is shared
  - ➢Improved knowledge and understanding of equipment
  - ➢Better organization of equipment maintenance procedures
  - ➢Efficient use of lubricants
  - ➢Efficient purchase of spare parts
  - ➢Better organization of maintenance department operations

Slide 19

General Safety Measures

Following general safety measures shall always be followed at the FSTP: -

1. No person shall make any direct skin contact with the Faecal sludge. In case of direct contact immediately wash the portion with soap, dry with clean cloth.
2. The entire staff that is involved shall wear rubber hand gloves up to elbow, gum boots and cover their face with a mask and safety glasses.
3. The premises shall have mandatory signs indicating “No Smoking” and “No Alcohol” area.
4. Staff can have their food within the premises, however before taking the meal they are required to clean their hands and face with soap.
5. As there is no hazardous waste coming to the premises safety equipment other than Gloves, gum boot, mask and safety glasses will not be required.
6. A first aid kit shall be kept available for the emergency situations.

Slide 20

Exercise

- **Group work:**

Divide the participants into 5 groups (1. Sludge Reception Area, 2. Settling Tank, 3. Anaerobic Digestion/Biogas, 4. Drying Bed, 5. Anaerobic Baffled Reactor)

- Each group: (In tabular form)
  - List of maintenance activities that is done in each unit
  - Frequency of conducting those activities
  - Tools needed
  - Safety measures they needed
- 30 minutes for group work.
- 5 minutes presentation from each group

Slide 21

References

- USAID – DWSSM Faecal Sludge Management Training Package
- Faecal Sludge Management: System Approach for Implementation and Operation (Chapter 11: Operation, Maintenance and Monitoring of Faecal Sludge Treatment Plant) (https://www.researchgate.net/publication/264357136_Faecal_Sludge_Management_Systems_Approach_for_Implementation_and_Operation)

Slide 22

Thank you!
धन्यवाद !

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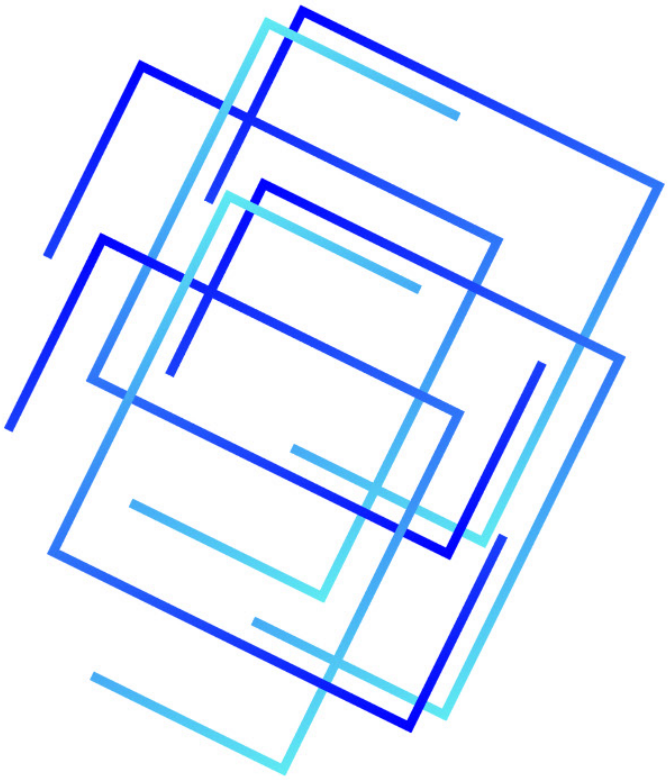


Lesson Plan 7: Monitoring

Slide 1

Operation and Maintenance of FSTP

Monitoring

Resource Person

Government of Nepal
Ministry of Water Supply
National Water Supply and Sanitation Research, Innovation and Capacity Development Center

Slide 2

Before Starting …

What are the things to monitor for long term functionality and sustainability of FSTP?

To introduce the session, ask the participants " What are the things to monitor for long term functionality and sustainability of the FSTP?". Distribute the metacards and get responses from the participants. Read out few of the cards and stick all of them on the flipchart and display them where they can be seen.
Inform them, that we will further learn on monitoring of FSTP in this session.
Allocate around 5 minutes for this Introduction activity.

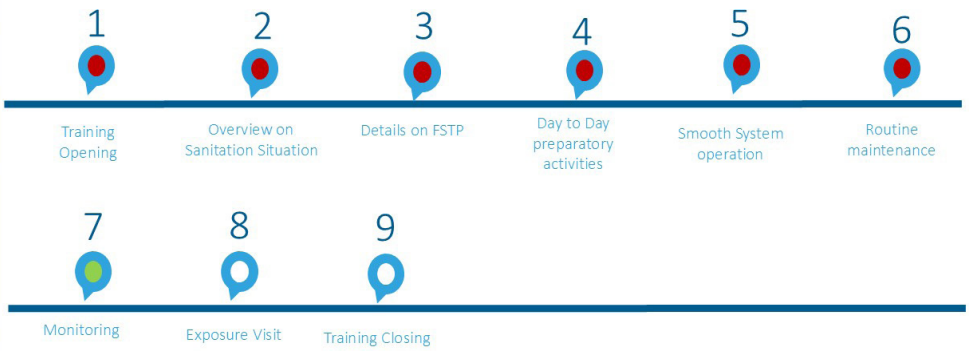
Slide 3

Learning Outcomes

- Understand what and how to monitor for sustainable O&M of FSTP, **as an FSTP operator**

Slide 4

Training Structure



Slide 5

Presentation Outline

- Background on monitoring
- Record keeping (as foundation of monitoring)
- Process monitoring
  - ➢FSTP Unit wise/Module wise monitoring
- Performance monitoring
  - ➢Sample testing

Slide 6

Monitoring

Observe and check the progress or quality of (something) over a period of time; keep under systematic review.

Our goal: Monitoring of O&M activities of FSTPs

Why?

Because we want to ensure O&M to be continued for the long run and ensures smooth operation of FSTP.

Slide 7

Monitoring

- Proper monitoring should provide :
  - Information to the operator about the operational changes to be taken
  - To help taking the right operational decisions
  - To improve the operational efficiency of the FSTP
  - Control the effluent quality to meet discharge standards

Slide 8

What do we want to monitor?

Process

Process monitoring is the activity of continuously assessing if a system is operating under normal conditions and to rapidly detect any deviation from this state as soon as it takes place

Performance

Performance monitoring is a set of processes and tools to be able to determine how well the system is functioning

As an operator of the FSTP, What do we want to monitor? Get their answers and click to show what are we going to discuss on this session: Process monitoring and Performance monitoring. These two type of monitoring will can indicate whether FSTP's O&M is going in right direction

Slide 9

Aligning with the regulation for monitoring KPIs

Aligning the Operation and Maintenance (O&M) of a Faecal Sludge Treatment Plant (FSTP) with the regulations for monitoring Key Performance Indicators (KPIs) ensures **efficiency, compliance, safety, and sustainability.**

Slide 10

Step-by-step approach to align O&M with regulatory KPI monitoring:

Step 1: Understand the regulatory framework

- **Review national/local regulations**: Identify the existing sanitation, FSM, environmental, and public health regulations that govern FSTP operation.
- **Identify mandated KPIs**: These may include parameters like:
  - Influent/effluent quality (e.g., BOD, COD, TSS)
  - Sludge treatment capacity
  - Health and safety compliance
  - Reuse efficiency (e.g., compost or biogas output)
  - Downtime or breakdown frequency
  - Cost-efficiency per unit sludge treated

Slide 11

Step-by-step approach to align O&M with regulatory KPI monitoring:

Step 2: Integrate KPIs into O&M Plan

- **Develop a KPI-anchored O&M Plan:**
  - Include clear indicators for daily, weekly, and monthly operation.
  - Embed standard procedures that directly influence measurable indicators (e.g., desludging schedule, drying bed turnaround).
- **Assign Responsibilities:**
  - Link each KPI to responsible personnel such as plant operator, lab technician, supervisor
- **Routine Monitoring Procedures:**
  - Ensure scheduled sampling, laboratory testing, visual inspections, and logbook entries

Slide 12

Step-by-step approach to align O&M with regulatory KPI monitoring:

Step 3: Install Monitoring Systems

- **Instrumentation:**
  - use flow meters, pH meters, and temperature sensors to get real-time data.
- **Data Management:**
  - Set up a digital log system (can be Excel-based or app-based) for KPI tracking.
- **Lab Facilities**:
  - Ensure the plant has in-house or access to a certified lab for periodic water quality testing

Slide 13

Step-by-step approach to align O&M with regulatory KPI monitoring:

Step 4: Reporting and Review Mechanism

- **Monthly/Quarterly Reporting:**
  - Share KPI reports with municipal authorities or regulators.
  - Compare against benchmarks set by national standards or SDG targets.
- **Audits and Reviews:**
  - Conduct internal audits aligned with regulatory inspections.
  - Use audit findings to update SOPs and preventive maintenance schedules

Slide 14

Step-by-step approach to align O&M with regulatory KPI monitoring:

Step 5: Training and Capacity Building

- **Train O&M staff on:**
  - National KPI requirements.
  - Sampling, monitoring, and reporting procedures.
  - Troubleshooting linked to poor KPI performance (e.g., if TSS is above limit, review drying bed practices).

Slide 15

Step-by-step approach to align O&M with regulatory KPI monitoring:

Step 6: Continuous Improvement Cycle

- **Feedback Loop:**
  - Use performance trends to optimize O&M schedules.
- **Predictive Maintenance:**
  - Based on monitoring trends, shift from reactive to proactive maintenance
- **Technology Upgrades:**
  - Adopt innovations (like automation) to improve performance on key indicators

Before presenting the table, take ideas from participants and note it on newsprint paper or white board

Slide 16

Foundation of Process Monitoring

Recordkeeping

record keeping which is key foundation of process monitoring. Here, explain that the proper record keeping is the first step of monitoring and this will systematize the monitoring activity

Slide 17

Record Keeping

- To ensure effective operation and maintenance (O&M) of faecal sludge treatment plants (FSTPs), it is essential to maintain precise records of all O&M activities, monitoring processes, and any identified malfunctions.
- Some **examples of recordkeeping** that are useful for FSTPs include:
  - information on the operation of the FSTP including daily operating records, the operator's logbook, manifest reports, the treatment unit operating data sheet, and other records related to FS deliveries to the plant;
  - disaster response and emergency recovery records;
  - preventative and corrective maintenance records including the equipment maintenance logbooks and storeroom supply reports;
  - compliance reports including field and analytical data, and correspondence from regulatory officials; and
  - employee records, such as employee schedules, time sheets and injury reports.

Manifest report's example is given later on slide 20
The formats will be discussed during the session on monitoring.

Slide 18

Operator's logbook

- Provides a means of communication between operators of the plant and a written record of important events.
- It includes the name of people of duty, weather conditions, any equipment malfunctions, operating problems, important phone messages, security information, etc.

Slide 19

Manifest Form

Manifest Form

Sludge / septage origin

Name (Household unit owner)

Address

Date and time of collection

Source and volume of sludge/septage

Source	Check one	Volume (cubic metre)
Residential		
Commercial / industrial		
Institutional		
Wastewater treatment plant		

Commercial / industrial waste must be sampled and tested before it is offloaded at the treatment facility to ensure that the material will not contaminate the treatment process. Contamination can be caused by grease, oil, metals and chemicals.

Description of commercial / industrial waste:

Excavator / transporter

Operator / company	
Address	
Type of vehicle	
Plate number	
Name of driver	
Signature	
Driver's license number	
Name of other personnel	

Approved by authorised representative

(Name and signature)

Figure 11.3 Manifest form identifying the origin of the load, waste volume and driver's name adapted from the Philippines Department of Health (2007).

Slide 20

Faecal Sludge load Database Sheet

Sr. No.	Date	Origin of septage load	Desludger	Vehicle no.	Driver's name	Vehicle's arrival time	Volume of load in litres	Driver's Signature
1	1/2/20	Household from Saheed Nagar (Prop no ABC011234)	XYZ desludgers (private)				2,000	
2	2/2/20	Hotel from Vani Vihar (Prop no ABC025678) - trip 1	XYZ desludgers (private)				5,000	
3	2/2/20	Hotel from Vani Vihar (Prop no ABC025678) - trip 2	XYZ desludgers (private)				3,000	
4	3/2/20	Government institution	Municipality				3,500	
5	3/2/20	Community toilet	Municipality				5,000	

Slide 21

Treatment unit operation sheets

Treatment unit operation sheets are used to record:

- the quantity of FS loaded into each treatment unit,
- operational activities performed (e.g. load of FS of extraction of end products),
- the operational variable applied (e.g. mixing ratio of fresh to stabilized sludge, addition of lime) (if any)
- the quantity of end products and wastes extracted,
- the consumables required.
- numbers of employees required, and the relevant skills needed
- any difficulties encountered and solution undertaken

Slide 22

Daily O&M checklist for treatment modules

Date: Name of operator/s:				
Description of activity	**Time**	**Done/Not done**	**Remarks**	**Sign**
Apply sludge from vacuum emptying truck to the screening chamber				
Cleaning of the screens for free flow of septage				
Drying collected solids from screening chamber				
Disposing dried waste at nearby Solid waste Management facility				
Filling SDB with septage by directing the flow on to splash pad				
Removing dried sludge from SDB/s				
Levelling the filter media after removal of dried sludge from SDB/s				
Pumping treated wastewater from PGF to storage tank				
Disinfection using Chlorine dosing unit				

Before presenting the table, take ideas from participants and note it on newsprint paper or white board

Slide 23

Weekly O&M checklist for treatment modules

Date: Name of operator/s:					
Weekly activities					
Description of activity	**Date of performing the activity**				**Sign**
Remove any weed growth or unwanted plants on regular basis from SDB					
Monitoring and maintaining the drainage system and inspection chambers for SDB					
Monitoring scum and sludge levels of ABR unit					
Pruning plants from PGF					
Weeding out unwanted weeds and removing dried leaves from PGF					
Collecting samples from each module for quality testing					

Repeat the process of before presenting the table, take ideas from participants and note it on newsprint paper or white board

Slide 24

Yearly O&M checklist for treatment modules

Date: Name of operator/s:					
Yearly and need based activities					
Description of activity	**Date of performing the activity**				**Sign**
Replenishing filter media from SDB					
Removing excess scum and sludge from ABR and emptying it on the SDBs					
Replenishing filter media from PGF					
Replacing plants that have died in the PGF unit					
Annual painting works for weather proofing					
Structural repairs					
Maintenance of plumbing systems					

Take ideas from participants!

Again, before presenting the table, take ideas from participants and note it on newsprint paper or white board

Explain that these are just the examples and can be adapted as per the need and context of the FSTP

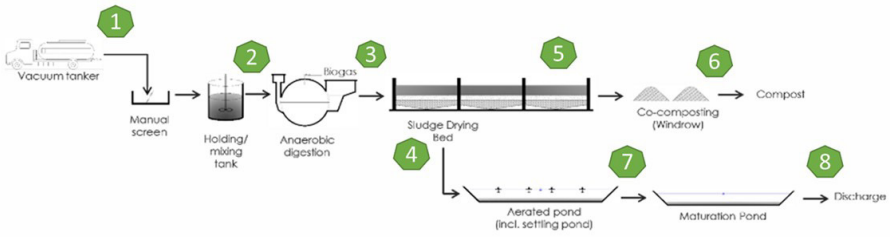
Slide 25

Performance Monitoring

- Sample testing is good and the feasible way to test the performance of each unit and overall system
- Robust O&M incorporates timely performance monitoring via lab testing of samples from specific sites of FSTP
- It is recommended to do lab testing at least once a year or at the time when system is not functioning to its optimum
- The responsibility of operator is to **support in** planning and timely performance monitoring
- Some of the big FSTP may also house small lab in their premises but most of the time they need to send the samples to the standard lab.

Slide 26

Sampling Points at FSTP

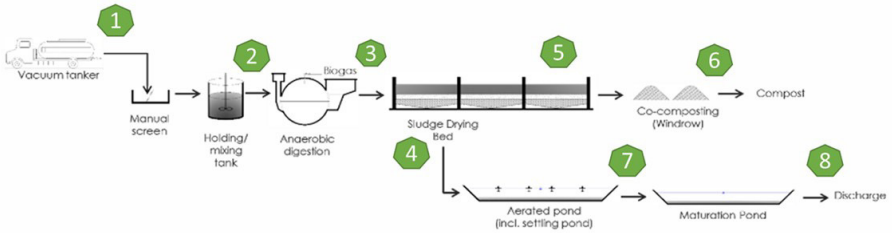


Proper sampling should be ensure with the support of lab personnel. These samples will be sent to lab for the further assessment.

Ask participants where should the sampling starts from? Or what would be the first sampling point?
Collect responses and reveal point one.
Similarly, repeat the process for 4 to 5 times.

Slide 27

Sampling Points at FSTP



Proper sampling should be ensure with the support of lab personnel. These samples will be sent to lab for the further assessment.

Ask participants where should the sampling starts from? Or what would be the first sampling point?
Collect responses and reveal point one.
Similarly, repeat the process for 4 to 5 times.

Slide 28

Parameters to be tested

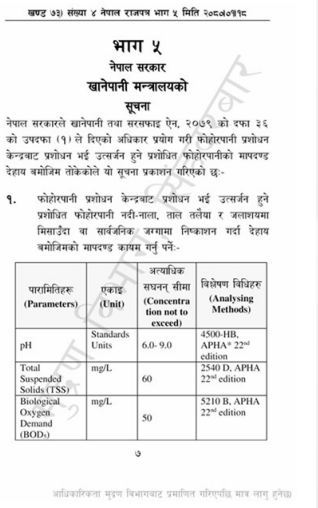
On-site measurement	pH	
	Conductivity	
	Turbidity	
	Dissolved oxygen	
	Temperature	
	Total Dissolved Solids	
Analysis in lab	Measuring with Spectroquant	Others
	COD	BOD
	Phosphate	TS/ VS/ FS/ TSS
	Ammonium	Settleable solids
	Nitrate	Bio Methane Potential
	Nitrite	Alkalinity
Analysis in lab	E.Coli and Helminths Eggs	

Source: CDD Society

Slide 29

Nepal's Wastewater Discharge Standards

Parameters	Unit	Concentration not to exceed
pH	Standards Units	6.0 – 9.0
Total Suspended Solids (TSS)	mg/L	60
Biological Oxygen Demand (BOD_5)	mg/L	50
Chemical Oxygen Demand (COD)	mg/L	Monitor and report only
E.Coli	CFU/100 mL	1000



खण्ड ७३ संख्या ४ नेपाल राजपत्र भाग ५ मिति २०८४०१।१८

भाग ५

नेपाल सरकार

खानेपानी मन्त्रालयको

सूचना

नेपाल सरकारले खानेपानी तथा सरसफाइ ऐन, २०७९ को दफा ३६ को उपदफा (१) ले दिएको अधिकार प्रयोग गरी फोहोरपानी प्रशोधन केन्द्रबाट प्रशोधन भई उत्सर्जन हुने प्रशोधित फोहोरपानीको मापदण्ड देहाय बमोजिम तोकेकोले यो सूचना प्रकाशन गरिएको छः-

१. फोहोरपानी प्रशोधन केन्द्रबाट प्रशोधन भई उत्सर्जन हुने प्रशोधित फोहोरपानी नदी-नाला, ताल तलैया र जलाशयमा मिसाउँदा वा सार्वजनिक जग्गामा निष्काशन गर्दा देहाय बमोजिमको मापदण्ड कायम गर्नु पर्नेः-

पारामितिहरु (Parameters)	एकाइ (Unit)	अत्याधिक सघनत् सीमा (Concentration not to exceed)	विश्लेषण विधिहरु (Analysing Methods)
pH	Standards Units	6.0- 9.0	4500-HB, APHA 22nd edition
Total Suspended Solids (TSS)	mg/L	60	2540 D, APHA 22nd edition
Biological Oxygen Demand (BOD_5)	mg/L	50	5210 B, APHA 22nd edition

७

आधिकारिकता मुद्रण विभागबाट प्रमाणित गरिएपछि मात्र लागु हुनेछ।

Slide 30

Lab test result record example

Date	Time	Sampling location	Temp°C	pH	BOD (mg/L)	COD (mg/L)	TSS (mg/L)	Total phosphate (mg/L)	TKN (mg/L)	Total coliform (MPN/100m	Faecal coliform
		Effluent standard for FSTP (CPCB)									
		Influent of SDB									
		Effluent of SDB									
		Effluent of ABR									
		Effluent of PGF									

Slide 31

Lab test result of different FSTPs (as per survey conducted by ENPHO)

Kakarbhitta FSTP

Effluent Test Result (From Outlet)		
Parameters	National Standard (Source: GoN)	Result
pH	6 to 9	8.5
BOD (mg/l)	50	40
COD (mg/l)	250	291
TSS (mg/l)	60	33

Tikapur FSTP

Effluent Test Result (From Outlet)		
Parameters	National Standard (Source: GoN)	Result
pH	6 to 9	8.01
BOD (mg/l)	50	36
COD (mg/l)	250	187
TSS (mg/l)	60	126

Lubhu FSTP

Effluent Test Result (From Outlet)		
Parameters	National Standard (Source: GoN)	Result
pH	6 to 9	8.21
BOD (mg/l)	50	27
COD (mg/l)	250	214
TSS (mg/l)	60	136

Slide 32

Expected Outcome of M&E

- Result and analysis of data from sampling
- Recommendations for improved operations and maintenance
- Recommendations for the reuse for biosolids and treated waste
- Recommendations for the technology adaptations in other plants

Slide 33

Group Exercise

How will you establish monitoring system in your respective FSTP??

5 groups

15 minutes

For any FSTPs (in general/ their respective FSTPs)

- Plan how will you establish monitoring system (use appropriate formats/checklist as shown in the session)
- 15 minutes for Group work and allocate 5 minutes for presentation by each of the group

Slide 34

References

- USAID – DWSSM Faecal Sludge Management Training Package
- Manual for Operation and Maintenance of Faecal Sludge Treatment Plants (https://cwas.org.in/resources/file_manager/O%26M%20manual%20for%20FSTP.pdf)
- Faecal Sludge Management: System Approach for Implementation and Operation (Chapter 11: Operation, Maintenance and Monitoring of Faecal Sludge Treatment Plant) (https://www.researchgate.net/publication/264357136_Faecal_Sludge_Management_Systems_Approach_for_Implementation_and_Operation
- Further reading: Faecal sludge sample collection and handling (https://www.eawag.ch/fileadmin/Domain1/Abteilungen/sandec/publikationen/EWM/FS_Methods_Book/Ch03_FS_Sample_Collection_And_Handling.pdf)

For any FSTPs (in general/ their respective FSTPs)

Plan how will you establish monitoring system (use appropriate formats/checklist as shown in the session)
15 minutes for Group work and allocate 5 minutes for presentation by each of the group

Slide 35

Thank you!

धन्यवाद !

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Lesson Plan 8: Training Closing

Slide 1

Operation and Maintenance of FSTP

Monitoring

Resource Person

Government of Nepal
Ministry of Water Supply
National Water Supply and Sanitation Research, Innovation and Capacity Development Center

Slide 2

Learning Outcomes

- Evaluate whether learning expectation were met
- Complete post test and final evaluation

Slide 3

Training Structure

1 Training Opening
2 Overview on Sanitation Situation
3 Details on FSTP
4 Day to Day preparatory activities
5 Smooth System operation
6 Routine maintenance
7 Monitoring
8 Exposure Visit
9 Training Closing

Slide 4

Learning Expectations

- Revisit learning expectation collected in the opening session

Bring the learning expectation in front of participant

Slide 5

Post-test

5-10 minutes

Bring the learning expectation in front of participant

Slide 6

Training Evaluation

- Training evaluation form
- 2 voices from the participant

5-10 minutes

Slide 7

Certificate Distribution

- Congratulation for the completion of the event
- Best wishes for future endeavor with the knowledge

Slide 8

Group Photo

- Closing Remarks
- Group photo
- End the training

Slide 9

Thank you!
धन्यवाद !

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