# Onsite Training Programme on
# “Planning and Designing of Faecal Sludge Management Systems”
## (September 16-18, 2025)

**PROMOTING SUSTAINABLE FSM IN SOUTH AFRICA**

A PARTNERSHIP PROGRAMME ON SANITATION AND WASTEWATER MANAGEMENT

**September 13-25, 2025. South Africa**

TRAININGS • FIELD ASSESSMENTS • MEETINGS • ACTION PLANNING

Participation only by invitation | For more info visit: www.cseindia.org

## Session Title: Understanding Different types of Sanitation Systems


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water & sanitation
Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

WATER RESEARCH COMMISSION

JG AFRIKA
EXPERIENCE QUALITY INTEGRITY

# PRESENTATION STRUCTURE

- To understand the scenario of sanitation systems
  - What are the types of sanitation systems?
  - What technology does what?
  - What are the ways to access sanitation facilities in India and SA?
  - What comes out of what?
  - What's there in India and what's in SA
- What better can SA do in their context?

# SANITATION SYSTEM

Multi-step process in which **human excreta** and **wastewater** are managed from the point of generation to the point of reuse or safe disposal **with minimal human intervention.**

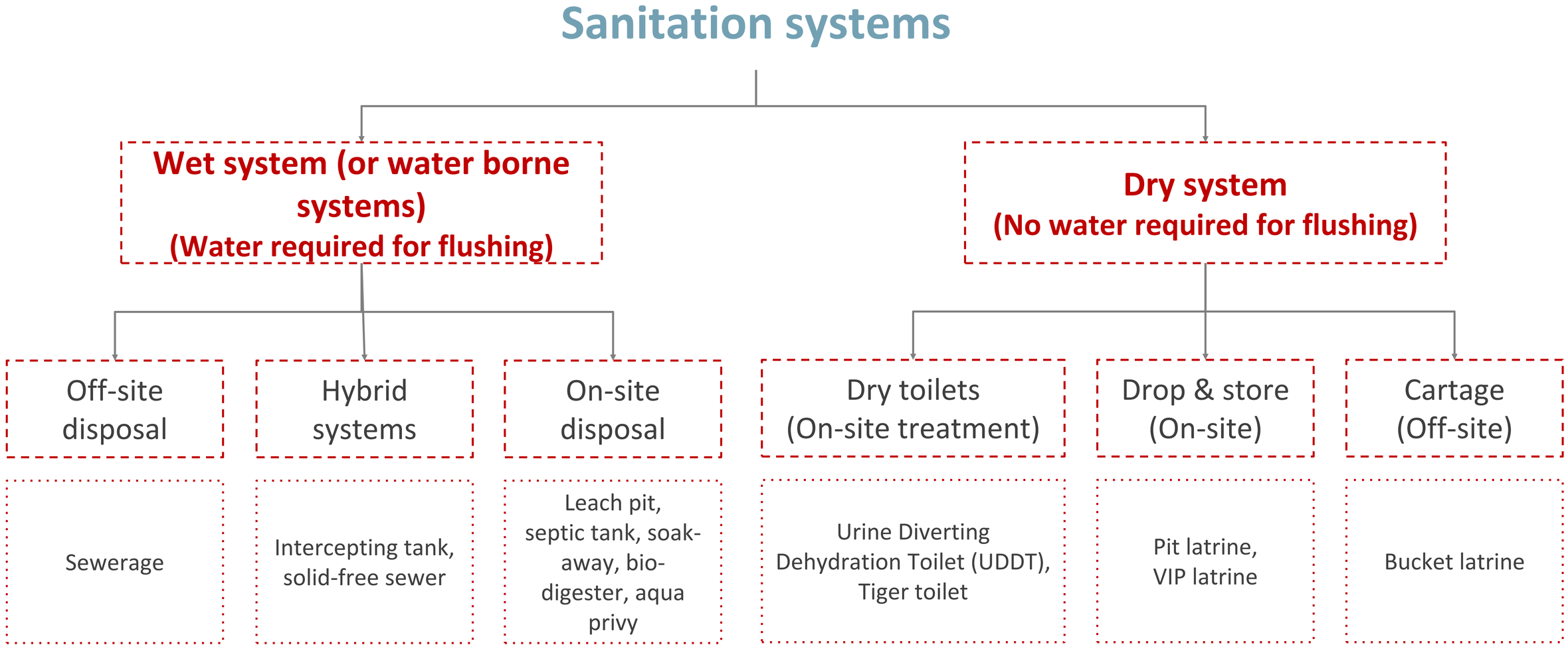
**Front End: User Interface**


**Back End: Offsite system (collection, conveyance and treatment); On-site collection, Transportation and Treatment (onsite or off-site) and Reuse / Disposal**

## Objectives

- Protect and promote health
- Protect the environment
- Be simple in technology
- Be affordable
- Be culturally acceptable
- Work for everyone

# TYPES OF SANITATION SYSTEMS



# TYPES OF SANITATION SYSTEMS

## South African OSS

1. Flush (Pour/Cistern/Low) toilet or Commode toilet with septic tank
2. Flush (Pour/Cistern/Low) toilet or Commode toilet with conservancy tank
3. Flush (Pour/Cistern/Low) toilet / Commode toilet with single or twin leach pit
4. Ventilated Improved Pits (VIPs)
5. Ventilated Improved Double pits
6. Pit Latrines
7. Pit latrines with Dual offsite
8. Urine Diversion Dry toilets
9. Urine Diversion Flush Toilet
10. Portable flush toilet / Chemical toilet / Container-based toilet (Loowatt, etc.)
11. Enviroloo
12. Bucket latrine

**30% of SA population uses OSS**

(source:Stats SA, 2023).

## Indian OSS

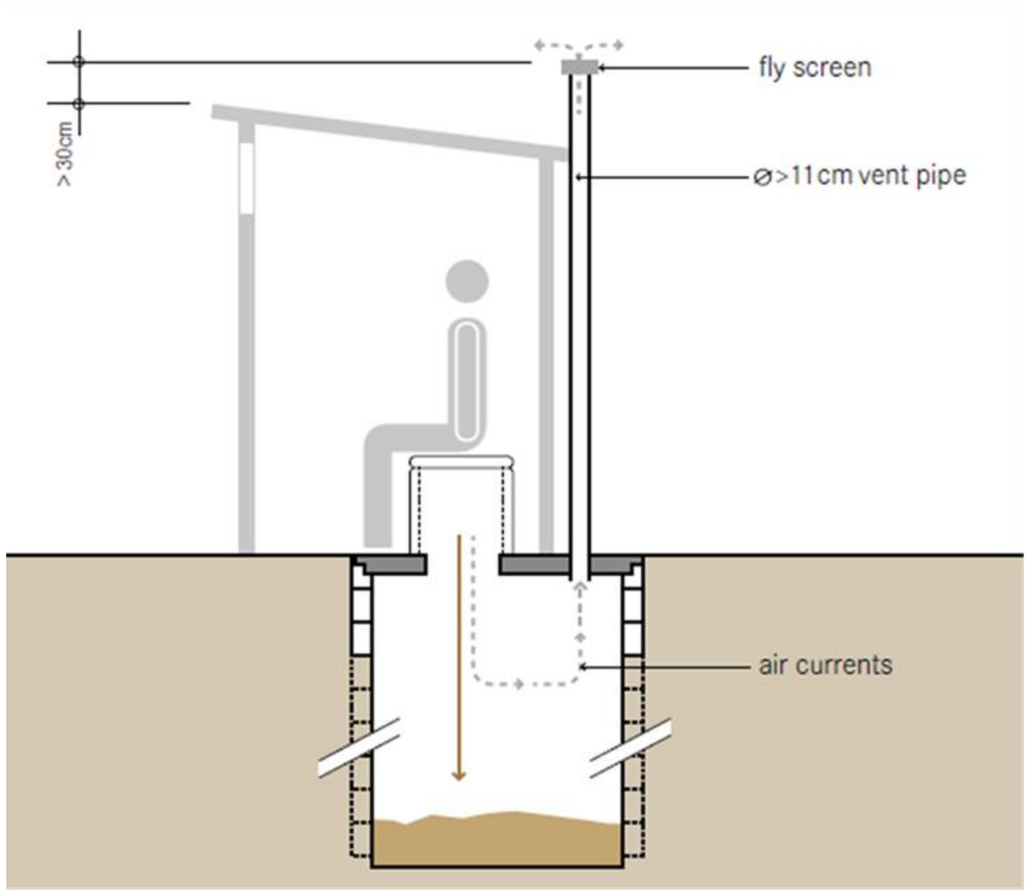
1. Flush (Pour/Cistern) toilet or Commode toilet with septic tank connected to Open drains/sewers/soak-away pit/open ground
2. Fully lined tanks (no baffled walls) connected to Open drains/sewers/soak-away pit/open ground
3. Flush (Pour/Cistern/Low) toilet / Commode toilet with single or twin leach pit
4. Semi-lined pit trines
5. Urine Diversion Dehydration toilets
6. Bio-digesters
7. Biogas

**60% of Indian population uses OSS**

(Source:SBM, 2024).

# DRY SANITATION SYSTEM

## PIT LATRINE




Source: Tilley et. al; (2014)

## BUCKET LATRINE

Source: Cambridge Bay Weather

# CONTAINER BASED TOILETS

- Collect human excreta in sealable, removable containers (also called cartridges)
- Feces can be contained, carried, transported and emptied into treatment facilities without exposing humans to pathogens.
- Container-based sanitation can be scaled up to provide more low-income urban populations with safe sanitation

# URINE DIVERSION DEHYDRATION TOILET

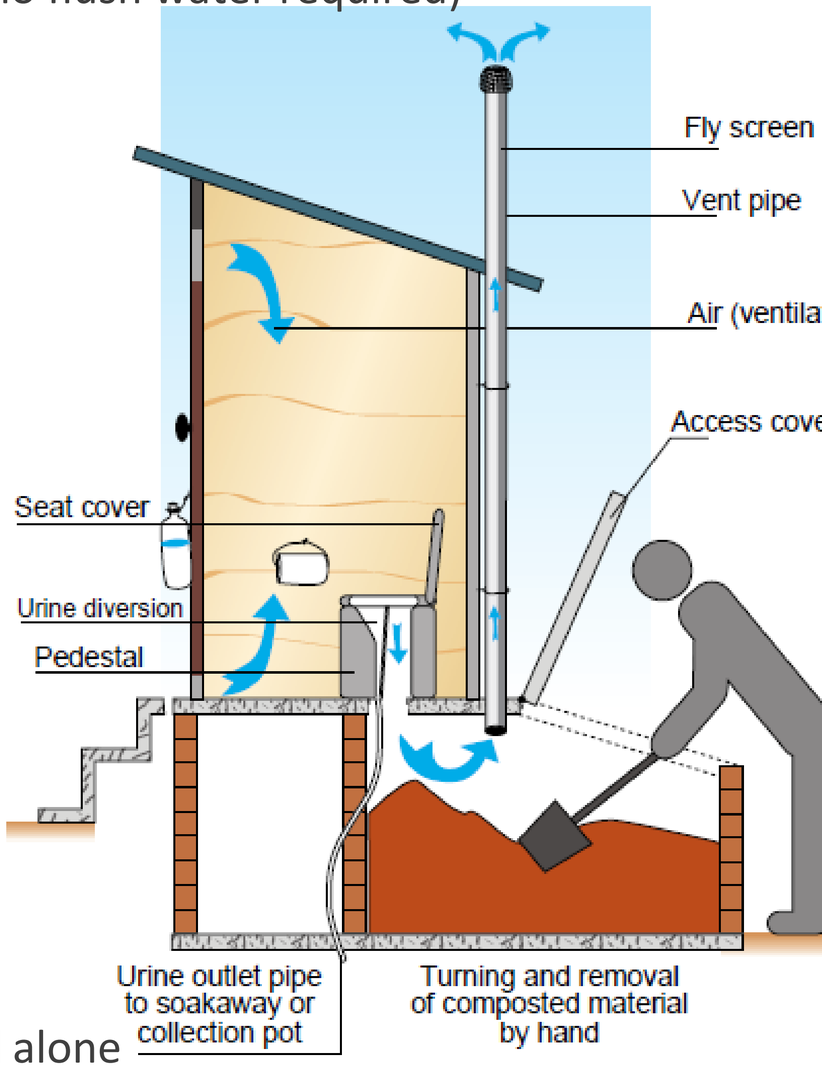
- **Segregates waste** – faeces, urine and anal cleansing water at source (no flush water required)
- **Can be used in onsite, hybrid and offsite sanitation systems**
- Recovers undiluted urine, which is a nutrient concentrate
- Can be constructed with locally available material such as bricks, mortar etc.
- Relatively high capital cost

Source: Waffler (2010)

UDDT
Squatting Three Hole Pan

UDDT
Western Two Hole Pan

Source: Waffler (2010)




- Some –contained dry toilets, sometimes referred to as mobile or stand alone units

Source:- susana/sani-tech-options-2010

# WET SANITATION SYSTEM

**Wet System**
(Flush or pour flush - requires water for flushing)

Hybrid systems
(Solids held on site, used water off site)

Septic tanks

**SEWERED SANITATION**

Off site disposal

Sewerage

Waste water Treatment

**NON SEWERED SANITATION**

On site disposal

Septic tank, Soak pits, Soak away, twin leach pit

FS treatment

Sullage

FS

Sludge from decentralized treatment plants

# TECHNICAL OPTIONS CONTAINMENT AND EMPTYING

## USER INTERFACE

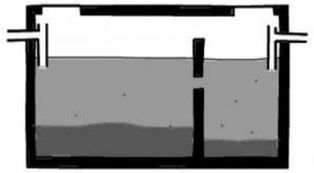
Pour flush toilet

Cistern flush toilet

Low flush toilet

Vacuum toilet

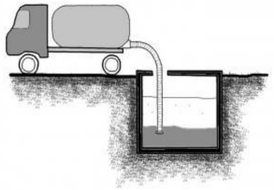
## CONTAINMENT



Septic tank*

Twin pit for flush toilet

## EMPTYING



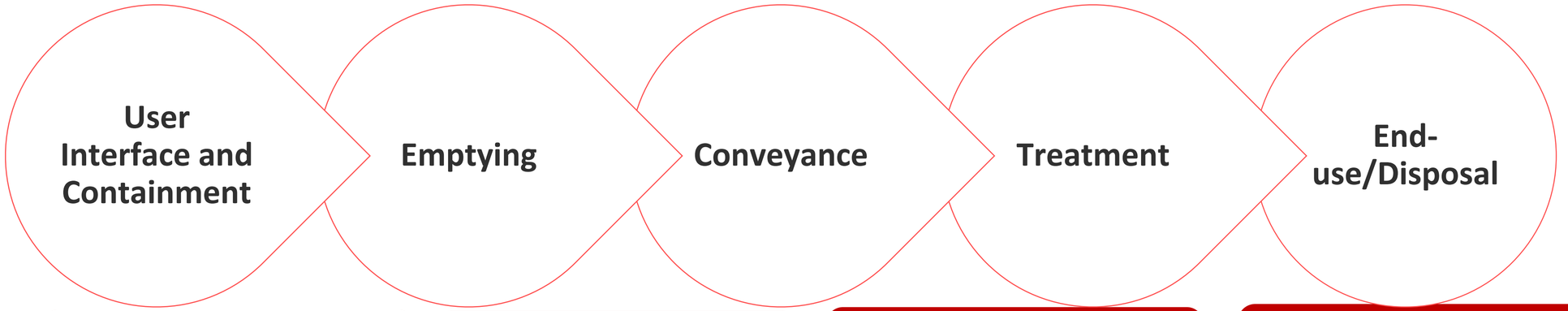
Motorised emptying & transport

Human powered emptying & transport

* Variations are possible based on design, type of wall and bottom

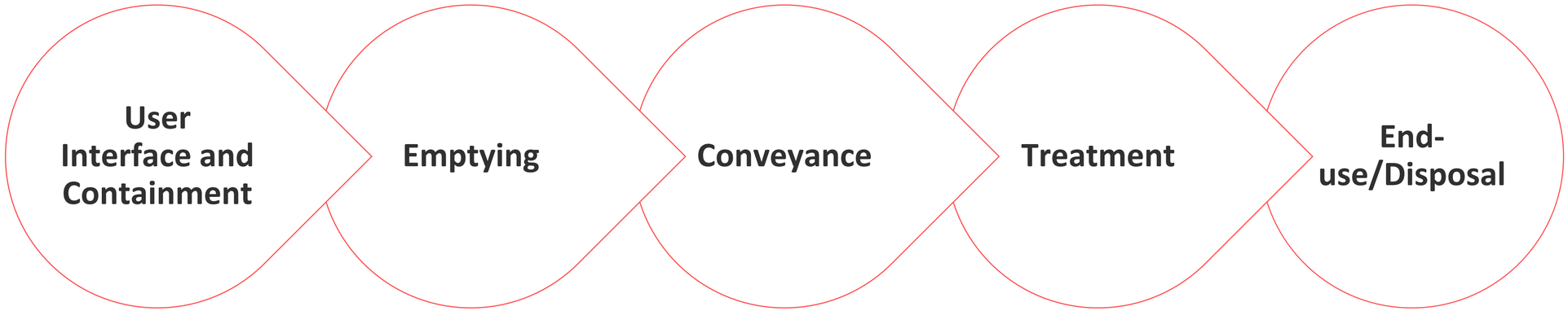
Source: Sustainable Sanitation and Water Management Toolbox

# SEWERED SANITATION




| Flush Toilet | Piped sewerage network | Sewage treatment works | End-use/ Disposal |
|---|---|---|---|
| -Domestic<br>-Commercial<br>-Institutional<br>-Public<br>-Shared/community<br>-Toilet with septic tank<br>-Household connection to sewer | *Conventional sewers<br>-Gravity or pumped<br>-Separate or combined<br><br>*Shallow, simplified or condominial sewers<br><br>*Solid free sewers (Small bore) | -Centralized treatment<br>-Decentralized treatment- multiple plants medium, small<br><br>-Central or decentralized treatment | -Direct discharge<br><br>-Reuse in agriculture, fuels or animal feed |

# NON-SEWERED SANITATION




**Non-sewered or non-networked:** On site sanitation and Fecal Sludge Management

| Toilet and Onsite Containment | Motorized emptying and Conveyance | Treatment | Enduse/ Disposal |
|---|---|---|---|
| • Twin Pit System<br>• Septic Tanks<br>• Other Onsite Containment System | • Vacuum Trucks/Tractor Trailers,<br>• Vacutug,<br>• Motorized Emptying Equipments | • FSTPs<br>• Co treatment in STPs<br>• Deep Row Entrenchment | |

Understanding Different Sanitation Systems

# TYPES OF ACCESS TO TOILET IN INDIA

Individual toilet

- Toilets used by households at their home

- On premise toilet

Community toilet

- Toilets used by residents / community that do not have toilet at their home

- Located near a community / slum area

Public toilet

- Toilets used by floating population

- Located in market area, bus stop , commercial area

# TYPES OF ACCESS TO TOILET IN SOUTH AFRICA

## INDIVIDUAL TOILES

- Is there a concept of Community or public toilets in **South Africa? Any criteria?**

**CRITERIA IN INDIA**

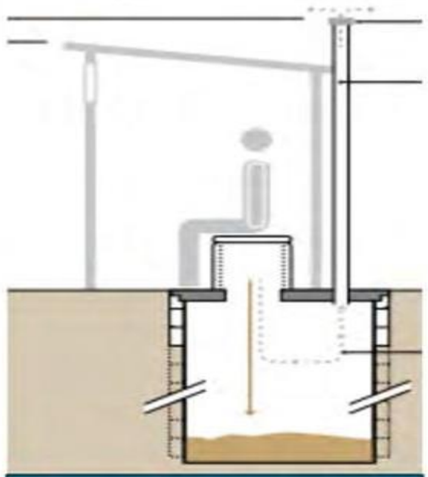
- Do we need public toilets is SA?
- Criteria for PT:

1. It should be accessible at commercial area with in 1km
2. Generally serves floating population public places like markets, bus/railway stations or tourists spots

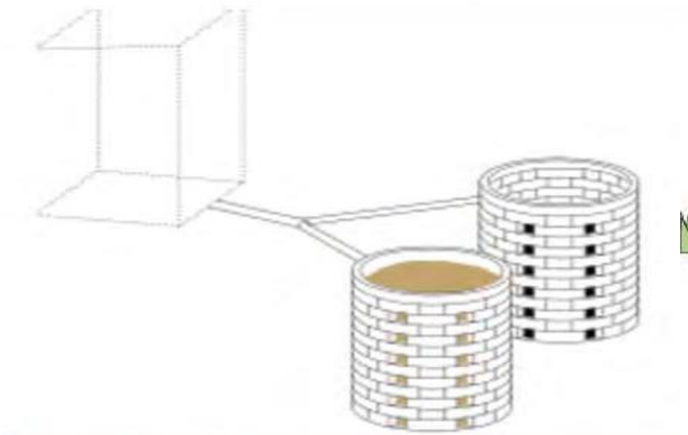
- Do we need Community based toilets
- Criteria for CT?

1. typically 1 seat per 25 women and 1 seat per 35 men.
2. Must be located in 500 meters of the community

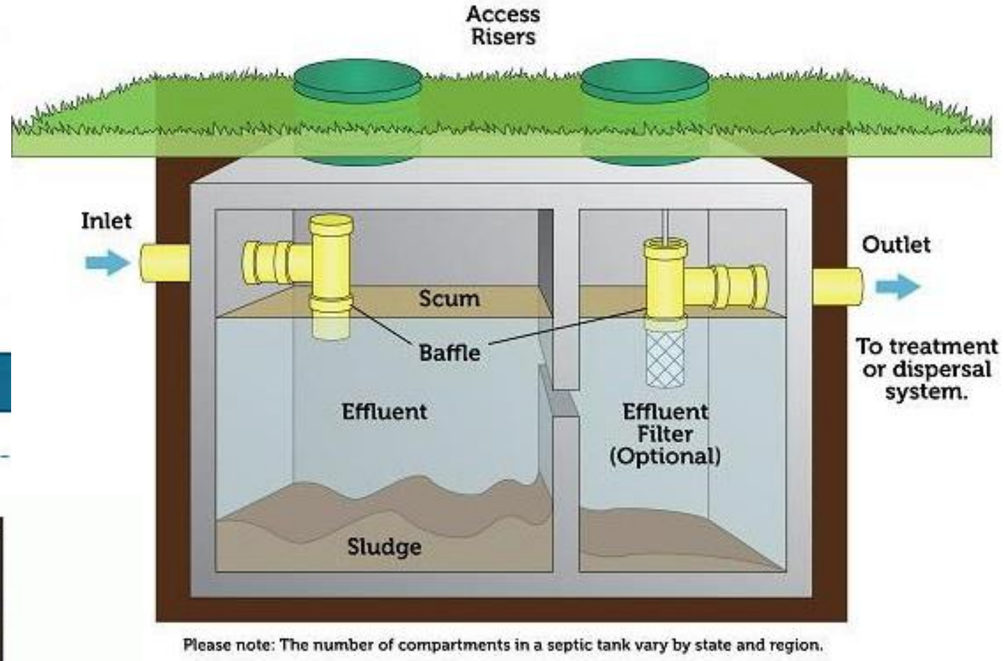
# TYPES OF CONTAINMENTS IN SOUTH AFRICA



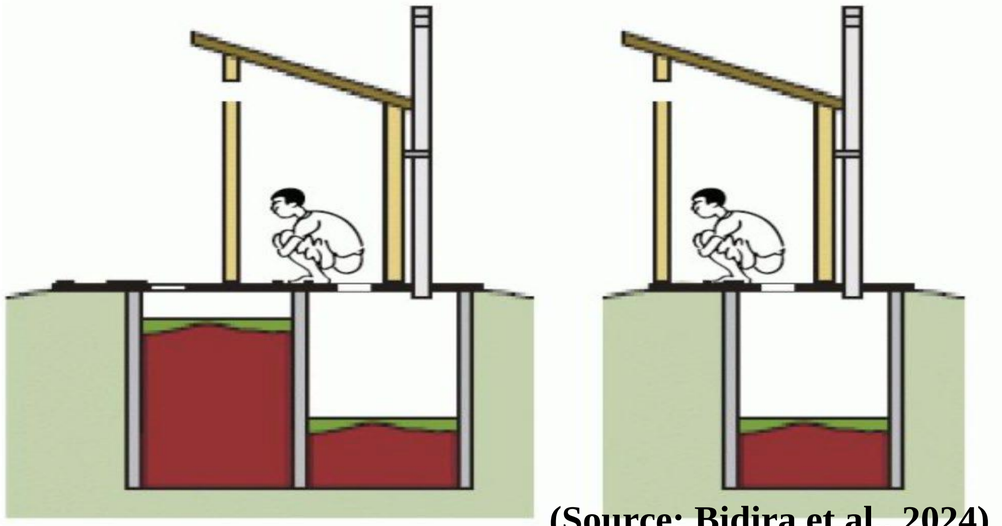
Single pit toilet



Twin pit toilet



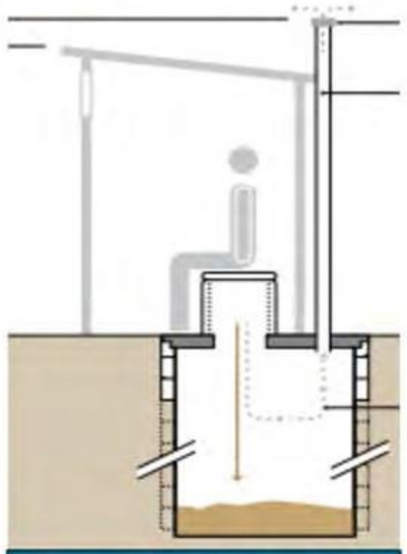

Septic Tanks



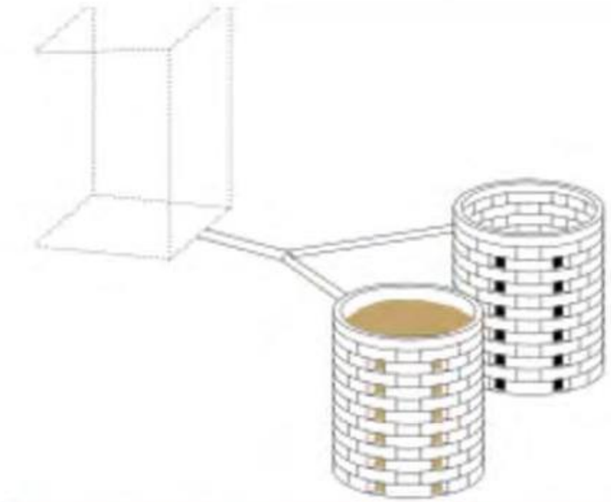
Ventilated Improved Pits (single and double

(Source: Bidira et al., 2024)

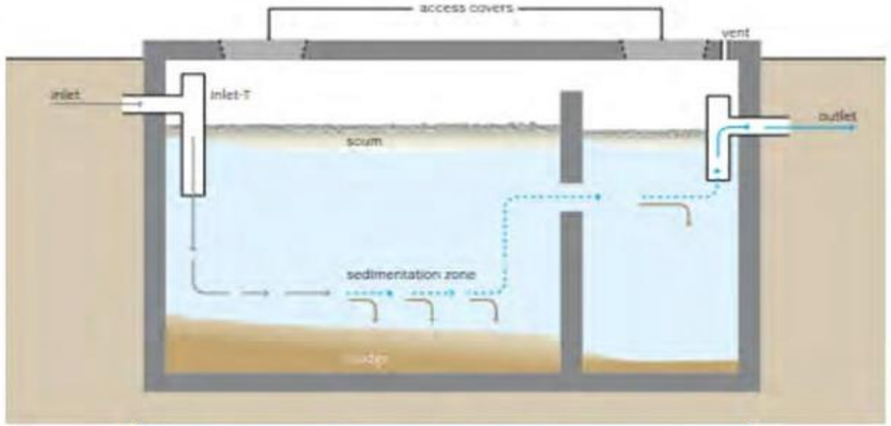
# TYPES OF CONTAINMENT SYSTEMS IN INDIA



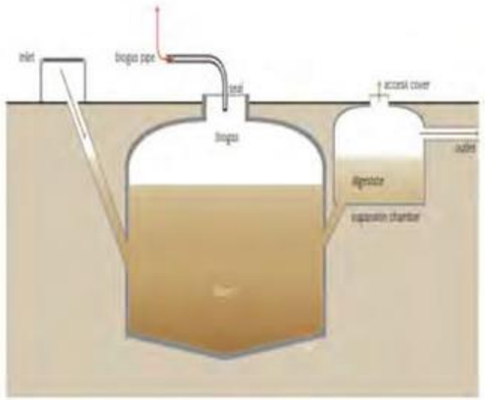
Single pit toilet



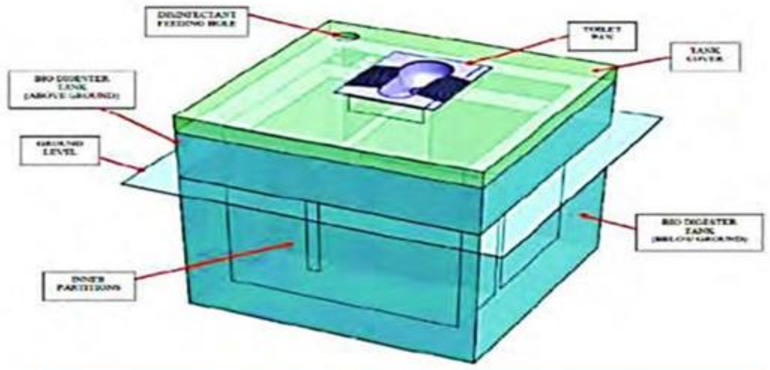
Twin pit toilet




Septic tank



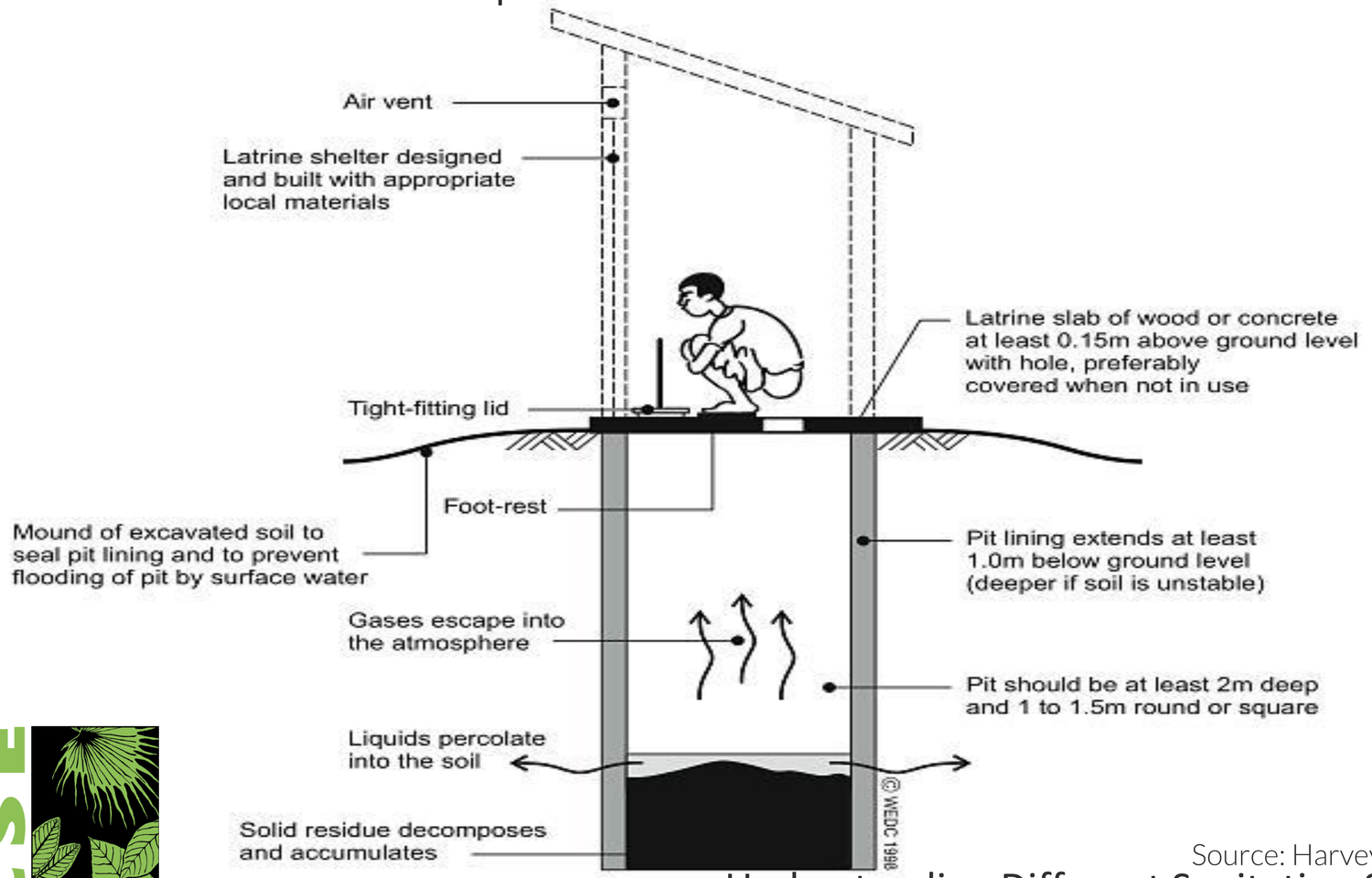

Biogas




Bio-digestor

# SINGLE PIT LATRINE

-One of the widely used sanitation technologies.
- Excreta, **along with anal cleansing materials** (water or solids) are deposited into a pit.
-To avoid people falling into the pit, increase convenience and reduce odour, **a slab with a hole** is used to cover the pit.




## Advantages

- Does not require constant source of water
- Low capital cost

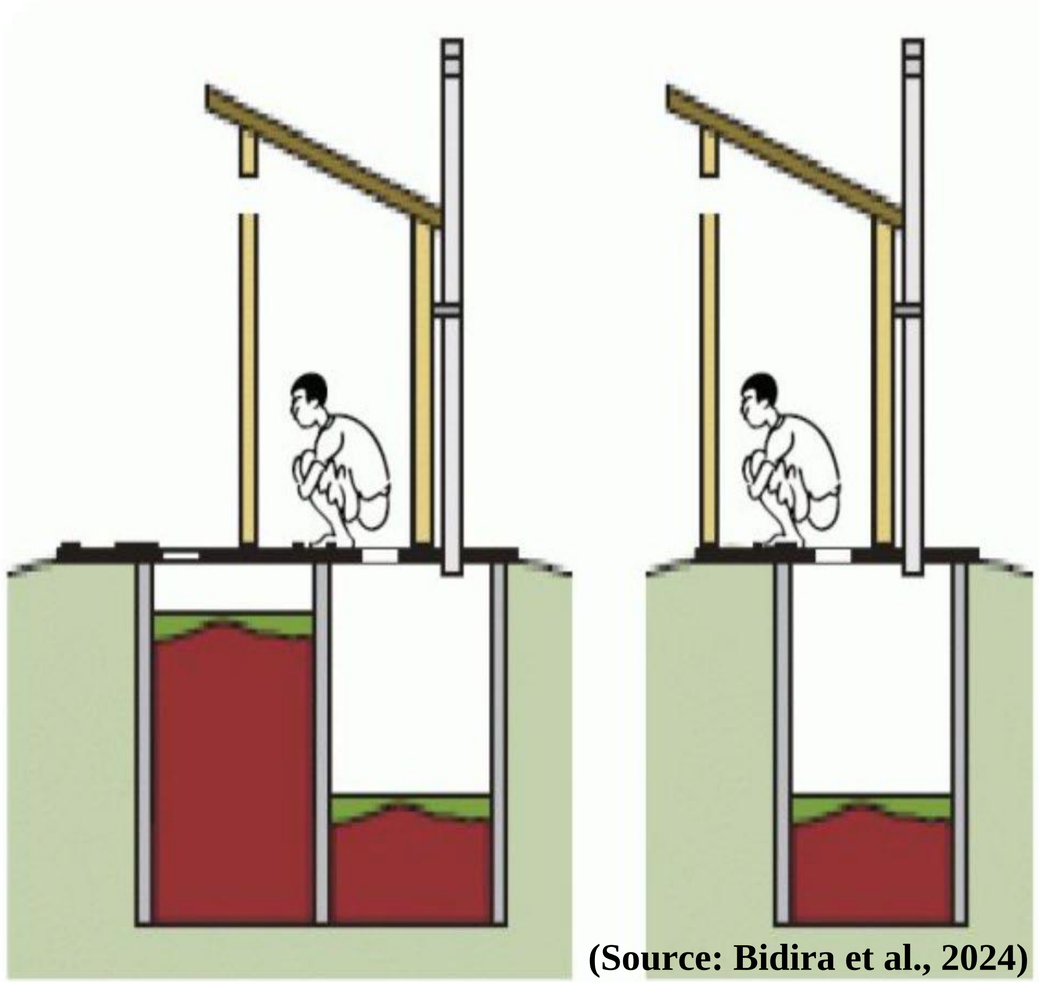
## Disadvantages

- Leachate can contaminate ground water
- Flies and odor are noticeable
- Pits may fail/overflow in case of flood
- Stagnant water promotes insect breeding
- Cost of emptying is high and may encourage scavenging

Source: Harvey et al

# VENTILATED IMPROVED PIT LATRINE (VIP)

The VIP is an improvement over the **single pit** because **continuous airflow through the ventilation pipe vents odours and acts as a trap for flies** as they escape towards the light.



(Source: Bidira et al., 2024)

## Advantages

- Flies and odor are significantly reduced
- Does not require constant source of water
- Low capital cost

## Disadvantages

- Leachate can contaminate ground water
- Health risks from flies, if not completely removed by ventilation
- Pits may fail/overflow in case of flood
- Stagnant water promotes insect breeding
- Manual emptying of the pit poses severe health hazard
- Low reduction of pathogens



Source:https//www.ugandanetwork.org.uk

# SOAK PIT

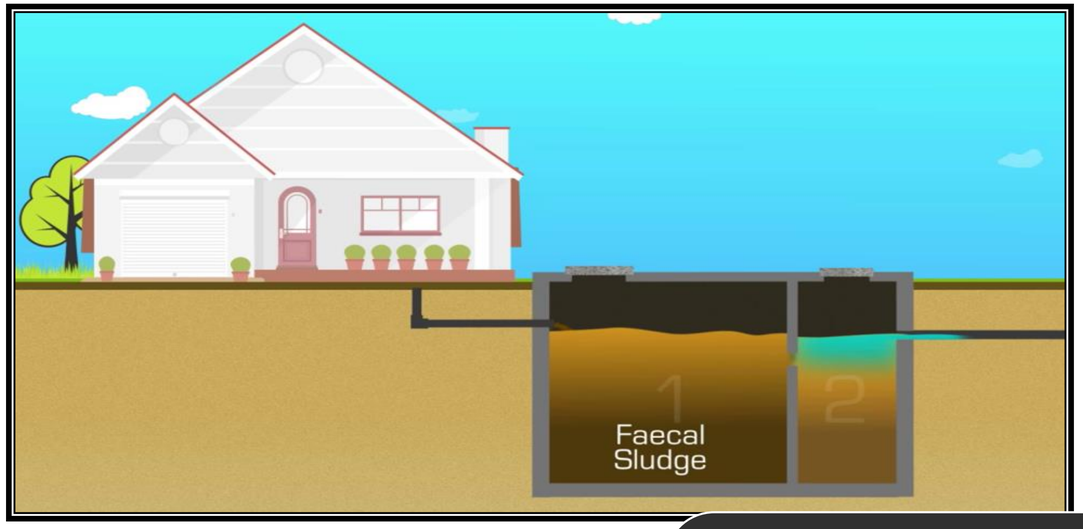
Soak pit is a **dug out pit** filled with stones or preferably over burnt bricks. The large numbers of stones or bricks increase the surface area over which Biological and chemical action takes place.

**Advantages**

- Low capital cost and requires minimal operation & maintenance
- Small land area required
- Can be built and repaired with locally available materials and by the community

**Disadvantages**

- High possibility of contaminating the ground water
- Pre treatment of effluent may be required to avoid clogging
- Should be avoided in places with high population density/ high ground water table/ where soil is majorly clay/ where areas are prone to floods

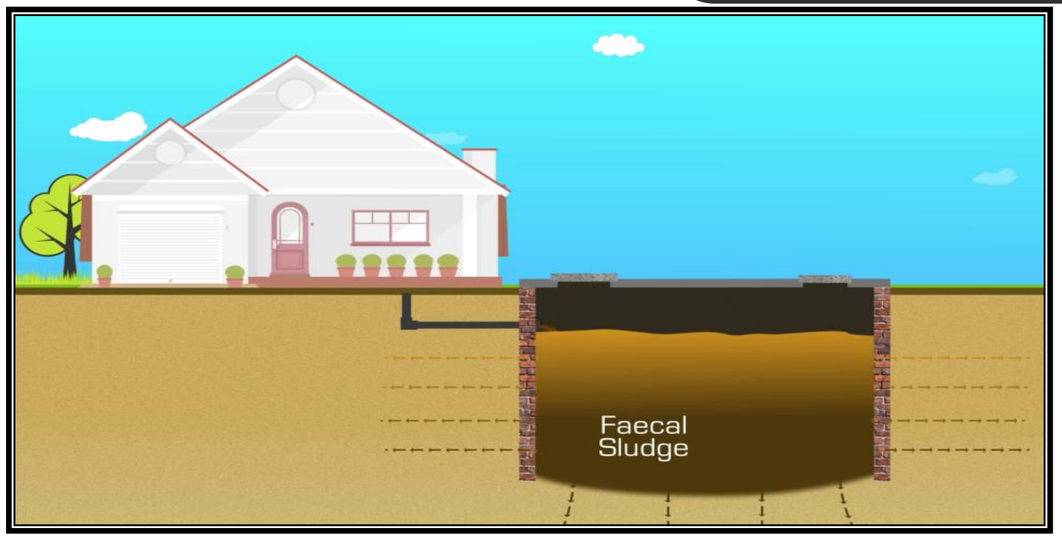



A


B

**What's Wrong ?**

**What's Right ?**

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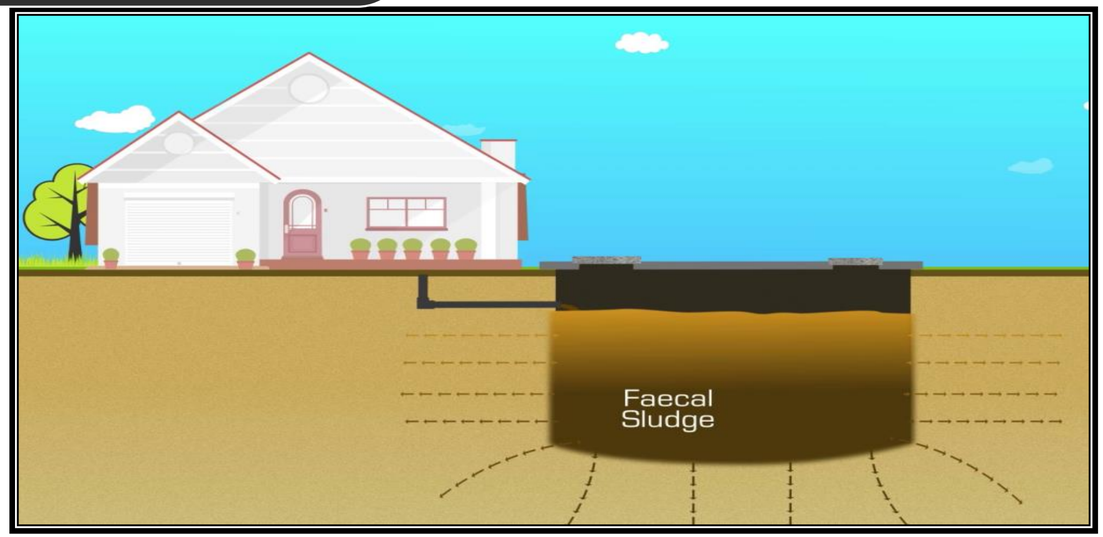
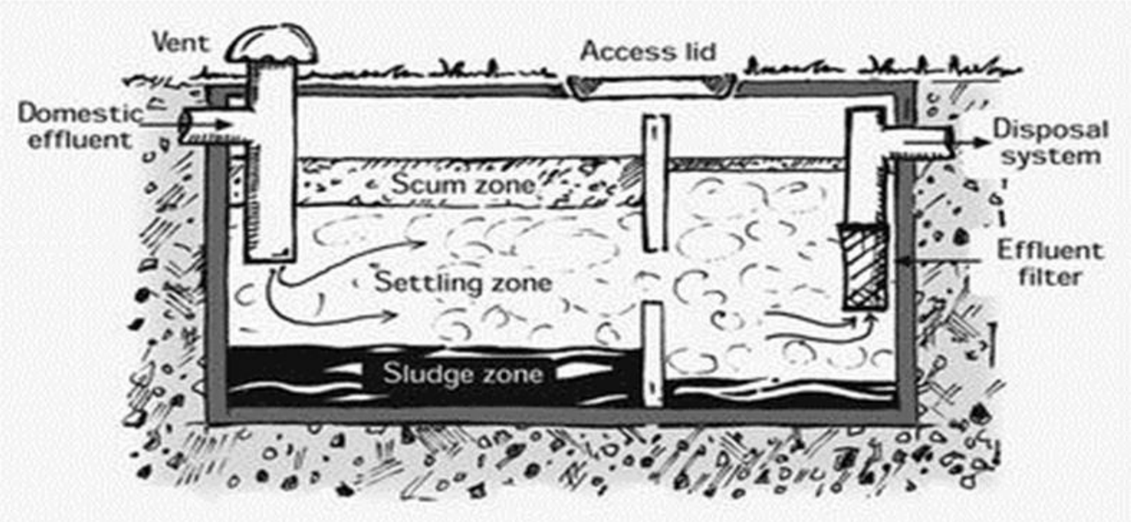
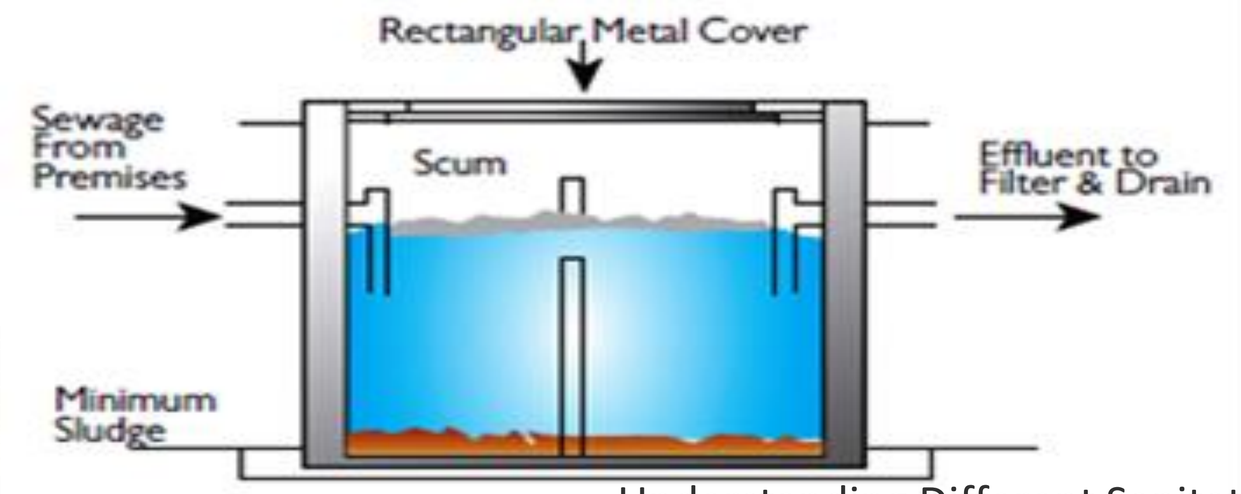



D

# SEPTIC TANK

A septic tank is a **watertight chamber** made of concrete, fibreglass, PVC or plastic, through which blackwater and greywater flows for **primary treatment**.
**Settling and anaerobic processes reduce solids and organics**, but the treatment is only moderate.




Source: AECOM, 2010

**Advantages**

- No energy required, Long life
- Low capital and O&M cost
- Less space required (under ground)
- Biogas can be recovered

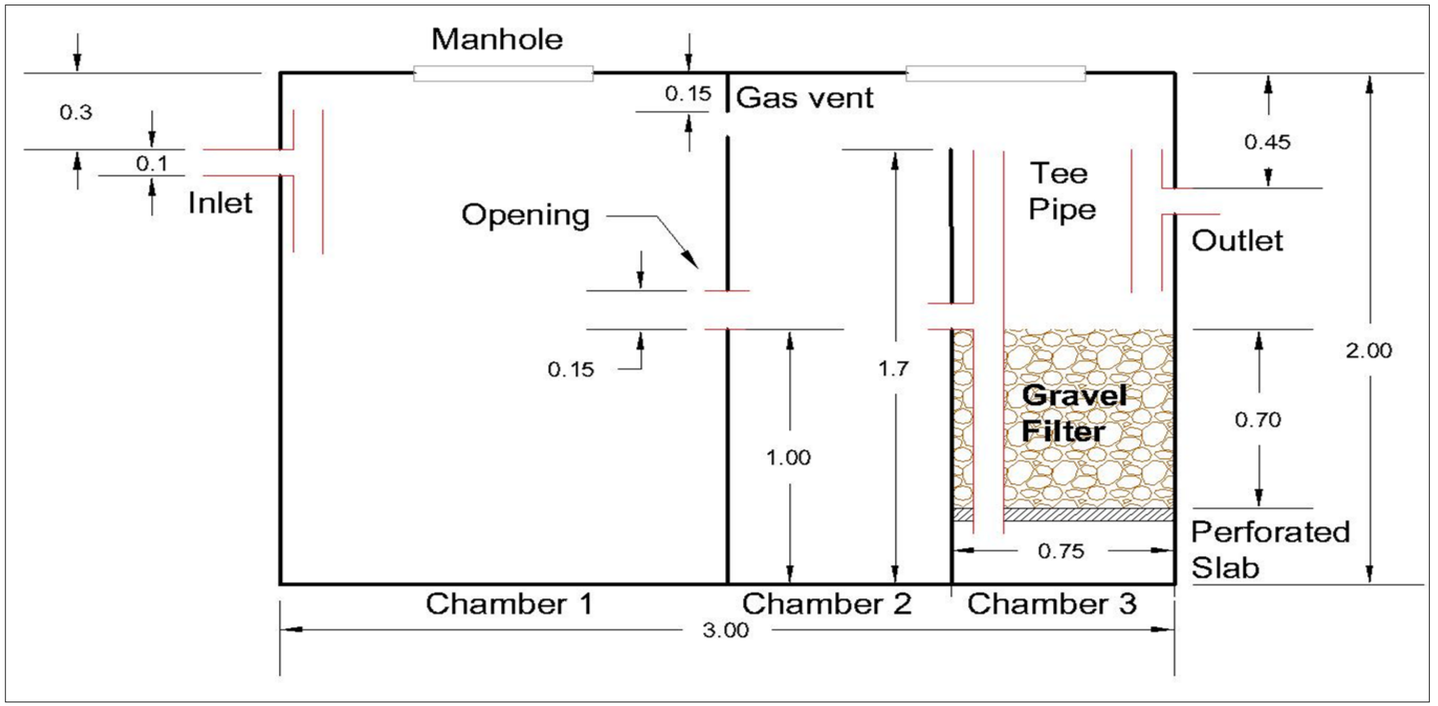
**Disadvantages**

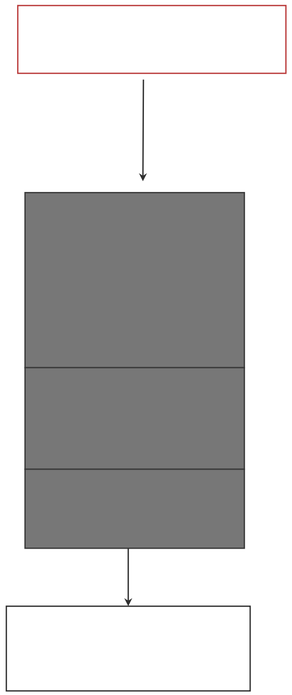
- De-sludging required:

Manual de-sludging is hazardous to health and mechanical de-sludging (vacuum trucks) requires the infrastructure and cost

# CASE STUDY: IMPROVED SEPTIC TANK AT AAETI, NIMLI

- **Addition of a chamber with filter media to treat the effluent of septic tank.**
- Effluent undergoes **anaerobic digestion** before releasing into environment.



**Implementing Agency:** CSE, New Delhi

**Year of Implementation:** 2017

**Knowledge Partner and Design:** CSE, New Delhi

**Treatment Capacity:** 1 KLD

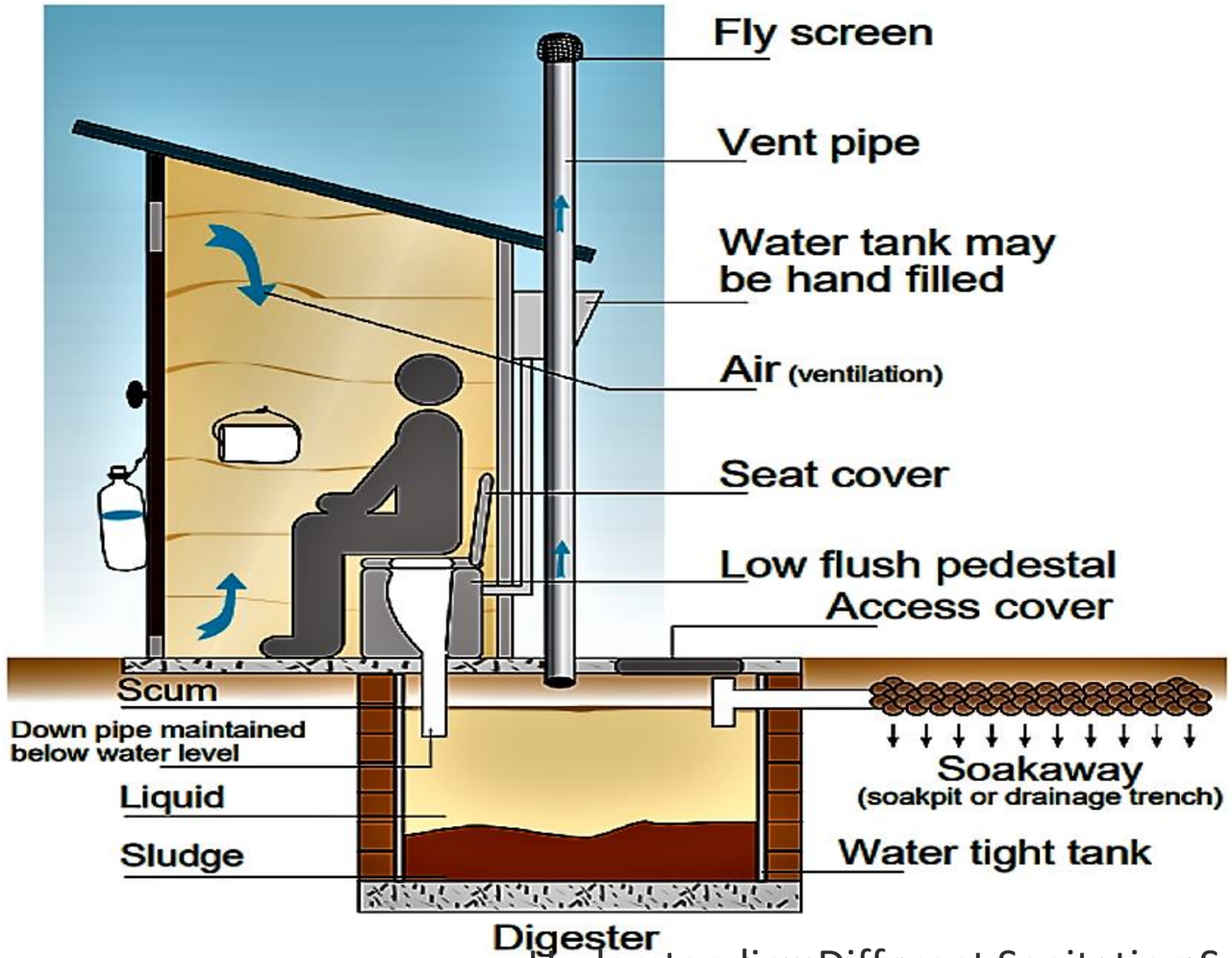
**Proposed use of treated water:** Disposed off into the soak-pit

**Capital cost:** $400–$420 USD (including civil and piping)

**O&M Cost:** Estimated to be Rs. $34–$35 USD in three years

# AQUA PRIVY

An aqua privy is very similar to a septic tank, **the latrine is located directly over the tank**, which means **less water is needed for flushing**. It also **reduces construction costs**, as the area of land required is less too and sub-surface drainage for soaking away the effluent is reduced




**Limitations:**

- Enough Water must be available nearby
- **More expensive than VIP or pour-flush latrine**
- Fly, mosquito and smell nuisance if seal is lost because insufficient water is added
- **Regular desludging required**, and sludge needs careful handling

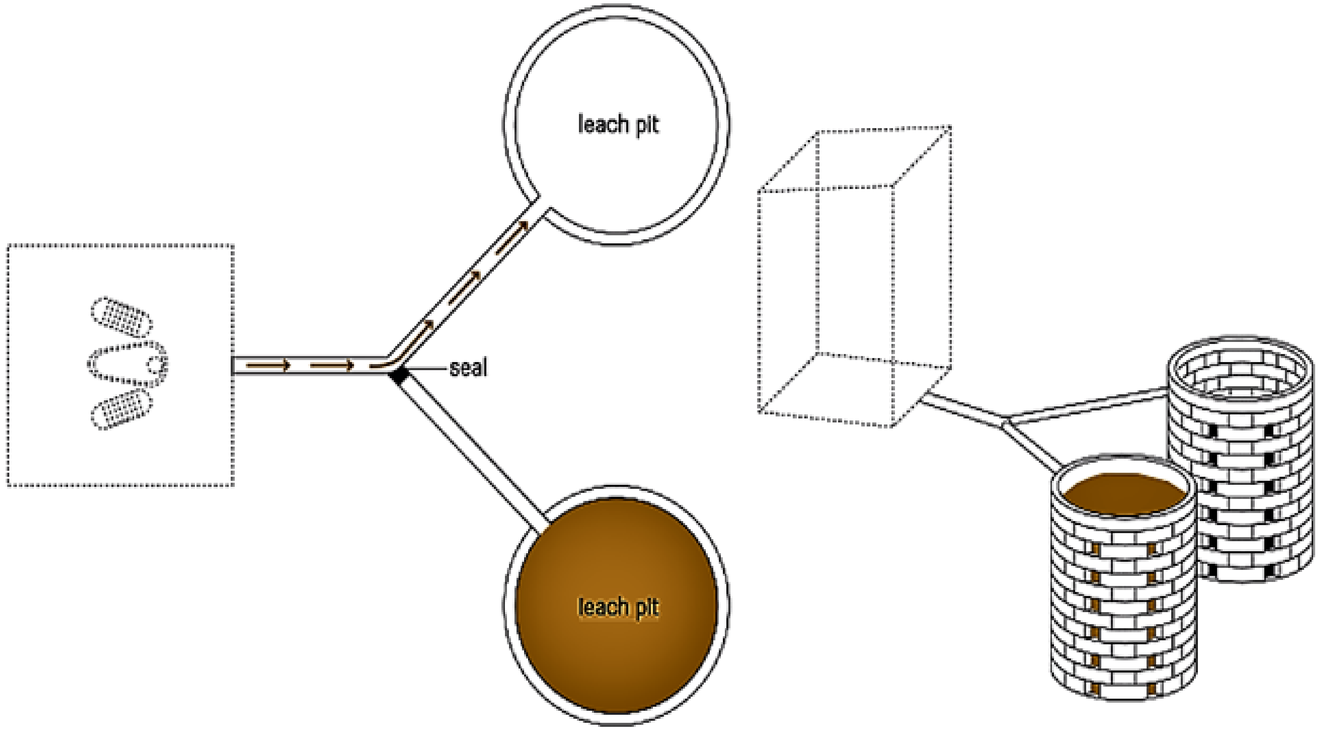
# TWIN PIT

This technology consists of **two alternate pits connected to a pour flush toilet**. The blackwater (and in some cases greywater) is collected in the pits and allowed to slowly infiltrate into the surrounding soil. Over time, the solids are sufficiently dewatered and can be manually removed with a shovel.

- Water-based (wet) technology, the full pits require a **longer retention time** (two years is recommended) to degrade the material before it can be excavated safely

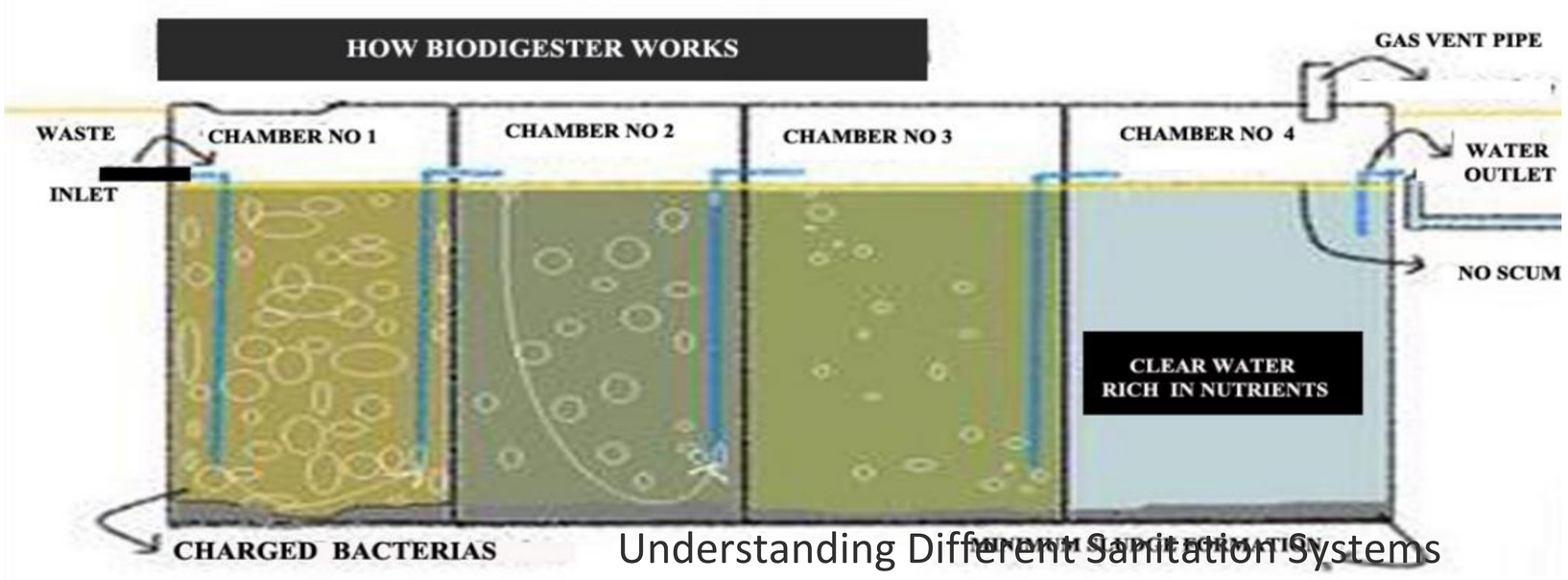
- recommended that the **pits be constructed over 1 m** from any structural foundation as leachate can negatively impact structural supports.

- It is normally recommended to have a **minimum horizontal distance of 30 m** between them to limit exposing the water source to microbial contamination



# BIO-DIGESTER

- No need to evacuate the digester tank at all as **NO SLUDGE** is formed
- All faecal matter **completely digested** and **converted into water, methane ( bio gas) and $CO_2$**
- Bio digester tank sealed tank construction – no mixing with ground water
- **Less maintenance**
- Saves huge cost to govts in design of city/municipal drainage systems (small drain pipes, less labour)

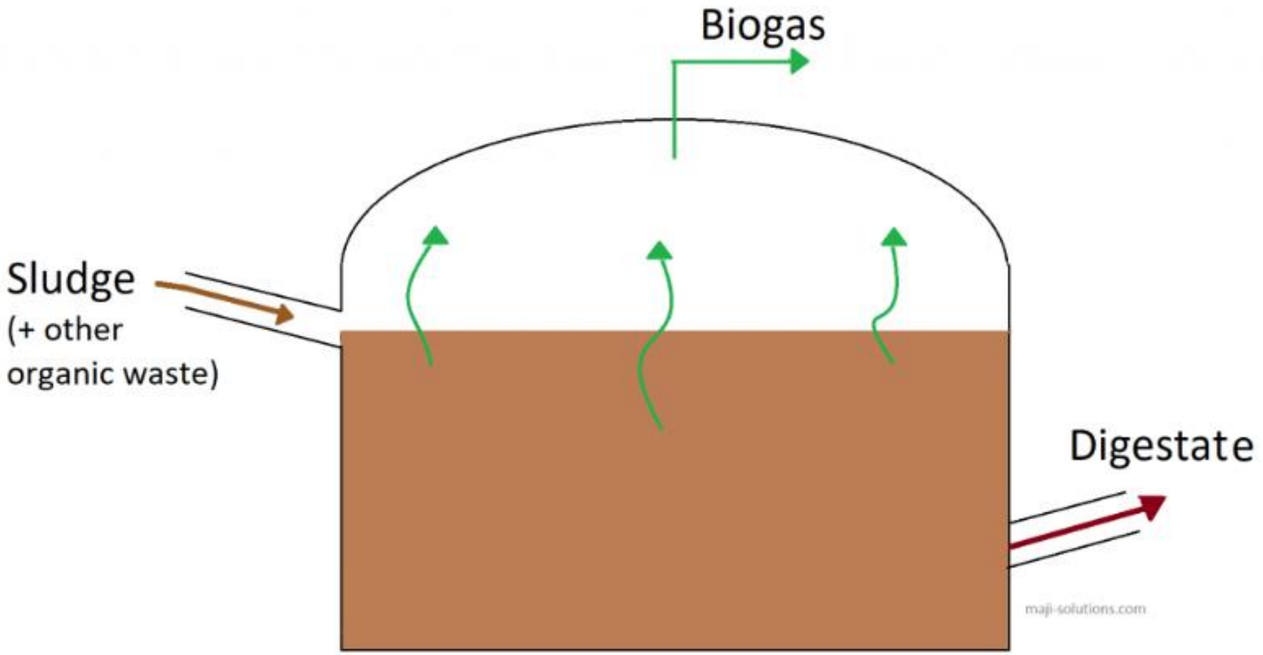



**Anaerobic digestion**.

# BIOGAS

A process that uses bacteria to **break down organic matter in faecal sludge to produce biogas**.

The biogas can be used for **cooking and lighting**, and the treated sludge can be used as **fertilizer.**



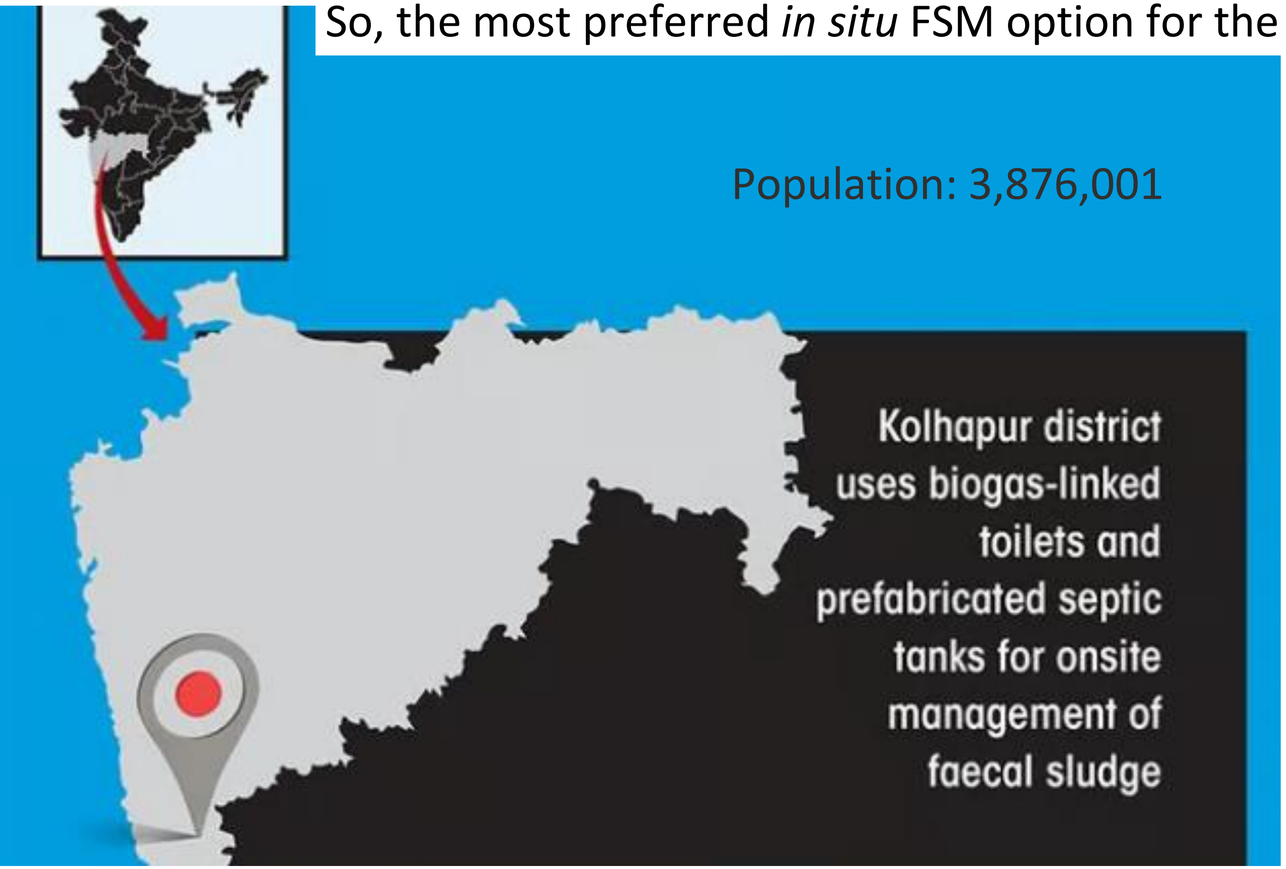

**Function**:

- **Biogas treatment** is the process of **purifying and upgrading** the biogas produced by the biodigester to **make it usable** as a clean and efficient energy source.
- These **impurities need to be removed or reduced in order to make the biogas usable for energy purposes** (like electricity generation, cooking, or even vehicle fuel).

The **biodigester** handles the initial breakdown and treatment of fecal sludge, while **biogas treatment** deals with refining the biogas produced during that process.

# CASE STUDY- KOLHAPUR, MAHARASHTRA, INDIA

Kolhapur district has a shallow water table, in the range of **2-20 metres below ground level** (mgbl).
So, the most preferred *in situ* FSM option for the district is **septic tanks.**




**75%** of the district depends on **septic tanks**.

Septic tanks are designed to ensure a **proper retention period** for the faecal sludge to **minimise the need for further treatment of semi-treated sludge** desludged from the tank.

Around 25% of the district uses **biogas-linked toilets at the household level** —sludge is converted to biogas.
Total of **119,780 toilets are connected to biogas** digesters in the district (up to March 2022).

Kolhapur district has installed **two-chambered septic tanks** in HHs- Ensuring proper settling of faecal sludge within the first chamber and **no overflow of sludge to the second chamber** of the septic tank.

Capex: Cost of 2 $m^3$ household-level biogas digester: **Rs 30,000-35,000**
Opex: Additional money not required

# CASE STUDY- KOLHAPUR

The **outlets of the septic tanks are connected to small modified leach pits** so that the effluent from the septic tanks percolates into the ground.

Local communities say that the septic tanks do not fill up with faecal sludge for at least 10-15 years.

**Cow dung and organic waste are added to digester tanks** to enhance the process of **digestion** for efficient supply of biogas.

The capacity of the biogas plants is **2m$^3$ per tonne** for a family of 5-7 people or less and total gas production per day per plant is 1.5 m$^3$.

**A biogas plant with a production capacity of 2 m$^3$ per day produces 60 m$^3$ biogas in a month.**

# JOHKASOU SYSTEM

- An **on-site compact sewage treatment plant.**
- Useful for households/ group of households not connected with sewerage system.
- Installed in **Aizawl, Mizoram and few places around Chennai**.
- Usually installed underground as **a single compact tank**.
- There are five functional chambers namely, **sedimentation, anaerobic, aeration, storage and disinfection in a tank**.
- Various **types, sizes and scale** of Johkasou units are available.

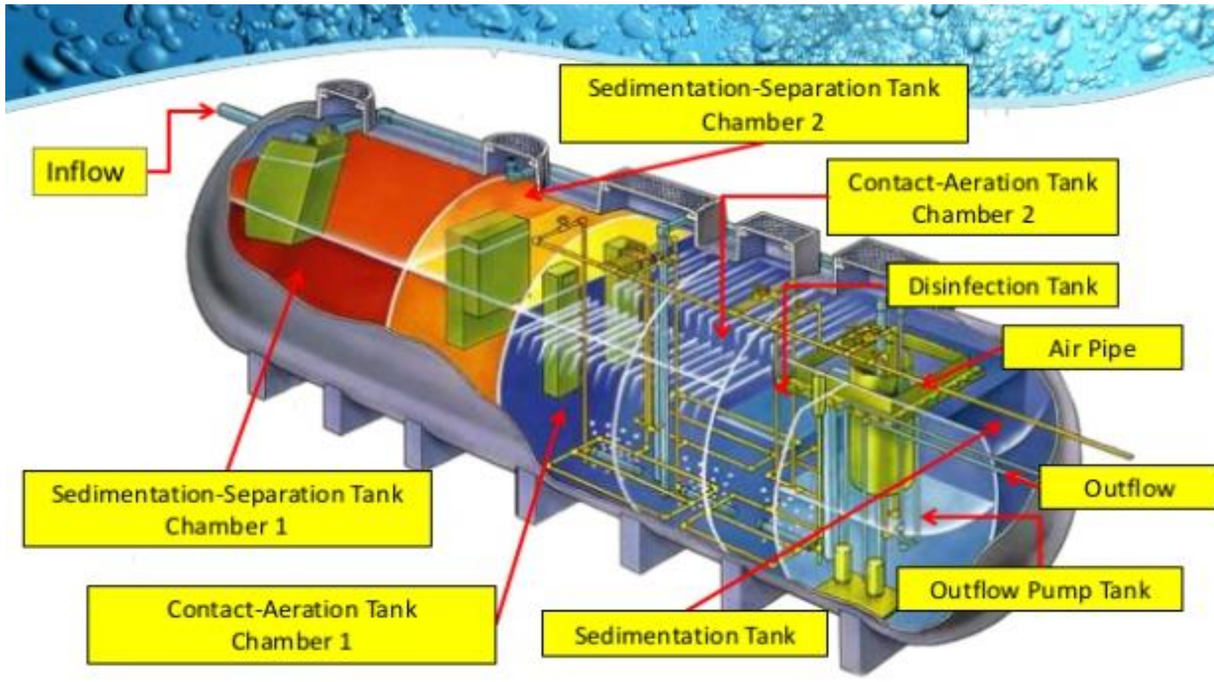



*Image courtesy of Japan Education Center of Environmental Sanitation*

**Advantages:**
- **Short installation time**.
- Johkasou-treated water and sludge are **easy to Reuse**.

**Limitations:**
- High Initial Investment Cost
- Uninterrupted Power Supply required
- Periodic Operation and Maintenance

# MOBILE/PORTABLE TOILETS

- Portable toilet- can be moved around easily
- They can be used in a variety of situations, for example in urban slums of developing countries, at festivals, for camping, or on vehicles
- Can be brought on site, such as a festival or building site, to quickly provide sanitation services.
- Some are re-usable and may be moved on to further sites, others are easily installed but become permanent once in place.
- Most types do not require any pre-existing services to be provided on-site, such as sewerage disposal, but are completely self-contained.
- Not connected to a hole in the ground (like a pit latrine), nor to a septic tank, nor is it plumbed into a municipal system leading to a sewage treatment plant;

# REINVENTED TOILETS


Solar-powered toilet that generates hydrogen and electricity

A sanitation system that converts human waste into biological charcoal

Toilet that produces biological charcoal, minerals, and clean water through hydrothermal carbonization

# REINVENTED TOILETS


**Toilet that converts human waste to fuel gas using microwaves**

**Urine-diverting toilet that recovers water for flushing using gravity-driven biological membrane**

# THANK YOU

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