

Septage Treatment options

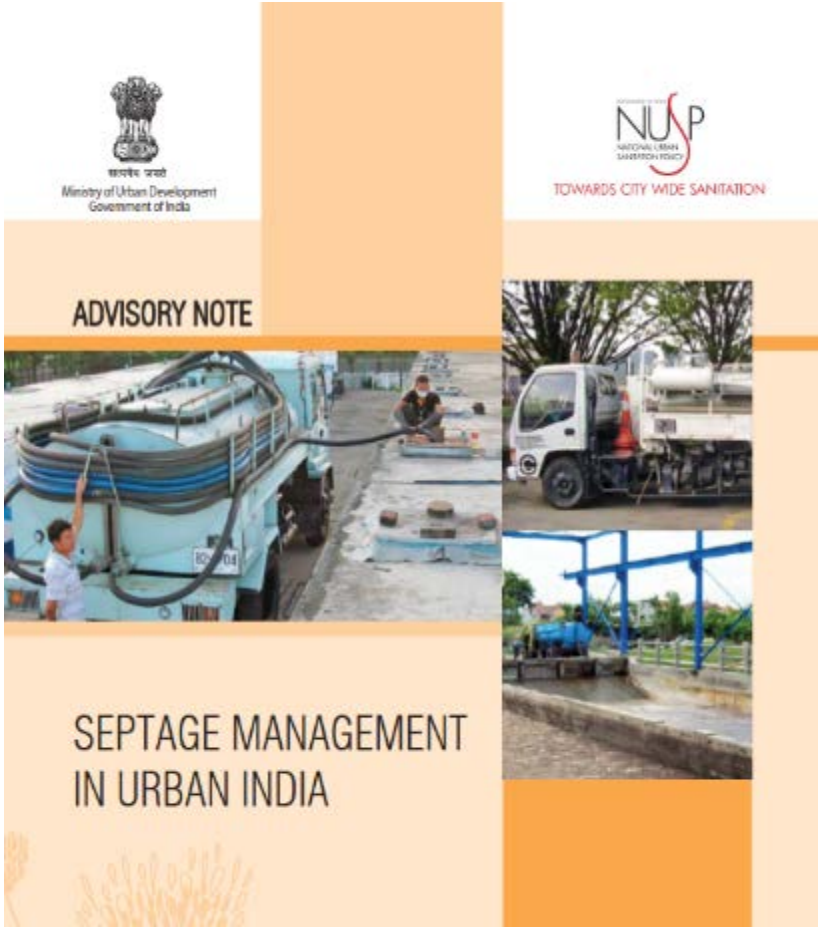
pas performance assessment system

PAS Project, CEPT University, INDIA

What is septage ?. . .

As per MoUD Advisory on Septage Management

"The settled solid matter in semi-solid condition usually a mixture of solids and water settled at the bottom of septic tank. It has an offensive odour, appearance and is high in organics and pathogenic micro-organisms."



Characteristics of septage

Physical and chemical characteristics of septage

Constituent (all units but for pH are in mg/l)	Average	Range
Biochemical Oxygen Demand	6,480	440 - 78,600
Chemical Oxygen Demand	31,900	1,500 - 703,000
Total Solids	34,106	1,132 - 130,745
Total Volatile Solids	23,100	353 - 71,402
Total Suspended Solids	12,862	310 - 93,378
Volatile Suspended Solids	9,027	95 - 51,500
Total Kjeldahal Nitrogen	588	66 - 1,060
Ammonia-Nitrogen	97	3 - 116
Total Phosphorus	210	20 - 760
Alkalinity	970	522 - 4,190
Grease	5,600	208 - 23,368
pH		1.5 - 12.6

Parameter	Type "A" high strength	Type "B" low strength
Example	Public toilet or bucket latrine sludge	Septage
Characterization	Highly concentrated, mostly fresh FS; stored for days or weeks only	FS of low concentration; usually stored for several years; more stabilized than Type "A"
COD (mg/L)	20-50,000	<15,000
COD/BOD	5:1 to 10:1	5:1 to 10:1
NH_4-N (mg/L)	2-5,000	<1,000
TS (%)	≥ 3.5 %	< 3 %
SS (mg/L)	≥30,000	7,000 (approx)
Helminth Eggs (unit/ml)	20-60,000	4,000 (approx)

* Detailed septage characterization (BOD, SS & other microbial characteristics) as well as its dewatering characteristics (Specific resistance etc.) should be mandatory prior to the design of any septage management facility.

Source: Strauss, 1996

Characteristics of septage in tropical countries

Source : Advisory note on Septage management in Urban India, MoUD Jan 2013

Septage quality results of cities. . .

Sr.No.	Parameter	Unit	Wai		Sinnar	
			Household septage	Community - Public toilet septage	Household septage	Community - Public toilet septage
			Result	Result	Result	Result
Test results						
2	BOD5 at 20°c	mg/l	6000 - 16500	228 - 5400	336 - 39000	346 - 2533
3	COD	mg/L	11408 - 27776	395.2 - 9523	1000 - 88000	920 - 7200
4	Total Solids by volume	%	0.992 - 8.07	0.071 - 1.36	0.42 - 7.74	0.43 - 1.06
5	Total Nitrogen (as N) , by volume	%	0.044 - 0.0719	0.016-0.067	0.02 - 0.16	0.06 - 0.11
6	Phosphorus (as P), by volume	%	0.004 - 0.009	0.001 - 0.007	0.0002	0.0002
7	Pottasium (as K) by volume	%	0.004 - 0.014	0.005 - 0.015	0.006 - 0.027	0.017 - 0.029
8	Gross Calorific Value, on dry basis	cal/g	4148	*	3226 - 4817	1281 - 2732
9	Faecal Coliforms	/100ml	>1600	>1600	22 - 920	32 - 170

Note : * - Not analyzed due to insufficient quantity of sample

- **BOD and Total Solids are affected by emptying frequency**
  - ❑ **The more frequently the septic tank is emptied : Less is the BOD and Total solids and vice a versa**
- **The emptying frequency is also dependent on type of housing .**
  - ❑ **Flats are emptied more frequently as compared to bunglows / row houses**

Septage Quality differs City to City . . .

Septage treatment as per MoUD Advisory . . .

Treatment / Reuse / Disposal

- Treatment at **existing sewage treatment plants**
  - Septage addition at the **nearest sewer** manhole
  - Septage addition **at the STP**
  - Septage addition to **sludge digesters/sludge drying beds**
- Treatment at **independent septage treatment plants**
  - **Space is not a constraint** : Lime treatment, Sludge drying beds, Anaerobic baffled reactor, stabilization pond, Constructed wetland, co-composting with solid waste
  - **Space is a constraint** : Mechanical Dewatering system
- Properly **treated sludge** can be **reused** to reclaim parched land by application **as soil conditioner**, and/or as a **fertilizer**

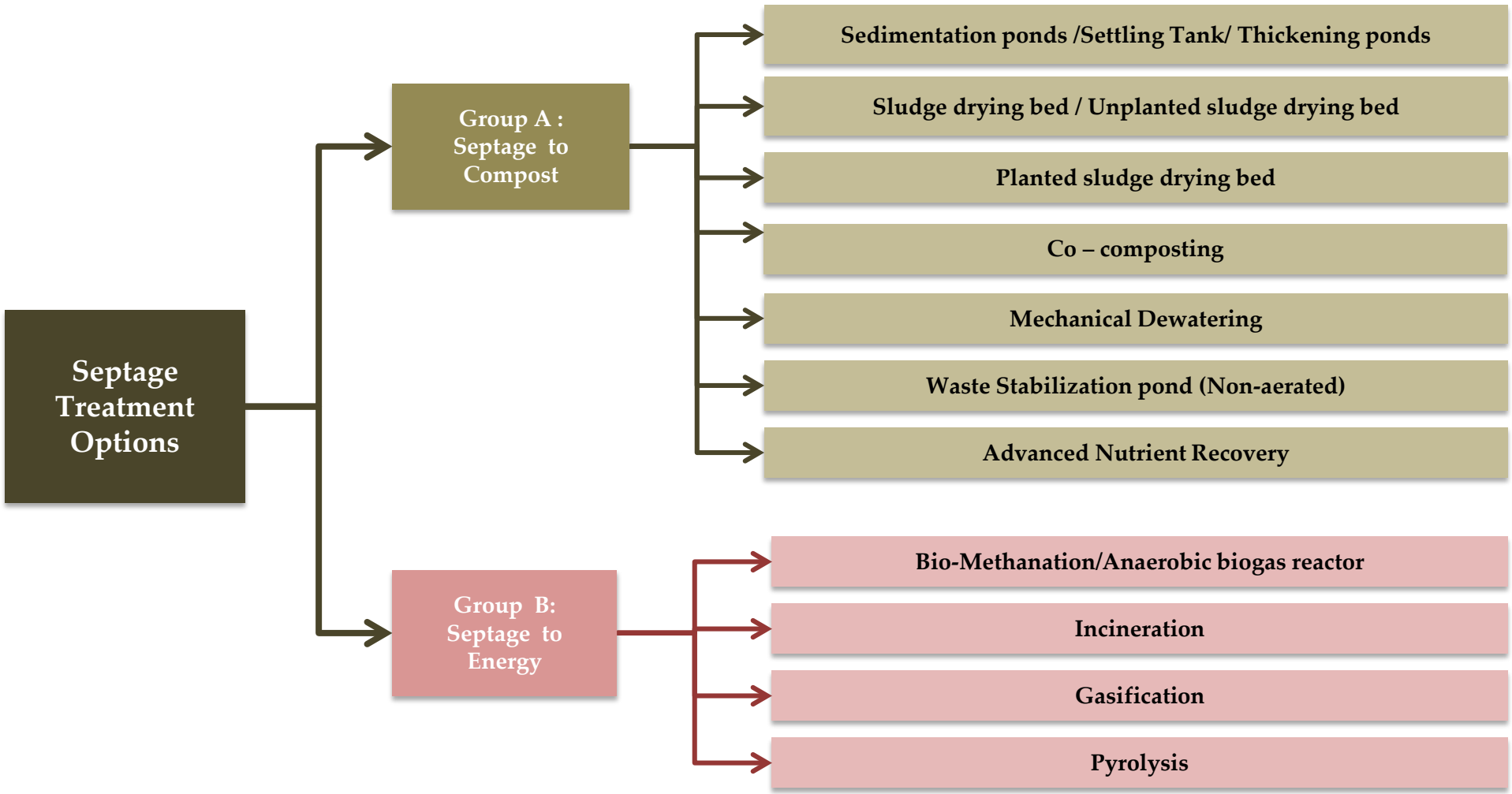





Factors affecting selection of treatment option

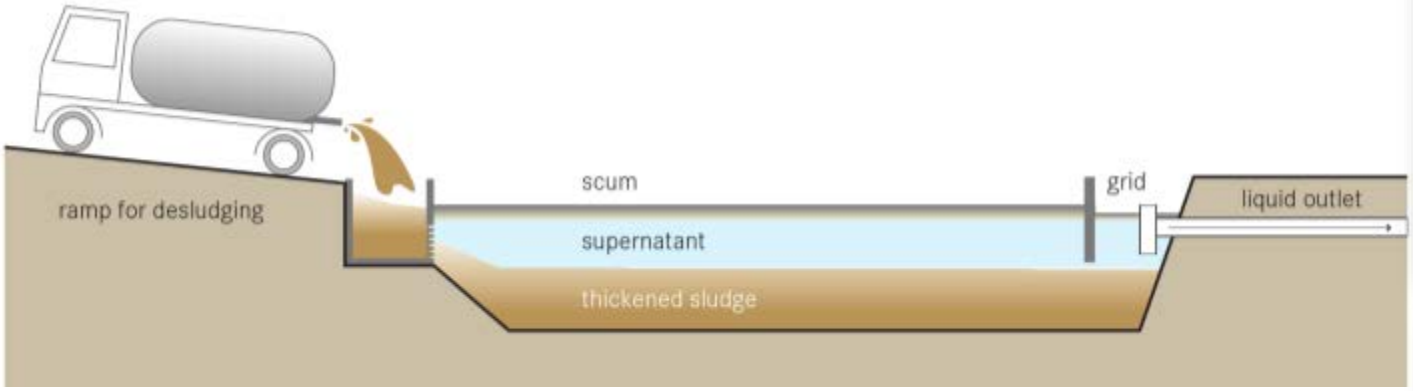
- **Technical performance of treatment option:**
  - Technology providing required quality output,
  - Popularity in local context, advantages and disadvantages,
  - requirement of pre-treatment or post treatment,
  - level of difficulty in handling or discharging endproduct generated, etc.
- **Site condition:** Permeability, groundwater table, soil type etc
- **Capital and operating cost**
- **Simplicity in Construction & Operation**
- **Level of mechanization** required for its operation
- Efficiency of **energy recovery**

Various Septage treatment options are available. . .



Based on literature reviews and international case studies . . .

Sedimentation/Thickening ponds . . .



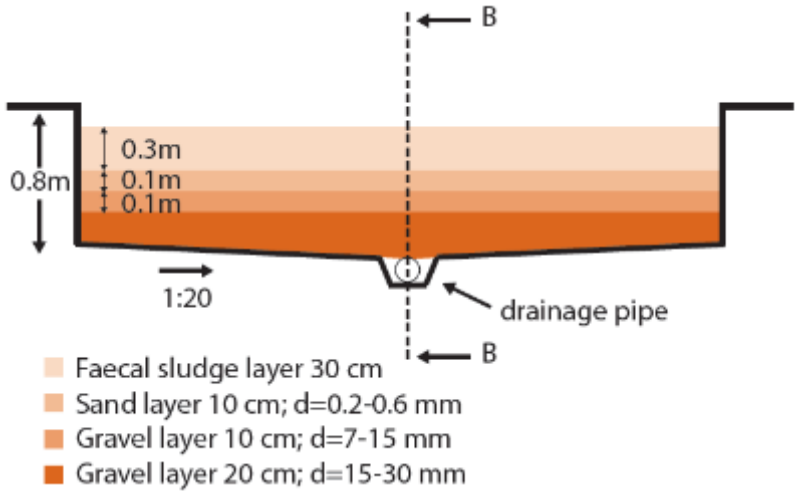
Simple settling ponds that allow the sludge to thicken and dewater. The effluent is removed and treated, while the thickened sludge can be treated in a subsequent technology.

Design Considerations :

- Two tanks operating in parallel are required; one can be operated, while the other is emptied.
- To achieve maximum efficiency, loading and resting periods should not exceed 4 to 5 weeks, although much longer cycles are common.
- When a 4-week loading and 4-week resting cycle is used, total solids (TS) can be increased to 14%
- Affected by seasonal changes.
- Best used in hot and temperate climate

Output : Thickened septage and effluent

Unplanted sludge drying bed . . .

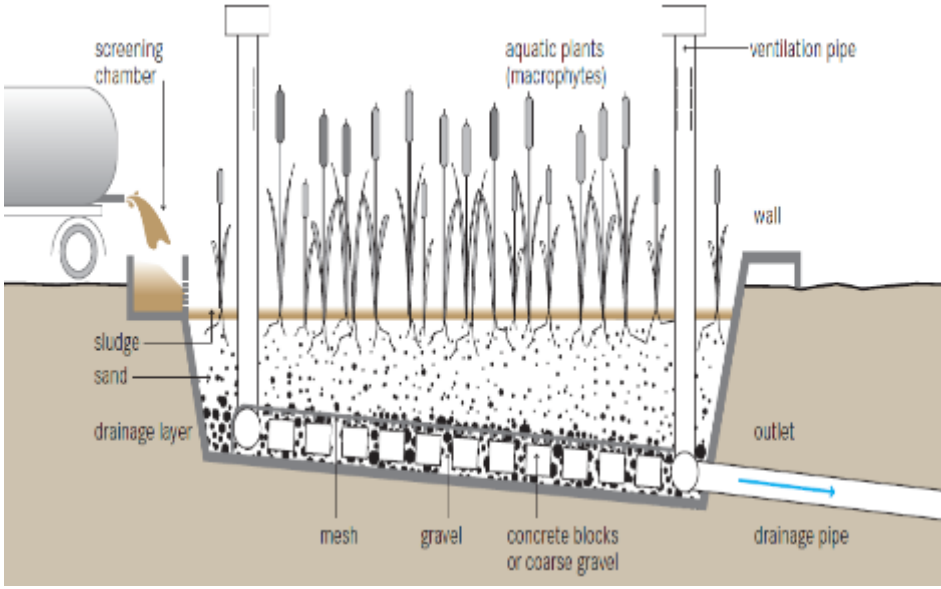


An Unplanted sludge Drying Bed is a simple, permeable bed that, when loaded with sludge, collects percolated leachate and allows the sludge to dry by evaporation

- This technology is affected by seasonal changes and can be used in hot and temperate climate. Excessive rain may prevent the sludge from proper settling and thickening.
- Dried sludge must be removed every 10 to 15 days. Sand must be replaced when the layer gets thin. Treated Septage and leachate may require further treatment based on output quality

Output : Dried Septage and effluent

Planted sludge drying bed . . .

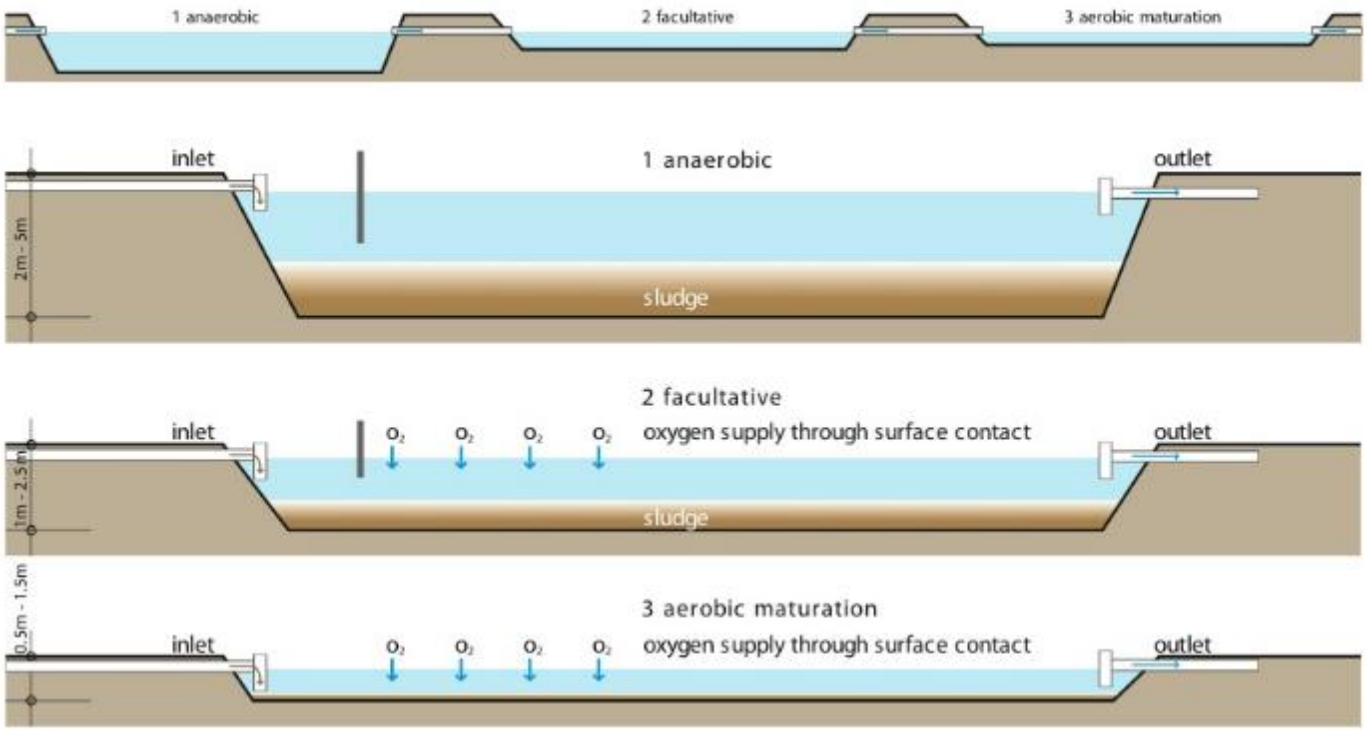


Planted sludge Drying Bed is similar to an Unplanted sludge Drying Bed with the benefit of increased transpiration

- The key feature is that the filters do not need to be desludged after each feeding /drying cycle. Fresh sludge can be applied directly onto the previous layer
- Dried sludge must be removed every 2-3 years. leachate may require further treatment based on output quality

Output : Dried Septage, effluent and biomass

Waste Stabilization pond

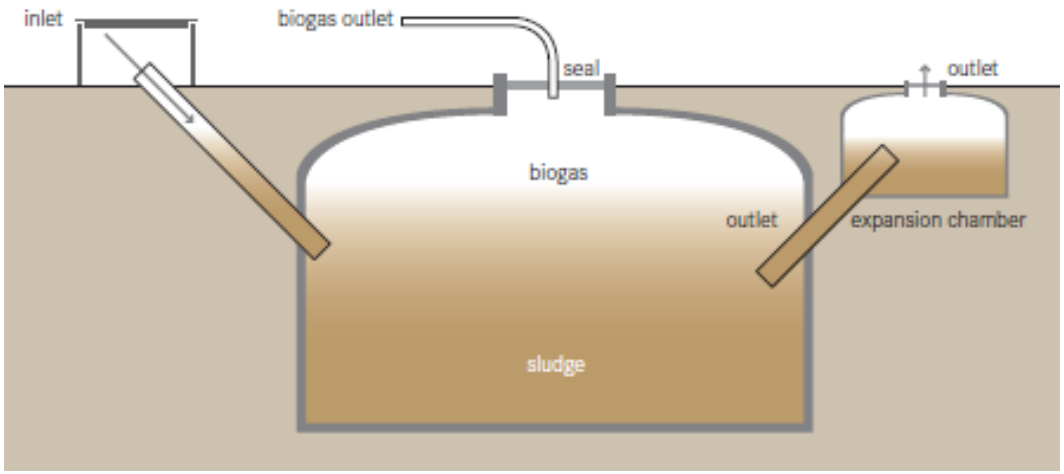


Comprises of pre-treatment units for solid-liquid separation followed by a series of one or more anaerobic ponds and one facultative pond

- Problems arise when municipal wastewater & Faecal Sludge is co-treated
- Due to the high ammonia concentration and high organic loads and solid content, treating **solely FS in WSPs is not recommended**

Output : Septage and effluent

Anaerobic biogas reactor



An Anaerobic Biogas Reactor is an anaerobic treatment technology that produces :

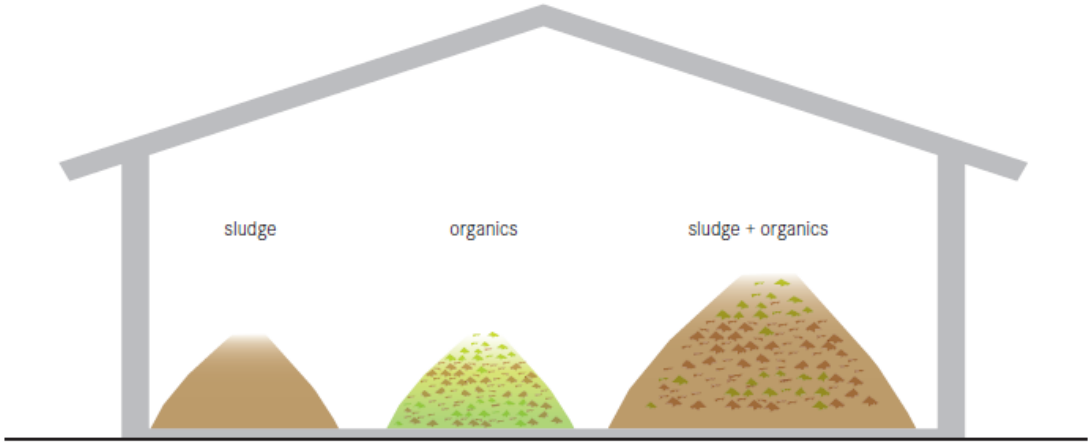
(a) **Digested slurry** to be used as a soil amendment

(a) **Biogas** which can be used **for energy.**

- The **hydraulic retention time** (HRT) in the reactor should a **minimum of 15 days** in **hot climates** and **25 days** in **temperate climates**.
- Most often **Biogas Reactors** are **directly connected** to indoor (**private or public**) **toilets** with an additional access point for organic materials
- Depending on the design and the inputs, the **reactor** should be **emptied** once **every 6 months to 10 years**
- The **tank is essentially self mixing**, but it should **be manually stirred once a week** to prevent uneven reactions.
- **Grit and sand** that has settled to the bottom should be **removed once every year**

Output : 1. Biogas (Methane)
2. Digested sludge

Co – Composting



Co-Composting is the controlled aerobic degradation of organics using more than one feedstock (Faecal sludge and Organic solid waste).

Design Considerations :

- For **Dewatered sludge's**, a **ratio of 1:2 to 1:3** of **sludge's to solid waste** should be used.
- **Liquid sludge's** should be used at **ratio of 1:5 to 1:10**
- There are **two types** of Co-Composting **1. Open and 2. In vessel**
- In Open, **sludge and solid waste is mixed** and **piled in 1m high heaps** called **Windrows. These** need to be **turned periodically** to **provide oxygen** for **treatment**
- **In-vessel composting** requires **controlled moisture** and **air supply**, as well as **mechanical mixing**

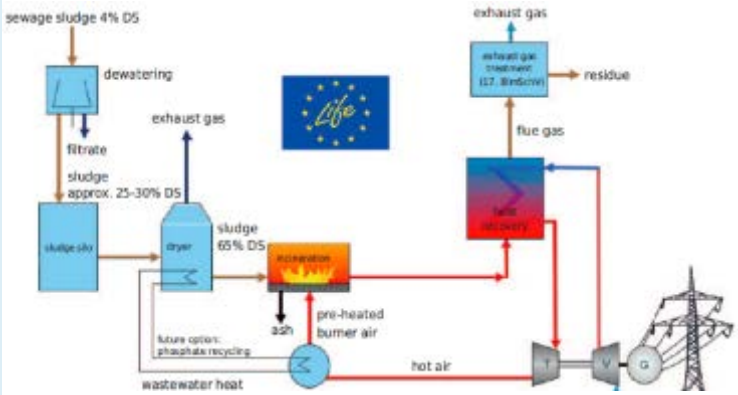
Output : Compost

Septage to Energy treatment options . . .

Unexplored in India

Incineration

- Oxidation of organics in the sludge under the conditions of complete aeration and requires high temperature.
- Conversion: Sludge to heat
- Requires trained operators. Risk of malfunction if not properly maintained and operated
- In India prevalent mostly for bio-medical wastes. Sludge incineration is not proven in India



Gasification

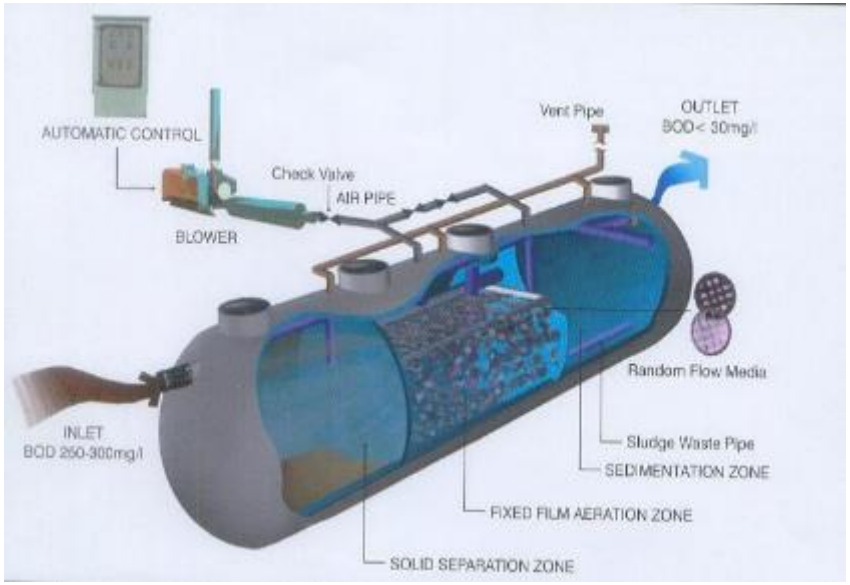
- Thermal transformation of organic mass under limited supply of air/oxygen to syngas
- Conversion: Sludge to Syngas & Biochar
- The produced gas can be converted into any type of fuel by FT synthesis

Pyrolysis

- Thermal conversion of carbonaceous materials in sludge to produce complex oil in the absence of air/oxygen
- Conversion: Sludge to Bio-oil, Pyrolytic Gas and Bio-char
- Energy recovery efficiency is high.
- Attempted only for the treatment of plastic and related feedstocks so far.

Package septage treatment technologies . . .

- Various **technology providers** are there , who provide **PACKAGE treatment plants** for treating of septage
- **Technology** used : MBBR, Master bio-tank (DRDO) , RMBR and various others patented technologies.



Quality Standards for Reuse of treated Septage . . .

- ***Dewatered septage/sludge use as a fertilizer in agriculture , should satisfy criteria of Class A Bio-solids of US EPA :***
  - Fecal coliform density < 1000 MPN/g total dry solids
  - Salmonella sp. Density < 3MPN/4g total dry solids
  - Helminth egg concentration < 1/g total dry solids (WHO, 2006)
  - E – Coli of 1000/g total solids (WHO, 2006)

- ***As per MSW Rules, 2000 compost quality should not exceed the prescribed limit as below:***

Parameter	Concentration not to exceed (mg/kg dry basis, except for pH and carbon to nitrogen ratio)
Arsenic	10
Cadmium	5
Chromium	50
Copper	300
Lead	100
Mercury	0.15
Nickel	50
Zinc	1000
C/N ratio	20 – 40
pH	5.5 – 8.5

Properly **treated sludge** can be **reused to reclaim parched land** by application as soil conditioner, and/or as a fertilizer.

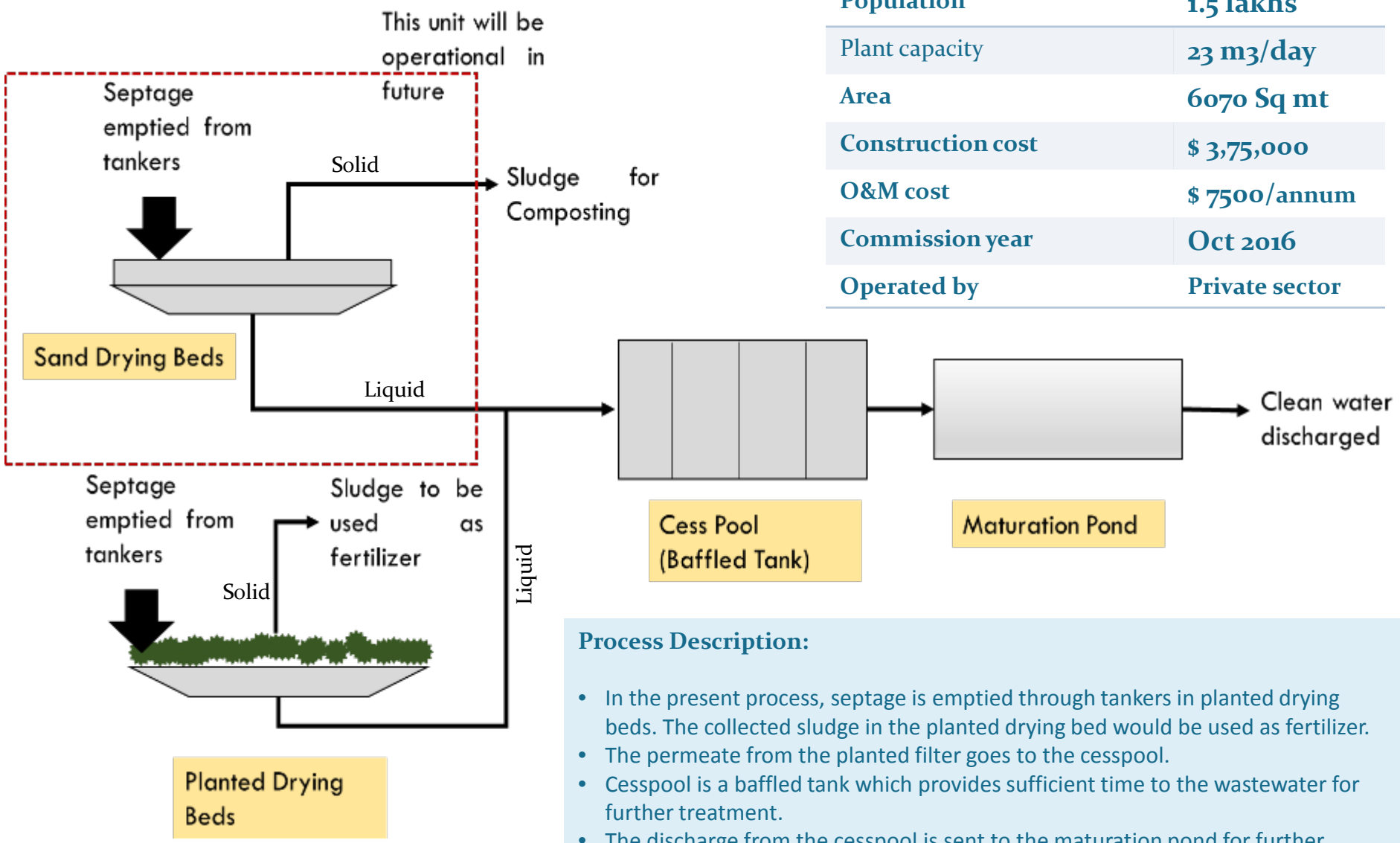
Deteriorated land areas, which cannot support the plant vegetation due to lack of nutrients, soil organic matter, low pH and low water holding capacity, can be **reclaimed and improved by the application of treated septage**

Source : Advisory note on Septage management in Urban India, MoUD Jan 2013

Case studies showing combination of these technologies . . .

Faridpur, Bangladesh

Population	**1.5 lakhs**
Plant capacity	**23 m3/day**
Area	**6070 Sq mt**
Construction cost	**$ 3,75,000**
O&M cost	**$ 7500/annum**
Commission year	**Oct 2016**
Operated by	**Private sector**

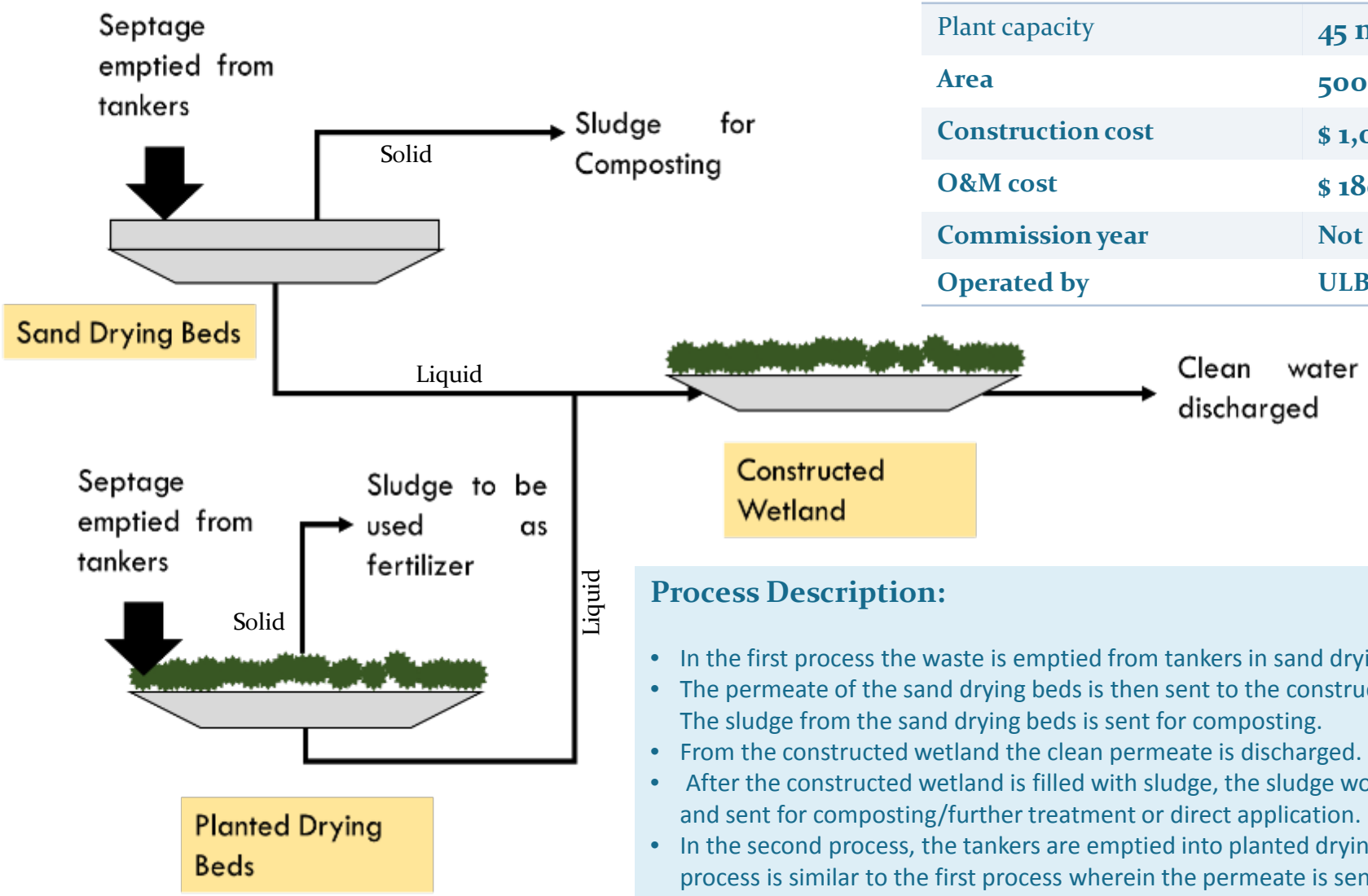


Process Description:

- In the present process, septage is emptied through tankers in planted drying beds. The collected sludge in the planted drying bed would be used as fertilizer.
- The permeate from the planted filter goes to the cesspool.
- Cesspool is a baffled tank which provides sufficient time to the wastewater for further treatment.
- The discharge from the cesspool is sent to the maturation pond for further polishing treatment.
- The water from the maturation pond is discharged in the nearby water body.

Jhenaidah, Bangladesh

Population	**1.5 lakhs**
Plant capacity	**45 m3/day**
Area	**500 Sq mt**
Construction cost	**$ 1,00,000**
O&M cost	**$ 1800/ annum**
Commission year	**Not started**
Operated by	**ULB**

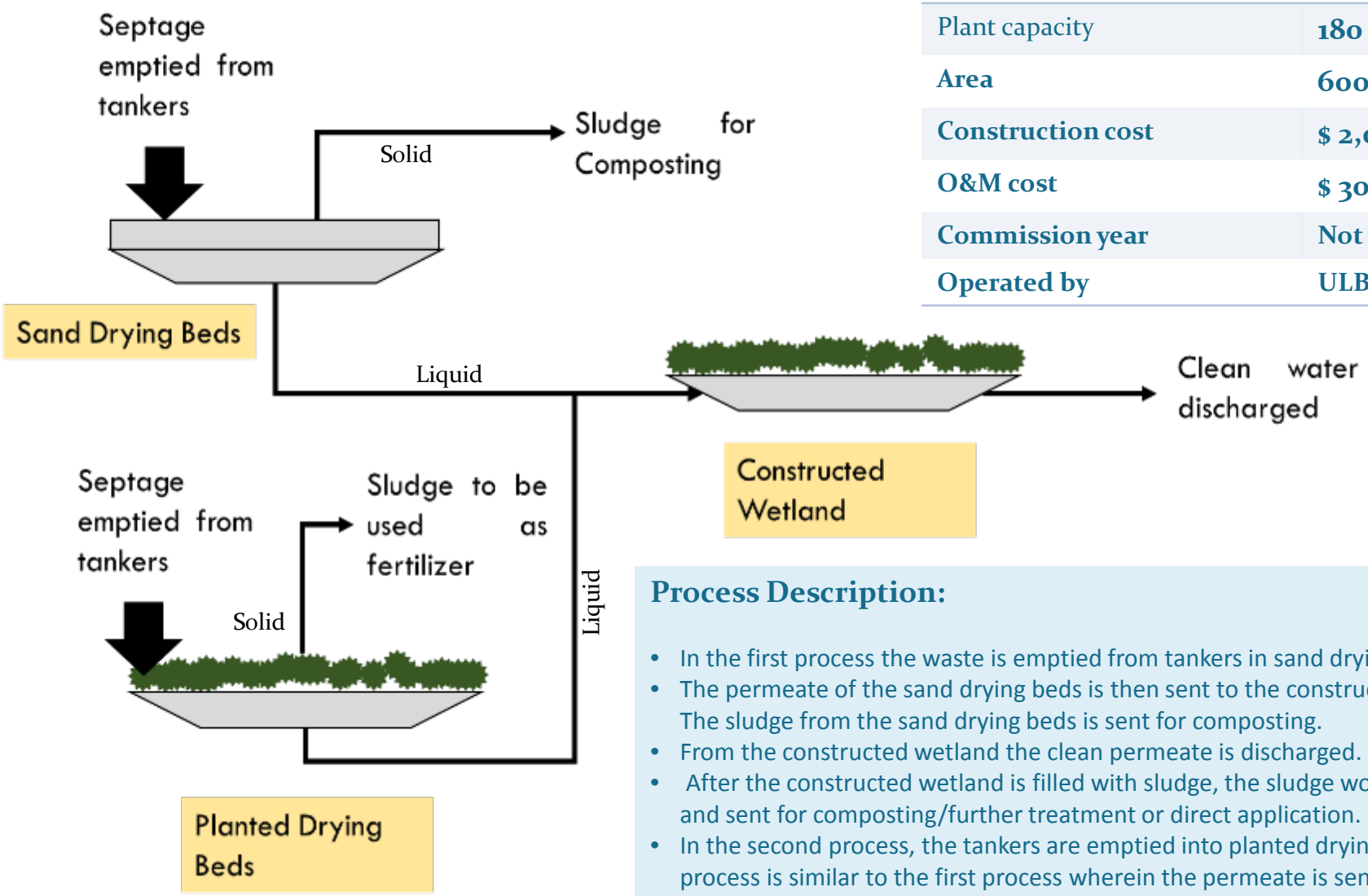


Process Description:

- In the first process the waste is emptied from tankers in sand drying beds.
- The permeate of the sand drying beds is then sent to the constructed wetland. The sludge from the sand drying beds is sent for composting.
- From the constructed wetland the clean permeate is discharged.
- After the constructed wetland is filled with sludge, the sludge would be removed and sent for composting/further treatment or direct application.
- In the second process, the tankers are emptied into planted drying beds. The process is similar to the first process wherein the permeate is sent to the same constructed wetlands as the first process.
- The sludge from the planted drying beds here is used directly as fertilizer.

Khulna, Bangladesh

Population	**15 lakhs**
Plant capacity	**180 m3/day**
Area	**6000 Sq mt**
Construction cost	**$ 2,00,000**
O&M cost	**$ 3000/ annum**
Commission year	**Not started**
Operated by	**ULB**



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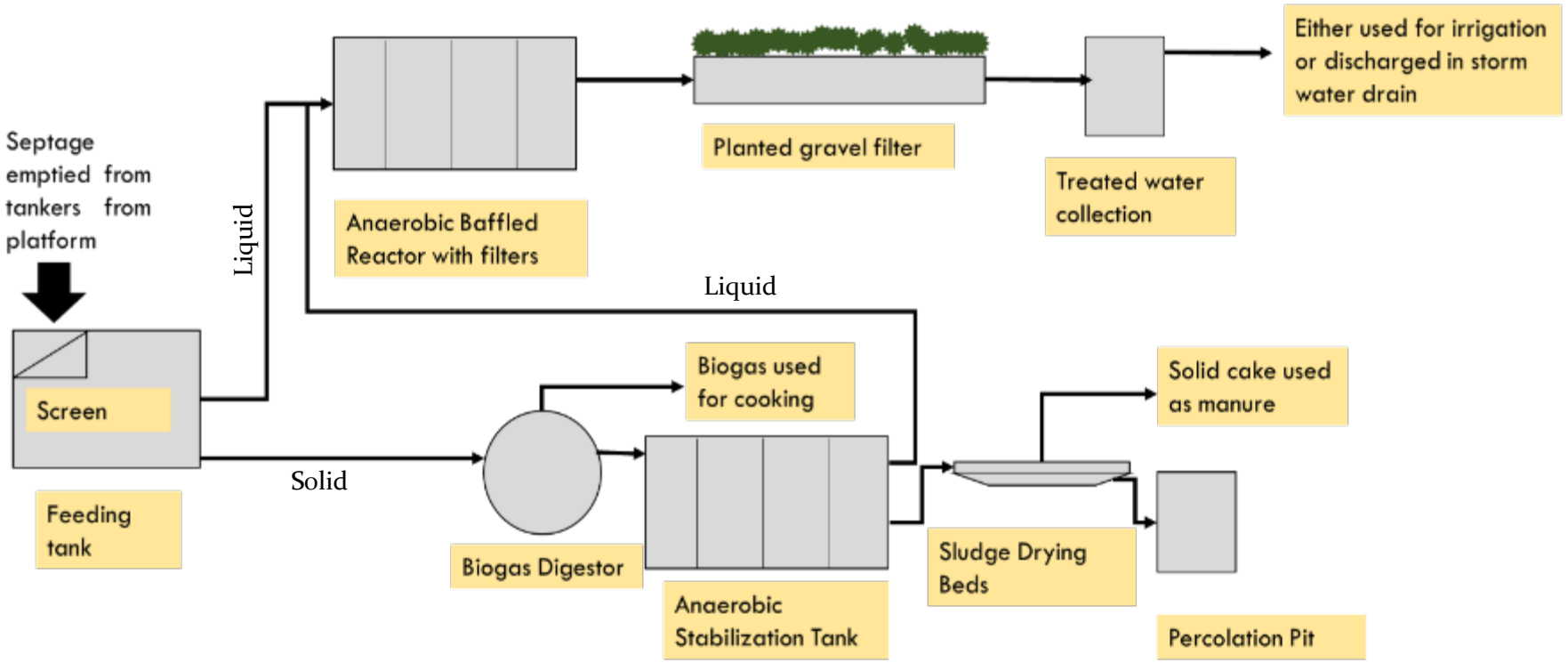
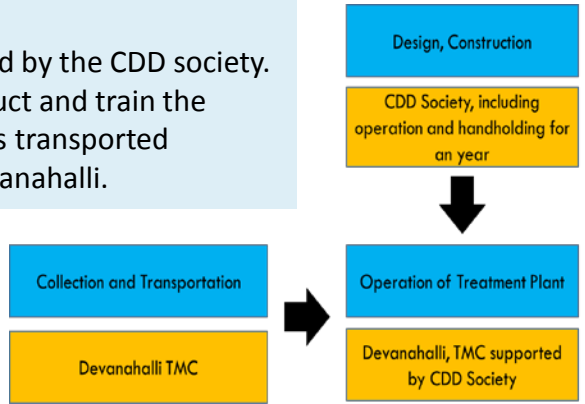
Devanahalli, Karnataka



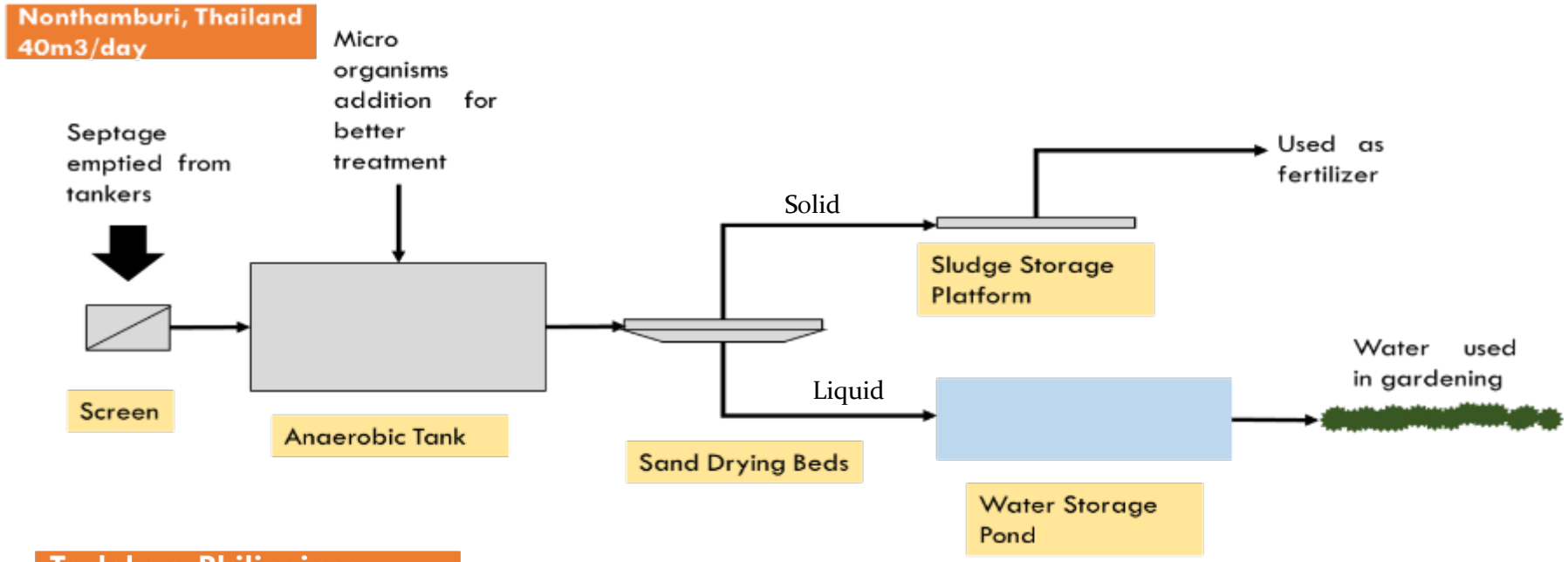
Population	**28,051**
Plant capacity	**6 m3/day**
Area	**625 Sq mt**
Construction cost	**70 lakhs**
O&M cost	**3-4 lakhs/ annum**
Commission year	**Nov 2015**
Operated by	**Private sector**

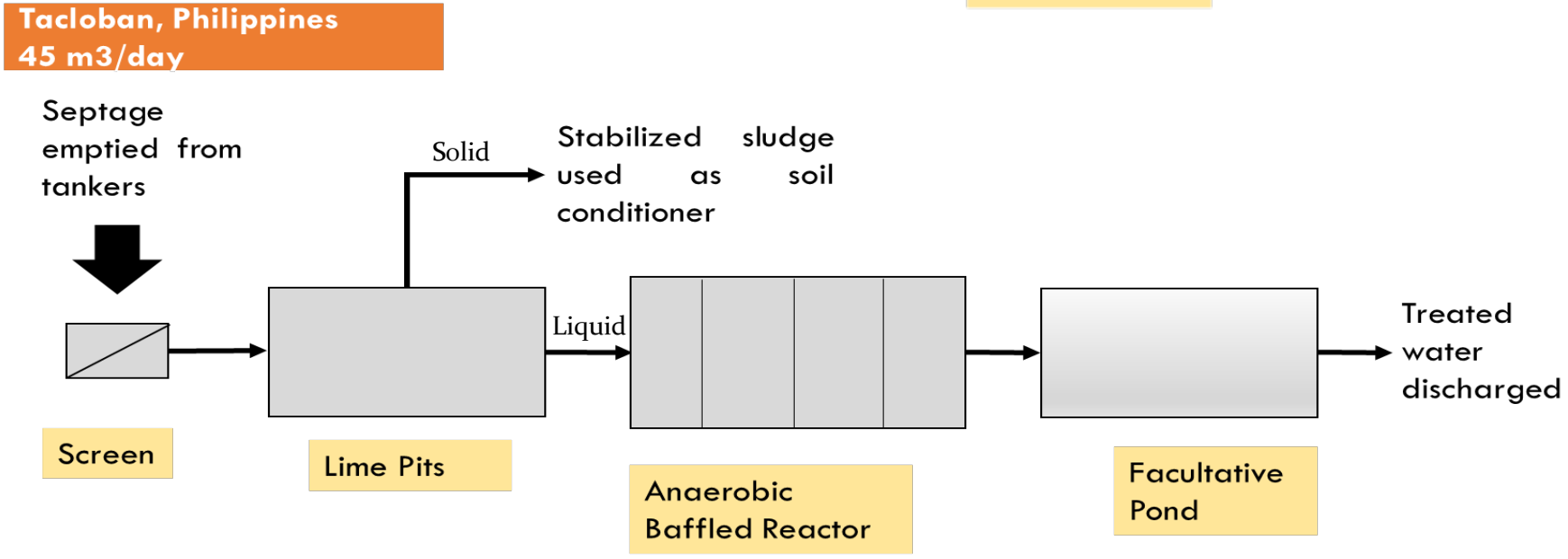
Stakeholder and Responsibilities

At present the FSTP is being maintained by the CDD society. They have a contract to design, construct and train the operator for an year. The fecal sludge is transported through trucks owned by the TMC Devanahalli.

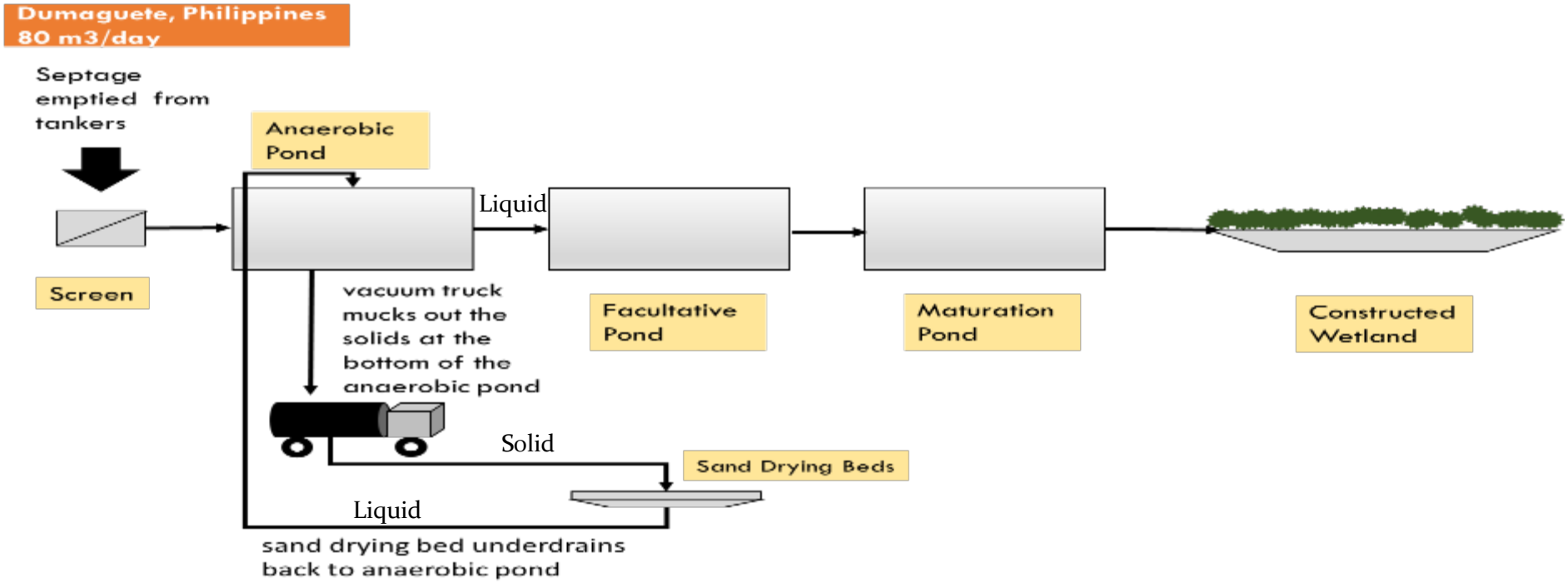


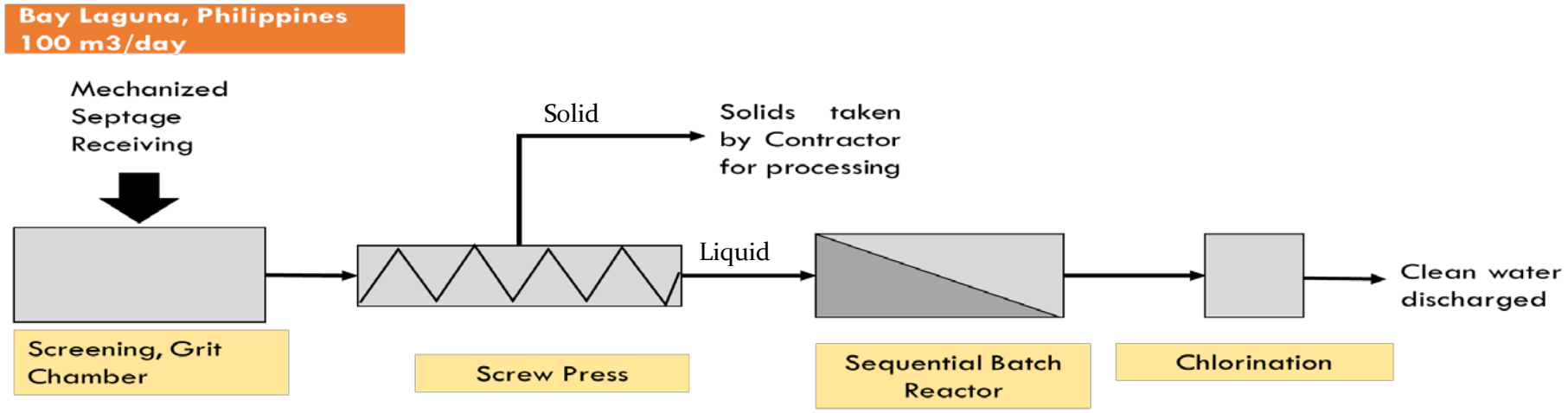
Other septage treatment plants . . . (1/2)





Other septage treatment plants . . . (2/2)





Way forward for cities . . .

- Assess the quality of septage, which is to be treated
- Compare various septage treatment options across various parameters like
  - Design , construction and operations expertise requirement
  - Land availability
  - Geological parameters
  - Mechanical / Non Mechanical
  - Capex & Opex

Thank you

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