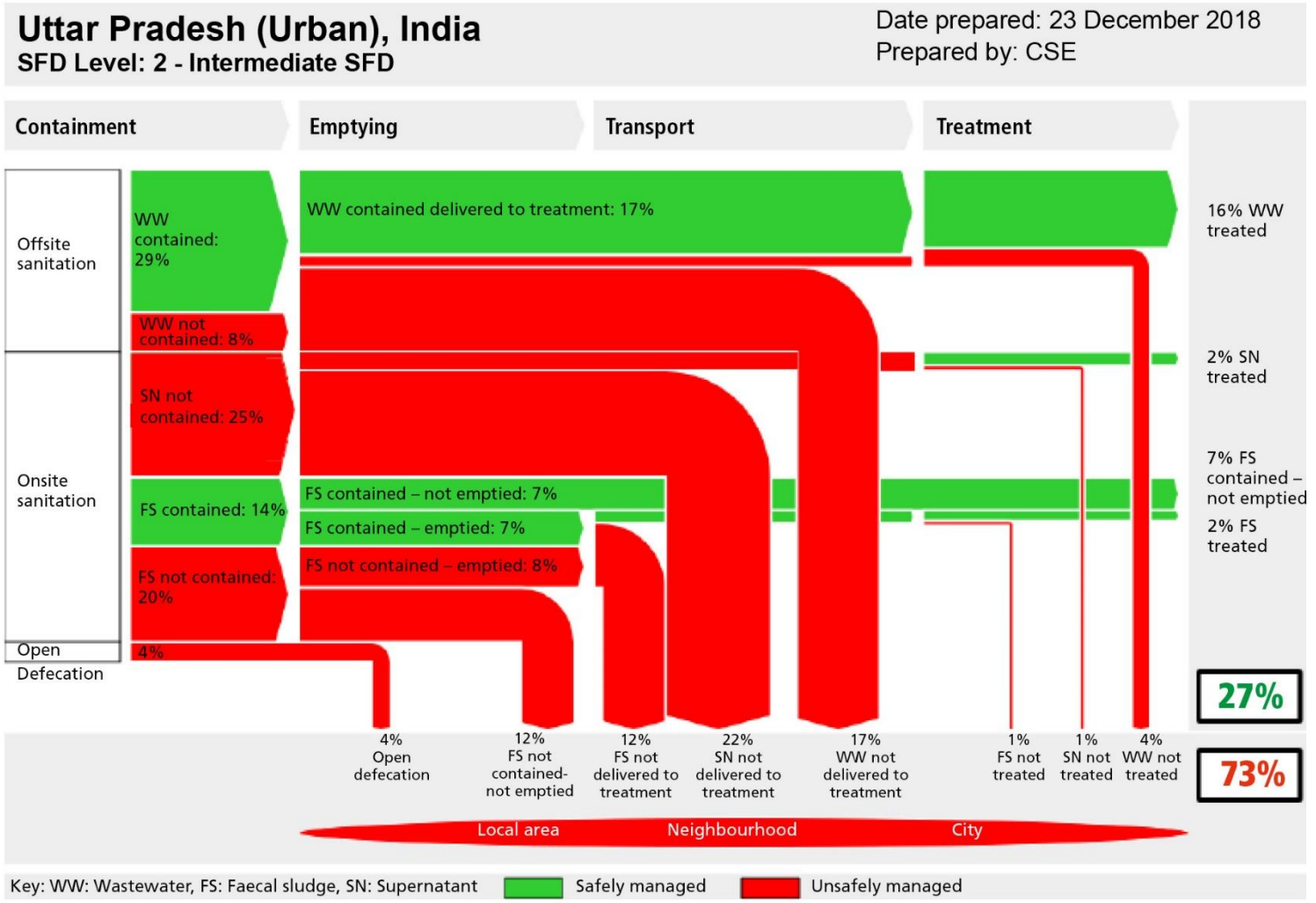
Mainstreaming Co-Treatment of Faecal Sludge and Septage (FSS) in STPs:

Co-Treatment of FSS Option in Bharwara STP Lucknow

Mainstreaming and Scaling-up Co-Treatment in U.P.

- Uttar Pradesh has over **99 STPs** including 21 STPs along the river Ganga.
- Installed capacity of the STPs ~ **3200 MLD**; majorly **underutilized** and scope for Co-Treatment of **FSS ~ 32 MLD**
- FSS generation (Urban U.P.) ~ **8 MLD**; Potential for scaling-up of Co-Treatment in STPs across U.P. (Ganga Basin). Starting with Bharwara STP in Lucknow.
- Co-Treatment of FSS will help cities leapfrog in urban sanitation and **help them achieve ODF++** targets envisaged under Swachh Survekshan 2020 and beyond.



Note: This SFD is done based on study of 66 towns and cities, representing 60% of urban population in UP
To know more about SFDs, visit https://sfd.susana.org

Background: Why Co-Treatment …. ??

Co-treatment is a process where a Sewage Treatment Plant (STP), in addition to treating the domestic sewage transported through a sewerage city, also treats FSS emptied from various Onsite Sanitation Systems prevalent in the city.

- Uttar Pradesh has **99 no. of STPs** in the state (CPCB, 2015). Installed capacity: **3200 MLD**
- FS Generation (Urban U.P.): **8 MLD;** Co-Treatment potential: **32 MLD** (@1% of STP capacity)
- A number of them are running **under-capacity**.
- The influent in the STPs are also **diluted**
- None of the city has **100% coverage by sewerage network**.
- Outgrowth areas, census towns and gram panchayats (in vicinity) have **dependence upon onsite sanitation**
- **A quicker alternative to a dedicated Faecal Sludge Treatment Plant (FSTP):** Does not need land requirement, clearances, appointment of operator.
- Existing facilities, site infrastructure and manpower of the STP can also be used for co-treatment; Eliminating the need for engaging a new O&M operator and additional cost related to site infrastructure

Existing Co-Treatment in India

1) Faecal Sludge discharged at the inlet of the STP.
(For example: Bigawan STP in Kanpur, Nissapaka STP Chennai and Tonca STP in Goa)

2) Faecal Sludge discharged at multiple decanting sites like sewerage man-holes or pumping station.
(For example: Ghaziabad and Lucknow) – *A convenient option from logistical point of view; loss of control over what goes in (multiple points)!!*

3) Faecal Sludge discharged after preliminary treatment and solid-liquid separation at STP inlet.
(Manglaghat STP in Puri, Odisha is only such example in India)

Issues and Challenges in Co-Treatment

Difference between FSS and Sewage

Impact on Efficiency & for Sewerage System & STP

Co-Treatment Issues: FSS Vs Sewage

FSS Vs Sewage

FSS is approx. 10 times more concentrated than sewage i.e.

- Higher Solids Content
- Higher Organic Content

FSS is partially digested

- Higher particulate / stabilized solids

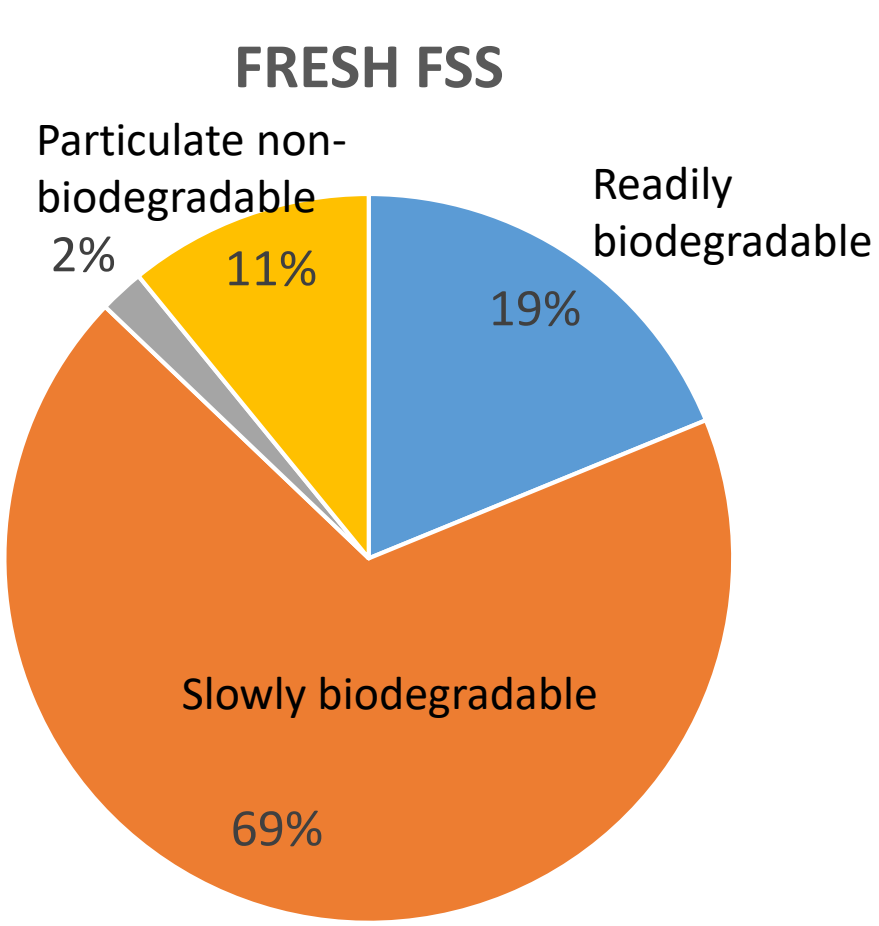
Item	Type 'A' (Fresh FSS)	Type 'B' (Partially Digested FSS)	Sewage
Example	Public toilet or bucket latrine sludge	Septage	Tropical sewage
COD (mg/l)	20,000–50,000	<15,000	500–2,500
COD/BOD	2:1–5:1	5:1–10:1	2:1
NH4-N (mg/l)	2,000–5,000	<1,000	30–70
TS (mg/l) (%)	≥ 3.5	< 3	< 1
SS (mg/l)	≥ 30,000	≈ 7,000	200–700
Helm. eggs, (no./l)	20,000–60,000	≈ 4,000	300–2,000

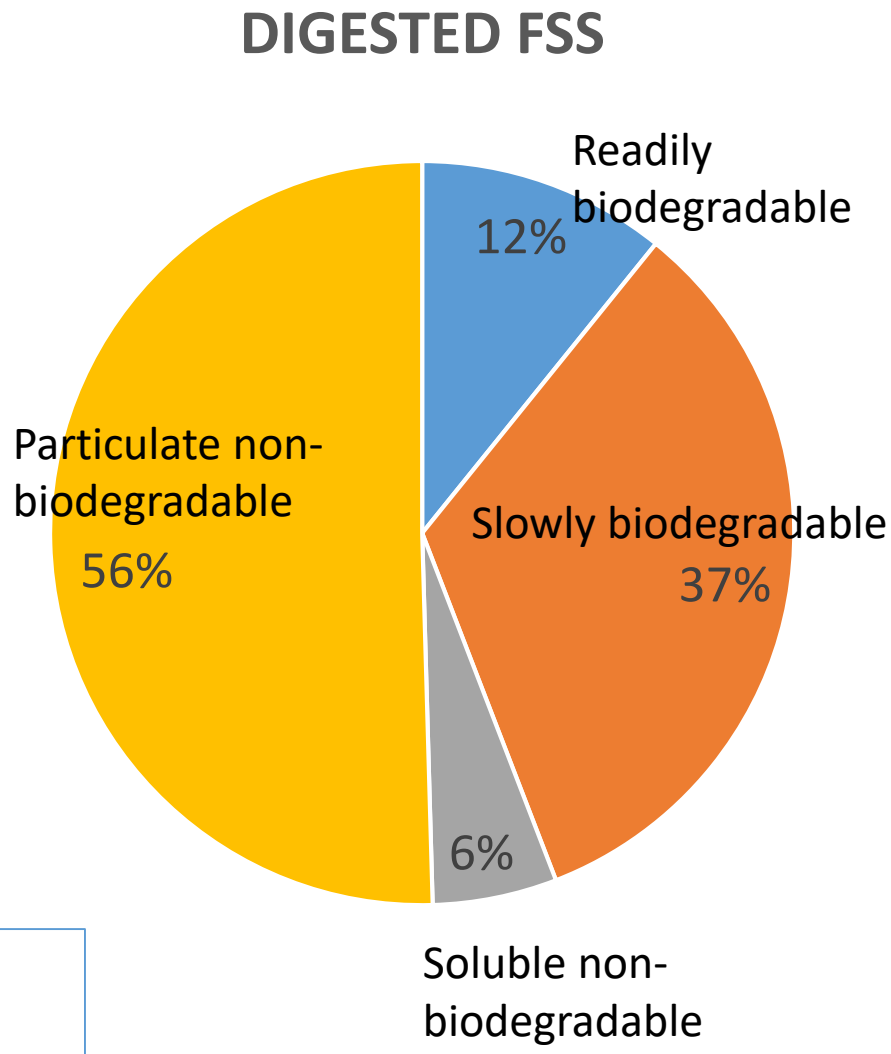
(Heinss et al., 1998)

Impact on STP

High Solids: Operational issues; sewerage system (slope; diameter) designed for transport of sewage.
High Organics: Can impact the STP Treatment Efficiency

Break-up of FSS Organic Portion (COD)





Removing Particulate Non-Biodegradable Organic Fraction → Liquid more amenable for treatment

Ref: Fecal Sludge and Septage Treatment Design Guide Book, Kevin Tayler

Variability of FSS - FSS Testing in Bijnor, Chunar and Lucknow

Factors on which FSS depends:

- Source of FSS and Toilet Usage
- Type of Containment System
- Storage Duration
- Emptying Methods
- Climate

Variation of FSS in Chunar, Bijnor and Lucknow:

- BOD: 2000 mg/l to 7000 mg/l
- COD: 6,000 mg/l to 120,000 mg/l
- Total Solids: 1% to 11%

FSS Testing at Bharwara STP (by UPJN)

Location	TS (mg/L)	COD (mg/L)	BOD (mg/L)	COD/ BOD
Khargapur	25,006	20,800	6,500	3.20
Lakshmanpuri	7,204	3,200	1,650	1.94
Abrar Nagar	14,300	7,900	2,150	3.67
Harihar Nagar	39,400	27,500	7,000	3.93
Vibhuti Khand	86,600	36,000	7,700	4.68

FSS Testing at Chunar (by CSE Lab)

Location	TS (mg/L)	COD (mg/L)	BOD (mg/L)	COD/ BOD
Jal Kal Camp.	32,160	67,950	5,800	11.7
Kanshiram Awas Colony	30,500	72,300	5610	12.9
Com. Toilet	60,960	10,0800	3,730	27.0
Public Toilet	17,360	31,800	2,960	10.7
Radiant Int. School	31,000	53,100	3,260	16.3

FSS Testing at Bijnor (by CSE Lab)

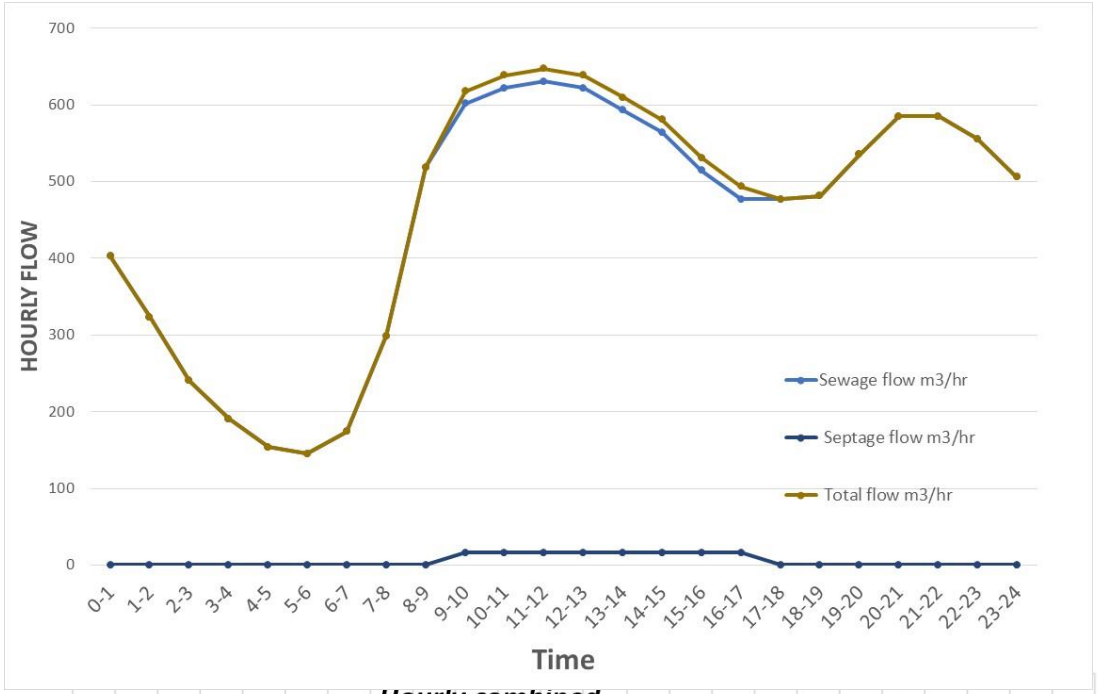
Location	TS (mg/L)	COD (mg/L)	BOD (mg/L)	COD/BOD
Household– Mukarpur Khema	118,348	72,300	5,430	13.3
Household– Valmiki basti	31,398	120,100	4,630	25.9
Krishna College	1,278	1,040	870	1.2
Household– Faridpur	42,264	45,550	1,640	27.8
CT-Ravidas Nagar	2,638	6,200	630	9.8
Household–Awas Vikas colony, Islampur Das	41,424	49,300	3,010	16.4

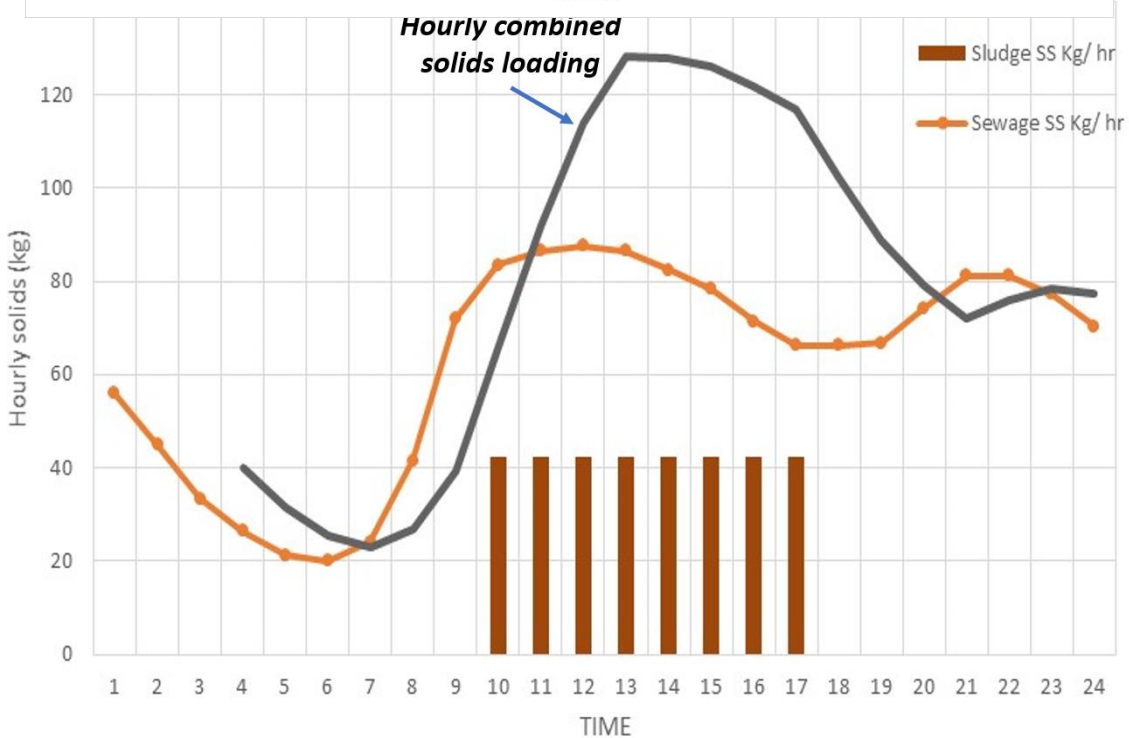
Impact on STP Loading Rate:

- Impact on Hydraulic Loading Rate is negligible
- Potential Impact on Organic and Solid Loading Rate
- **Intermittent nature of FSS flow** – Shock Loading

Ex:
STP Capacity: 10 MLD
FSS Loading: 0.2 MLD

Impact on Hydraullic Loading: 2%
Impact on Organic / Solids Loading: ~40%





Impact of FSS Co-Treatment on STP

- **High Solids:** Operational problems such as solids deposition, clogging, corrosion of sewerage infrastructure.
- **High Organics:** Affect the Treatment Efficiency of STP.
- **High instantaneous / shock loads:** can lead to process failure

Feasibility: Co-Treatment of FSS in STP

Study of STP:

1) **Scope for dilution:** The spare capacity in the STP to treat the additional load from FSS (depends on the influent load)
2) Study the **existing treatment efficiency of the STP and identify the limiting factors**, which can affect treatment efficiency like F/M ratio, oxygen requirement in case of aerobic process and pH, ammoniacal nitrogen content in anaerobic process. **Treatment Efficiency → Are optimal conditions being achieved in STP ..?? How FSS would impact ..??**

Physical and economical factors:

1) Land availability at the STP?
2) Distance of STP from the city?

Important Considerations:

- ❑ Greater the size of STP → Greater the ability to absorb shock loads from FSS.
- ❑ Need to plan for future loading conditions / scenarios.

Co-Treatment: Reduce impact of FSS

- Rejection of Industrial / Commercial Wastewater Streams
- **Preliminary Treatment** - to remove trash
- **Homogenization / Attenuation Tank** – Intermittent / Shock loads,
- **Solid-Liquid Separation** – Remove particulate non-biodegradable organics; making the separated liquid more amenable for treatment in STP

Volume of FSS Addition: Start with a conservational approach; Increase the volume while monitoring the impact on the STP

Options for Co-Treatment

Solid-Liquid separation (mechanical / non-mechanical) ; Direct dilution

Co-Treatment Options (Solid-Liquid Separation)

1) Direct Decanting at Drying Beds (existing STP)

Adv:	**Dis-Adv:**
1) No. capital expenditure needed. 2) Good efficiency of solid-liquid separation and organic load reduction.	1) Direct loading of FSS: may include trash; Oil/Grease causing blockage of underdrainage system 2) High land requirement 3) Needs favourable weather conditions

2) Use of Geobags at Drying Beds (existing STP)

Adv:	**Dis-Adv:**
1) Reduces the requirement of Sludge drying beds. 2) Geo-bags achieves Solid-Liquid separation.	1) Disposal of Geobags. 2) Recurring cost of Geobags

Capex: Rs 20k – 30k per bag; 10cum to 90cum capacity per bag

Co-Treatment Options

3) Settling Thickening Tank with drying beds

Adv:	**Dis-Adv:**
1) Achieves homogenization as well as Solid-Liquid separation. 2) Removes Fat-Oil-Grease	1) Needs good Settleability characteristics of FSS. 2) Needs active sludge management (to be removed every 1-2 weeks.)

Capex: Rs 20-25 lakh (30KLD); Area: 100 sqm (STT); 800 m2 drying beds;

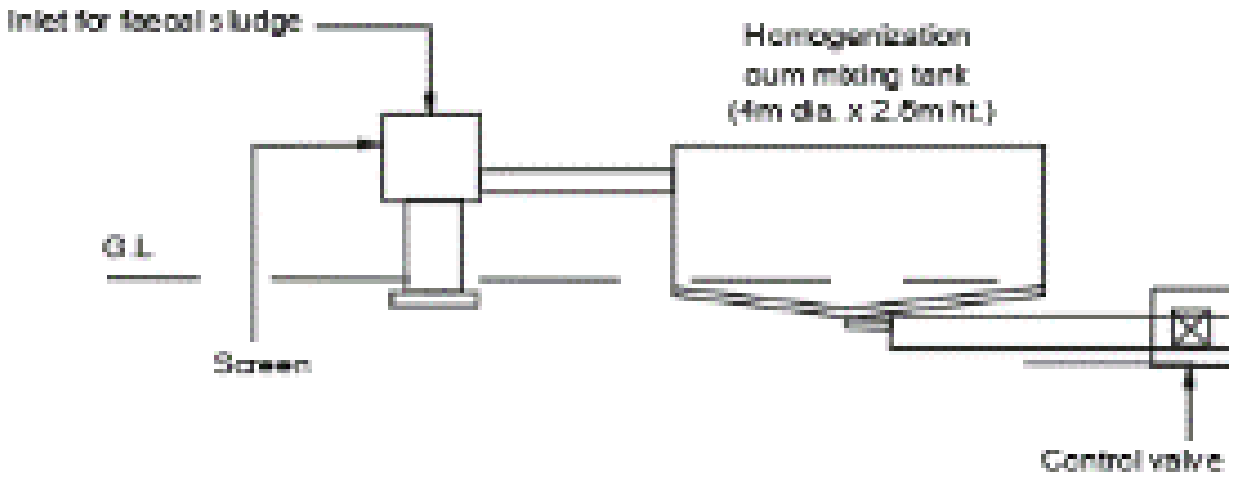
4) Mechanized Solid-Liquid Separation

Adv:	**Dis-Adv:**
1) Reduces the land requirement. 2) Reduces the need for sludge drying beds.	1) Increased power requirement. 2) Skilled Manpower 3) Availability of spare-parts and consumables (polymer dosing) 4) Need for repair and maintenance.

Capex: Rs 30-35 lakh (30KLD); Area: 100 sqm;

Co-Treatment Options

5) Dilution : Homogenisation & Controlled Discharge



Adv:	Dis-Adv:
1) Reduced capital intervention and easy operation.	1) Only suitable with diluted Sewage and diluted FSS i.e. low solid content (~1%). 2) Only suitable when available dilution capacity of the STP

Capex: Rs 18-20 lakh (30KLD); Area: 70 sqm;

- The quality of the end product / bio-solids is compromised since mixed with sewage.
- Stabilized Solids (Particulate Non-Biodegradable) fractions of FSS Organics are not removed which can lead to operational issues.
- The STP Sludge Drying Beds adequacy can be affected.

Bharwara STP: Existing Scenario

Present Conditions:

STP Capacity: 345 MLD
Presently operating under full capacity

Influent Sewage:
BOD: 140 mg/l *(design value of 250)*
COD: 275 mg/l *(design value of 500)*

Influent FSS:
3 to 4 truck loads a day i.e. 20 KLD
BOD: 5,000 mg/l
COD: 40,000 mg/l

Lucknow FSS Generation~ 100 KLD

Impact of FSS on Loading conditions at Bharwara STP:
Hydraulic Loading: 0.006%
BOD Loading: 0.2%
COD Loading: 0.8%

FSS impact on STP Treatment efficiency:

1) Ability of absorb shock load:
Hydraulic load of FSS is 0.006% influent sewage;
Due to sheer size of STP, impact is insignificant.

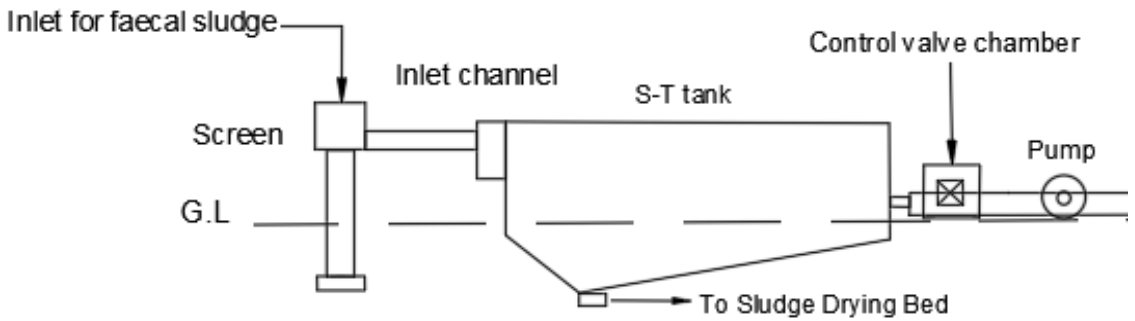
2) Spare Capacity / Dilution Capacity:
Spare capacity of 69,000 Kg(COD)/day
Combined BOD Load - 140.3; COD Load - 277.3
Impact on Organic Loading in negligible

Bharwara STP: Co-Treatment Option

Planning for Future Scenario

1) Increased sewerage connection i.e. increase in Organic and Solids Loading
2) Variability of FSS influent through regular desludging & greater geographical spread

- **Settling Thickening Tank with Drying Beds**
  - Preliminary Screening Unit
  - Homogenization and Attenuation to deal with:
    - Variability of FSS
    - Intermittent nature of FSS loading
  - Solid – Liquid Separation
    - Settled solids pumped to drying beds
    - Supernatant (Clear water) overflows into the STP
  - The STP has **107 existing drying beds** (27m x 27m). **One spare drying bed** can cater to the need for Co-Treatment for 30 KLD.
- Quality of compost: FSS bio-solids vis-à-vis Sewage bio-solids



Settling Thickening Tank
(30 KLD)
(4m x 10m x 2.5m)

Scaling-up Co-Treatment: Models for Implementation

Approach: 1

- Technology: Settling Thickening Tank with Drying Beds.
- Implemented through Civil – item rate contract
- Existing STP Operator / management in-charge of O&M
- Revenue from re-use of bio-solids from FSS to be shared with operator (incentive)

Approach: 2

- Technology: Agnostic (incentive for cost effectiveness & less land requirement)
- Long term performance based contract for the operator
- Output based performance criteria; BOD and Solids reduction *(since operation of STP not in his scope)*
- Revenue from re-use of bio-solids from FSS to be shared with operator (incentive)

Co-Composting: Treated FSS & Organic Municipal Solid Waste (MSW) → Improved Product

- FSS high in 'Nitrogen' and 'Moisture Content'; Organic MSW rich in 'Carbon' and Bulking Properties;
- High temperatures achieved during 'Aerobic Composting' helps inactivate pathogen

Monitoring for Co-Treatment

- Monitoring FSS Impact on STP Treatment Efficiency:
  - Check operational parameters:
    - UASB – Sludge Retention Time (3-4 weeks); Hydraulic Retention Time (Up-flow velocity: 0.5-0.6m/hr & COD Loading Rate: 1.15-1.45 kg/m3 . Day)
    - Sufficiency of Aeration / Oxygen requirement (ASP)
  - Process control parameters:
    - Influent / Effluent monitoring at each step – (parameters like F/M ratio, MLSS can be measure to assess optimal conditions are being maintained)
  - Monitoring influent FSS Load and its impact on treatment performance
- Routine Maintenance: Sludge/Silt control; Corrosion control; Lubrication & Maintenance of Mechanical
- Challenges with multiple decanting stations like manholes / SPS:
  - Monitoring what goes in (rejecting industrial / commercial waste)

Scaling-up Co-Treatment in U.P. /Ganga Basin

- Co-Treatment modules like Settling-Thickening Tanks are easy to implement and operate. Can be implemented within 3 – 6 months.
- The Intervention at Bharwara (Pilot) can be used as a learning for scaling-up Co-Treatment across the U.P. and Ganga Basin
- CSE Lab can support in testing and monitoring the STP performance Pre- and Post- the Co-Treatment Intervention

Thank You