BORDA

City-Wide Inclusive Sanitation:

Approaches and Options

Series 1: Understanding the Basics of STPs and FSTPs

Presentation to the Policy and Practice Group

31st May, 2023

Contents

Indian Cities…need a mix of solutions

Options for CWIS

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1. Centralized Sewerage

- Manage **100%** of wastewater
- **One / few STPs in city**
- **100% Govt CapEx and OpEx**
- Treated water re-use: agri/industry
- Tested, proven approach globally

1. **Simplified Sewers:** A stripped-down network, smaller, shallow pipes
2. **Solids-Free Sewers:** Remove solids at / near source, less O&M, less slope and depth, fewer manholes

Only little experience of these in India

2. De-centralized Sewerage

- Manage **100%** of wastewater
- **Small capacity** (~0.1 - 5 MLD)
- Can use various suitable tech.
- **Localized treated water re-use**
- **Network is simplified and cheaper**
- **O&M is more complex**

1. **Neighbourhood Level:** Govt cost. Integrate STPs into urban infra (parks, public space, underground)
2. **Large Buildings / Campus:** Private responsibility / cost. Needs strong monitoring. Reduces public spends

3. FSSM

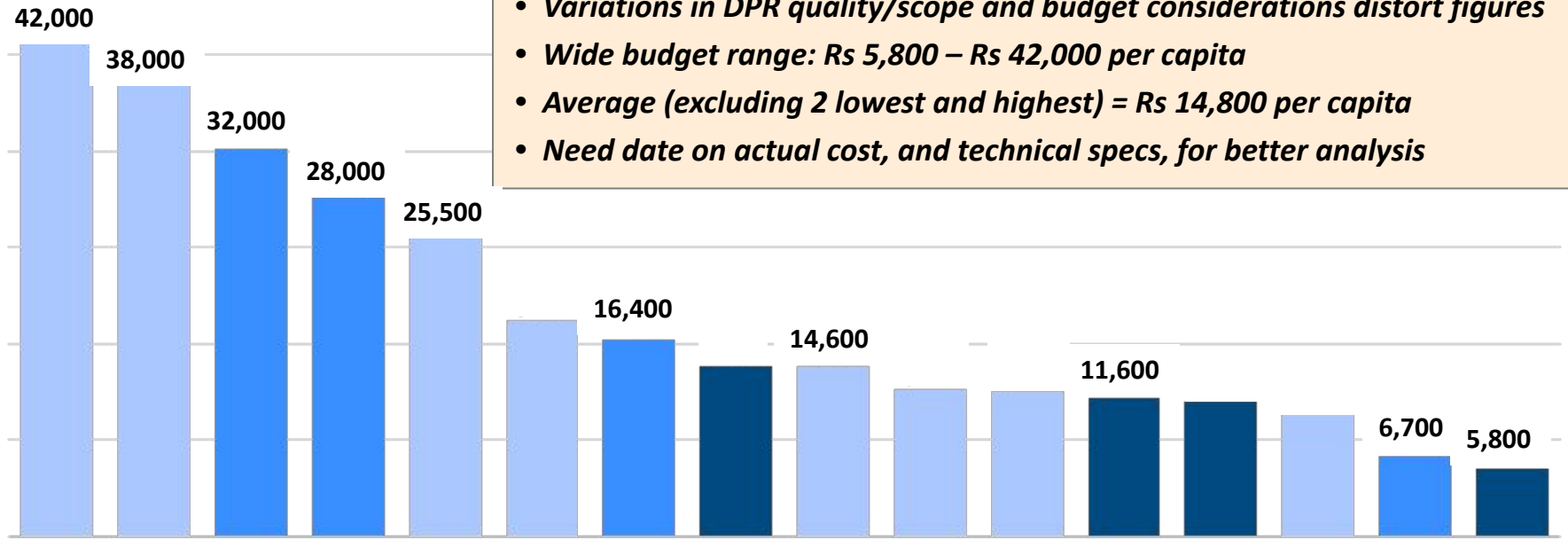
- **A PARTIAL SOLUTION:** Only **~1%** of wastewater, but **most dangerous faction**, is *properly (??)* managed
- Inexpensive + quick to deploy
- Septic tanks are the weakest link
- **Requires good on-going O&M**

1. **Scheduled Cleaning:** Better pollution control. Must be managed and paid for by local authorities
2. **On-Demand Cleaning:** Greater Pollution impact. Lower Cost.

Per Capita Sewer System Cost (US$) based on DPRs

Analysis by Innpact Solutions

- *Need to consider per-capita and also total cost for a town*
- *Variations in DPR quality/scope and budget considerations distort figures*
- *Wide budget range: Rs 5,800 – Rs 42,000 per capita*
- *Average (excluding 2 lowest and highest) = Rs 14,800 per capita*
- *Need date on actual cost, and technical specs, for better analysis*

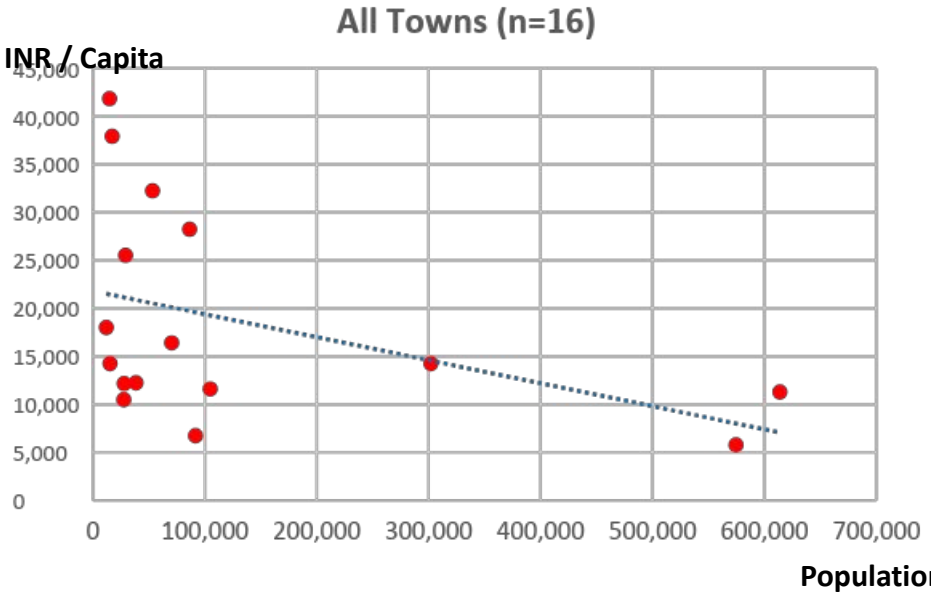


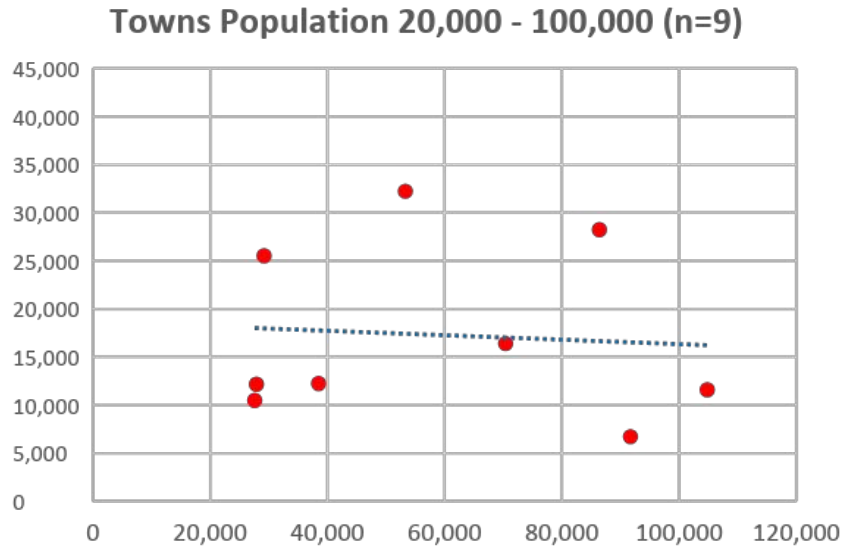
	Joshimath	Alappuzha	Ankapalli	Guntur	Vallikeezhu	Sanchi	Maiher	Pahari	Rajnagar	Dhamnod	Khajuraho	Kozhikode	Ujjain	Chitrakoot	Nagda	Trivandrum
Pop.	14,866	17,212	53,308	86,389	29,194	11,980	70,428	3,01,800	15,267	38,540	27,900	1,04,797	6,13,830	27,625	91,685	5,74,605

<50 K | > (50 -100) k | > 100k

om various state governments in last 5 years

Sewerage System Cost and Population, based on DPRs





There are economies of scale for larger cities

Population < 20,000 = Rs 28,800 / capita

20,000 – 105,000 = Rs 16,900

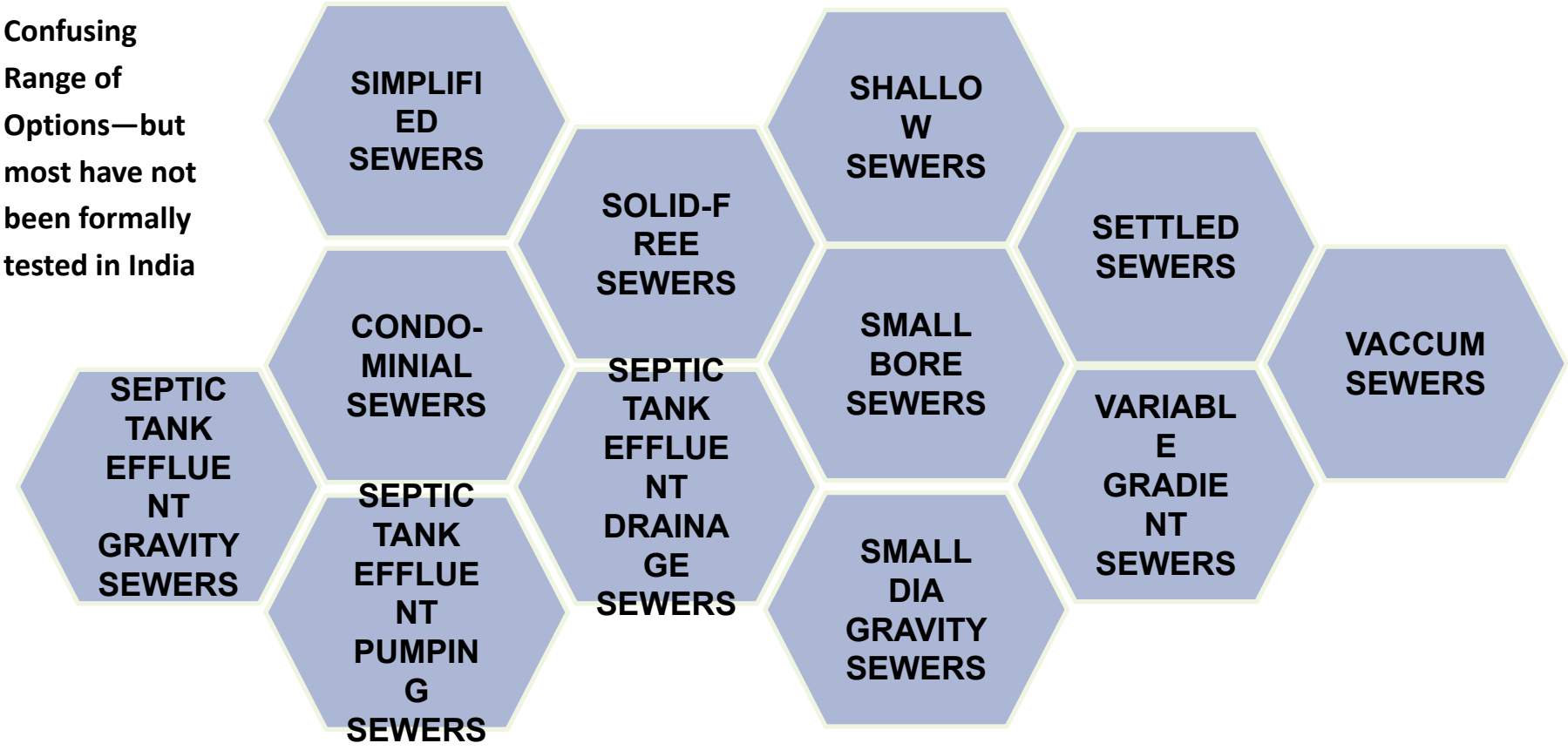
> 105,000 = Rs 9,100

Analysis by Innpact Solutions

Source – Approved DPR from state governments in last 5 years

Many Options: Different Types of Shallow / Simplified Sewers

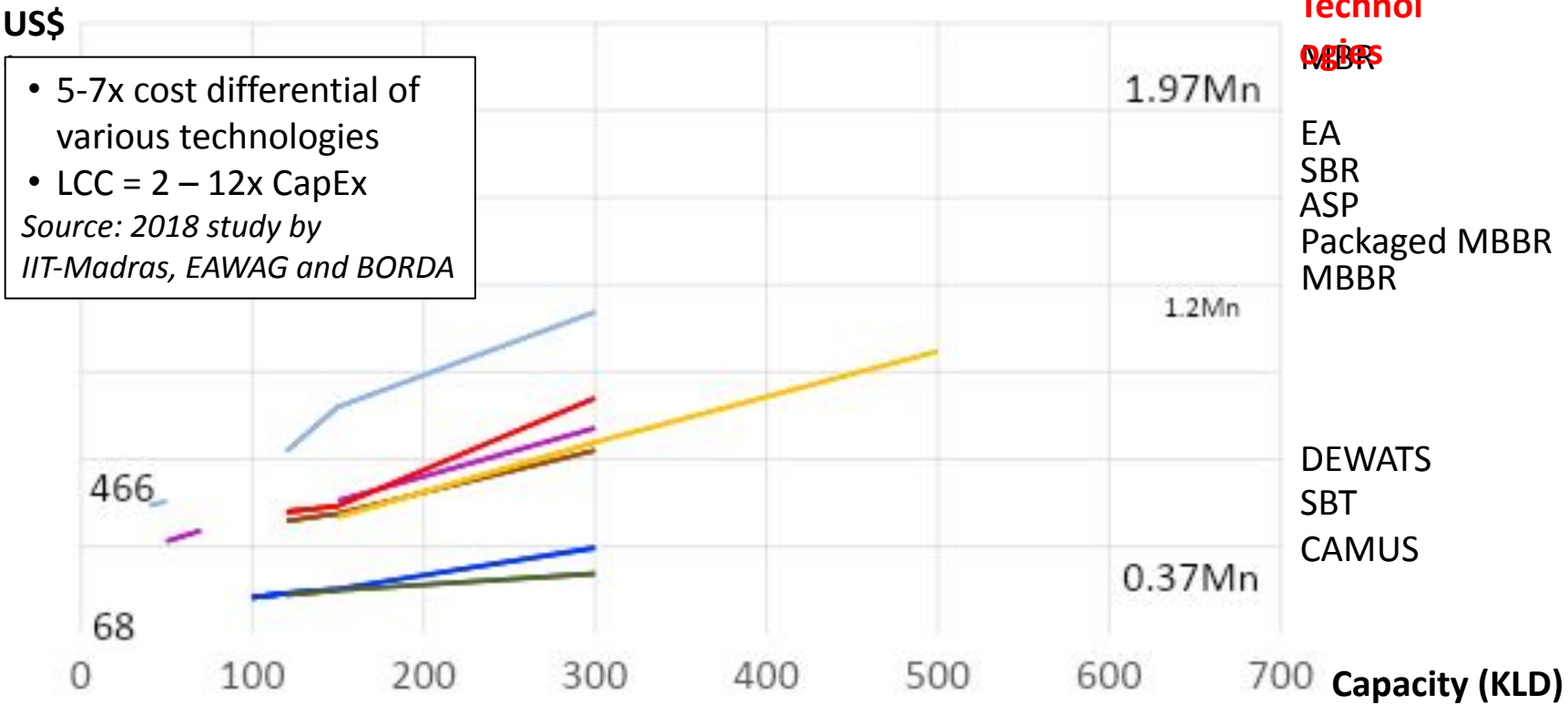
Confusing Range of Options—but most have not been formally tested in India



De-Centralized STPs: Life-Cycle Cost (10-year) at Small-Scale

- 5-7x cost differential of various technologies
- LCC = 2 – 12x CapEx

Source: 2018 study by IIT-Madras, EAWAG and BORDA



De-Centralized STPs | Example of Kargil, Ladakh

Area: 8.8 km^2

Population: 43,000 (2011: 16,338)

Road Length: 87km

Temp: -48°C - +35°C

-Septic tanks freeze in winter so toilets cannot be used—use dry toilets

-Ground water pollution in some places

-MBBR was suitable due to cold climate

-Original design had 9 STPs and No Pumping Stations—CapEx would be higher, but it would have been easier to build shorter Trunk Pipes and smaller STPs on hills. A detailed costing was never done.

Sewerage Project Plan:

Network: 58km with ~5,000 manholes

HH Coverage: 100%

Sewer Population: 145,000 (30-yrs)

STP Population: 98,900 (15 years)

3 Pumping Stations

6 STPs (1.0 – 5.1 MLD) = 9.9 MLD (MBBR)

	INR Cr.	%
Sewer Network	81	40%
Pumping Stations	2	1%
STPs	35	17%
Branch Network	33	16%
Household Connections	41	20%
Total	**204**	**100%**
O&M (10 Years)	68	3.4% / Yr

Economics of Solids-Free Sewers| Calculations for Dwarka, Gujarat

Area: 42.1 km^2

Population: 39,000

Existing STP: 7.4 MLD

3 Zones with 13,400 people without sewers

Solid Free Sewer can cost 20% lower than Conventional Network.

Requires simpler STP too.

Total savings can be 25%+

No	Component	Conventional w/ HDPE Pipes	Solid Free Sewerage
1	Network Pipe Cost (A1)	53,437	53,457
2	Network Excavation (A2)	59,011	72,347
3	Manholes/Chambers (B)	300,086	241,039
4	Trunk Mains (est.—2.3km Pipe + Excav.)	64,266	13,718
	Sub-Total for Network Only	**476,800**	**380,561**
	% change wrt Conventional System		*-20.2%*
5	Sewage Treatment Plant (estimated)	375,000	255,000
	Sub-Total for Network + Treatment Only	**851,800**	**635,561**
	% change wrt Conventional System		*-25.4%*
	Per Capita Cost	Rs 5,113	Rs 3,815

FSM: What are we Solving For??

FSM: Case Studies | Leh and Devanahalli

HH	Septic Tank %	Trips / Day	Capacity (KLD)	Capacity Utilization
5,600	10%	1	8 KLD	**30%**
5,800	1%	5	12 KLD	**98%**

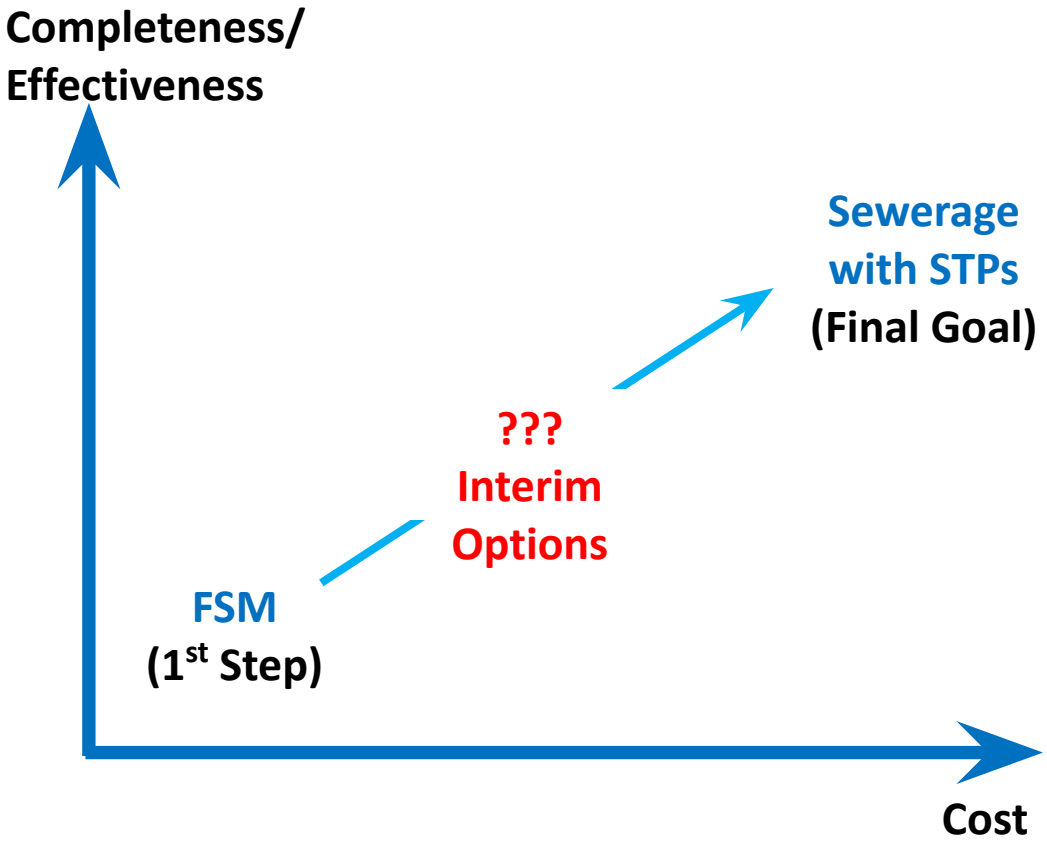
Why such difference in performance?

Scheduled v On-Call? Govt. role? Contract of Private Party??

FSM: Leh and Devanahalli | Digging Deeper

Sludge / “Solids”	Leh	Devanahalli
Est Total Sludge Generated / Year	2.5 ML	2.8 ML
Total Sludge to FSTP	0.125ML	0.084 ML
% Sludge Treated at FSTP	**5%**	**3%**

Re-Focus?



Lessons:

1. Collect all waste streams
2. Primary treat EVERYTHING
3. "License to Contravene"
4. Work towards Tertiary treatment of everything
5. Phased Plan for a town
6. Differential Standards based on Context and Re-use purpose
7. **Right Goals: *Building FSTP* versus *% of Sludge and Blackwater Treated***

Summary of CWIS Options

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1. Centralized Sewerage	2. De-centralized Sewerage		3. FSSM	
Options / Variants: **1a. Simplified** *(already being incorporated?)* **1b. Solids-Free Sewers**	**2a. Neighbour-hood Level STPs**	**2b. Buildings / Campus Level STPs**	**3a. Scheduled De-sludging**	**3b. On-Demand Services**

Cities have multiple options to mix-and-match,
to meet their short and long-term sanitation goals,
depending on location conditions, need-gaps, and budgets

There can be a role for Govt and Private Sector in each option

Language Confuses: "On-Site", "Off-Site", "Centralized", "De-centralized" are limiting

Other Considerations: What does the Future Hold?

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Reduce pathogens in the environment

Separating (and treating) max solids at (or near) the source

Design to reduce possibility of sewers flooding

Optimize nutrient Recovery +re-use

Promote circular economy

Climate Friendly

Reduce energy footprint (incl. embedded carbon in cement, steel)

Maximize used-water re-use <u>within the city</u>

Resilient to low water supply (shortage / efficiency)

Water usage must drop in the future (see next)

System should not fail, or lock us into high water usage

Modifiable and flexible for future upgrades

Able to regularly upgrade / integrate new technologies

Smart sewers with sensors etc

Example: Water Usage over Time

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Activity	Earlier Water Consumption (Liters)	Current Water Consumption (Liters)	Reduction %
Washing Machines	150 – 170	38 – 95	44 – 75%
Toilet Flush	19 – 27	3 – 5	83%
Dish Washer	38 – 58	13 – 15	66 – 74%
Shower (bucket bath: 25L)	Regular: 9.5 L / min (7 min = 66L)	Water Saver: 7.6 L / min (7min = 54L)	20% *(ban showers?)*
Faucet	Regular: 8.3 L / min	Aerated: 5.6 L / min	33%
Urinals	3-5 L / flush	Waterless (not compulsory!!)	100%

Can we find ways to be Comfortable + Healthy at 75 LPCD??

Can our Sewer Systems by Effective at 75 LPCD?

What is the financial and environmental impact of 135 versus 75 LPCD?

CWIS: An Approach

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While expanding Sewers, consider the following options, depending on local resources:

No	Option	Notes
1	**Implement 2A** (large building and campus level STPs)	• Easiest to do—policy framework exists (10-50% of WW??) • Adds <0.5% to construction costs—can be retro-fitted too • Need better enforcement—SPCBs can partner with NGOs?

Some Knowledge Gaps : Studies and Pilots Needed

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No	Topic	Question / Knowledge Gap
1	**Sewerage Systems**	• What is the actual cost of building good and complete systems across different town sizes, types and topographies? • Lifecycle cost calculations
2	**FSM / FSTPs**	• Detailed study across India to identify root causes of problems
3	**'De-centralized' STPs**	• Technical and Financial analysis of small-scale STP technologies Town studies on feasibility—tool-kits and methodologies
4	**New Sewerage Technologies**	• Solids-Free Sewers and Pressurized Sewers *(water networks cost 1/7th of sewer networks):* Technical and Financial Studies • Pilots needed urgently
5	**Water Usage**	• Options to minimize water usage (industry, domestic, agriculture)

Suggestions for Government / CPHEOO

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1. Knowledge and R&D

- India may spend $40-100 Billion (Rs 3-8 Lac Crores) on sewerage in next 10-20 years
- *Worth spending 1% -- $0.4 - 1 Billion (Rs 3,000 – 8,000 Cr) on studies and pilots of above ideas in next 2-4 years*

2. Spending Process

- Capital Grants encourage short-term planning over Lifecycle Cost Analysis
- Long-term budget planning or escrow funds for optimal decisions
- Nurture long-term vendors over L1 bidding. More HAMs maybe.

3. State Water + Wastewater Utilities

- Financial independence--Mandate to raise own capital (Bonds, Fees)
- *Long-term technical and O&M planning capabilities and authority*
- City-level is ideal, but difficult—maybe for large cities

4. An Integrated Approach

- *Align Policy + Finance + Capacity + R&D + Planning + Contracting*
- Planned Incremental Pathway is needed—who will coordinate / manage?

Thank You!