Orientation Training on SBM2.0 Guidelines

WASH Institute

3 Day Classroom Training Module

Orientation training on SBM 2.0 guidelines
3-day Classroom training
9:00 am- 5:30 pm

Time	Session	Time (Min)
10:00 am	Welcome address to the participants	15
10:15 am	Introduction to the trainings and objective setting	45
11:00 am	SBM 2.0 guidelines	45
11:45 am	Tea break	15
12:00 pm	Activities under SBM 2.0 – Toilet sustainability	90
13:30 pm	Lunch break	60
14:30 pm	Activities under SBM 2.0 -Used water management	60
15:30 pm	Zoning of a city – Case study	60
16:30 pm	Tea break	15
16:45 pm	City Sanitation action plan	30
17:15 pm	Feedback	15
09:00 am	Recap and Zoning assignment	75
10:15 am	Tea break	15
10:30 pm	Design basis and feasibility of sewerage networks with case study	90
12:00 pm	Exercise – Population projection	90
13:30 pm	Lunch break	60
14:30 pm	Fecal sludge management	60
15:30 pm	Estimating investment for FSM	60
16:30 pm	Tea break	15
16:45 pm	Drain based conveyance models – Design and feasibility- with case study	60
17:45 pm	Feedback and summary	15
09:00 am	Recap exercises	60
10:00 am	Wastewater treatment systems	90
11:30 am	Tea break	15
11:45 am	Estimating investment for drain based systems and I&D infrastructure	45
12:30 pm	Inclusive sanitation	60
13:30 pm	Feedback and summary	30

14:00 pm	Closing and certificate distribution	30
14:30 am	Lunch	60

Orientation training on SBM 2.0 Guidelines

3-Day training for ULB Executive officers/Engineers and SBM Nodal officers

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Time	Session
	Day 1
10:00 am	Welcome address to the participants
10:15 am	Introduction to the trainings and objective setting
11:00 am	SBM 2.0 guidelines
11:45 am	Tea break
12:00 pm	Activities under SBM 2.0 – Toilet sustainability
13:30 pm	Lunch break
14:30 pm	Activities under SBM 2.0 -Used water management
15:30 pm	Zoning of a city – Case study
16:30 pm	Tea break
16:45 pm	City Sanitation action plan
17:15 pm	Feedback
	Day 2
09:00 am	Recap and Zoning assignment
10:15 am	Tea break
10:30 pm	Design basis and feasibility of sewerage networks with case study
12:00 pm	Exercise – Population projection
13:30 pm	Lunch break
14:30 pm	Fecal sludge management
15:30 pm	Estimating investment for FSM
16:30 pm	Tea break
16:45 pm	Drain based conveyance models – Design and feasibility- with case study
17:45 pm	Feedback and summary
	Day 3
09:00 am	Recap exercises
10:00 am	Wastewater treatment systems
11:30 am	Tea break
11:45 am	Estimating investment for drain based systems and I&D infrastructure
12:30 pm	Inclusive sanitation
13:30 pm	Feedback and summary
14:00 pm	Closing and certificate distribution
14:30 am	Lunch

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Session 1 – Introduction to SBM 2.0 Guidelines

Orientation training on SBM 2.0 Guidelines

3

Session Objectives/Agenda

- ✓ Understand vision and objectives of SBM 2.0
- ✓ List down key components of the mission
- ✓ Be aware of the role of ULBs in mission implementation
- ✓ Discuss the mission strategies
- ✓ Discuss the toilet sustainability component (Chapter 5) of the guideline in detail

4

Period : The Mission will be in force for five years, from 1st October 2021 to 1st October 2026.

SBM 1.0

- Toilet construction (IIHL, CT & PT)
  शौचालय निर्माण (IIHL, सीटी और पीटी)
- Scientific solid waste management (Collection and transportation)
  वैज्ञानिक ठोस अपशिष्ट प्रबंधन (संग्रह और परिवहन)

SBM 2.0

- Toilet construction (IIHL, CT & PT)
  शौचालय निर्माण (IIHL, सीटी और पीटी)
- Complete management of solid waste
  ठोस कचरे का पूरा प्रबंधन
- Used water management
  प्रयुक्त जल प्रबंधन

Program objectives (उद्देश्य)

SBM 1.0

ODF

- All towns to eliminate open defecation

SBM 2.0

ODF ++

- All towns to 100 % treat used (waste) water (सभी कस्बों के लिए १००% इलाज का इस्तेमाल किया (अपशिष्ट) पानी)
- All towns to implement Faecal sludge management (सभी कस्बों मल कीचड़ प्रबंधन को लागू करने के लिए)

Garbage free cities

- 100 % source segregation (100% स्रोत अलगाव)
- 100 % door to door collection (100% डोर टू डोर कलेक्शन)
- 100% scientific management of solid waste streams (ठोस अपशिष्ट धाराओं का 100% वैज्ञानिक प्रबंधन)
- Reclaim all legacy waste sites (सभी विरासत अपशिष्ट साइटों को पुनः प्राप्त करें)

Water +

- 50% of the towns to reuse at least 20% of the used water (50% कस्बों का उपयोग पानी का कम से कम 20% पुन: उपयोग करने के लिए)

Which cities/towns are eligible?

Solid waste management and Toilets : All cities and towns

Used water management: All Statutory towns (less than 1 Lakh population, as per 2011 census) and added post 2011.

- Aligning property tax with market rates
  बाजार दरों के साथ संपत्ति कर संरेखित करना
- User charges for O&M
  ओएंडएम के लिए उपयोगकर्ता शुल्क
- Public financial management system (PFMS)

Components eligible for funding

Toilets

1. IHHL
2. CT & PT
3. Insanitary -> Sanitary latrines

Used Water Management

1. STP cum FSTP
2. Interception and Diversion arrangement
3. Machine for septic tank cleaning

Funding available

COMPONENT	Unit	Total	Central	State	ULB/15th FC/Pvt share
IHHL	Per toilet	Rs. 30,000	Rs 4,000	Rs 2,667	
CT/PT	Per seat	Rs 1,50,000	Rs 75,000	Rs 49,500	Rs 25,500
CT/PT – Aspirational	Per seat	Rs 2,50,000	Rs 1,25,000	Rs 82,500	Rs 42,500
Used Water Management	Per Capita	Class II - Rs. 3000 Class III – VI – 2000 For NE and hilly states Class II – 4000 Class III and below - 3000	Population less than 1 lakh – 50% Northeast and hilly towns – 90%	Population less than 1 lakh – 33% Northeast and hilly towns – 10%	Population less than 1 lakh – 17%

Funds available for used water management

= Population (2011 census) x Rs 2000

Urban – Rural Convergence

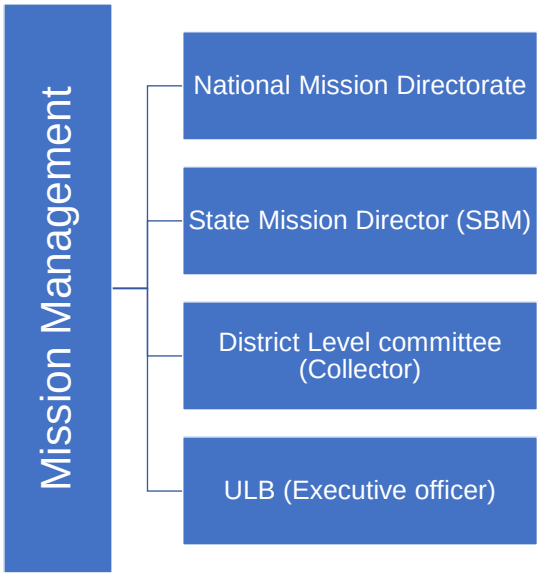
Infrastructure projects will be taken up on cluster basis to cater to groups of neighbouring ULBs and rural areas, so that common waste processing facilities are utilized efficiently.

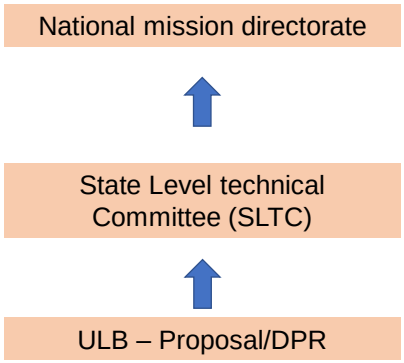
पड़ोसी यूएलबी और ग्रामीण क्षेत्रों के समूहों को पूरा करने के लिए क्लस्टर आधार पर बुनियादी ढांचा परियोजनाएं शुरू की जाएंगी, ताकि सामान्य अपशिष्ट प्रसंस्करण सुविधाओं का कुशलतापूर्वक उपयोग किया जा सके ।

What is not included in SBM 2.0 funding (शामिल नहीं)

• Cost of Land acquisition	• भूमि अधिग्रहण की लागत
• Operation and maintenance cost	• ऑपरेशन और रखरखाव लागत
• Cost of Sewerage network	• सीवरेज नेटवर्क की लागत
• Cost of storm water drains/Nallah	• बरसाती पानी नालियों/नाला की लागत
• Existing projects which are already sanctioned	• मौजूदा परियोजनाएं जो पहले से स्वीकृत हैं

Mission Management Structure





Role of ULBs

- The Municipal Commissioner (MC)/ Executive Officer (EO) of a ULB shall be the administrative authority responsible for implementing all components of the Mission at the ULB level.
- The MC/ EO will also be responsible for smooth and seamless implementation of all Mission components.
- **The responsibilities of the MC/ EO will include the following:**

1. facilitating **capacity building** of Municipal staff; (नगर निगम के कर्मचारियों की क्षमता निर्माण की सुविधा;)
2. conducting gap analysis and **preparation of CSAP and CSWAP**; (गैप विश्लेषण और CSAP और CSWAP की तैयारी का आयोजन;)
3. **preparation of DPR**; (डीपीआर तैयार करना;)
4. **coordinating with State** for getting sanctions from SHPC/ SLTC, and fund release for projects; (एसएचपीसी/एसएलटीसी से प्रतिबंध प्राप्त करने और परियोजनाओं के लिए निधि जारी करने के लिए राज्य के साथ समन्वय;)
5. **implementing projects** in a timebound manner, along with continuous monitoring to ensure sustained functionality; (निरंतर कार्यक्षमता सुनिश्चित करने के लिए निरंतर निगरानी के साथ-साथ समयबद्ध तरीके से परियोजनाओं को लागू करना;)
6. collection of **user charges** for ensuring financial sustainability of operations; (संचालन की वित्तीय स्थिरता सुनिश्चित करने के लिए उपयोगकर्ता शुल्क का संग्रह;)
7. **awareness** and citizen engagement; (जागरूकता और नागरिक सगाई;)
8. setting up **City Sanitation Committees** with participation of selected citizen representatives for periodically reviewing and monitoring efficient functioning of assets created.(सृजित परिसंपत्तियों के कुशल कार्यकरण की समय-समय पर समीक्षा और निगरानी के लिए चयनित नागरिक प्रतिनिधियों की भागीदारी के साथ शहर स्वच्छता समितियों का गठन करना।)

Mission Implementing Strategy - 1

All Self-help groups, especially women SHGs, either affiliated to Government programmes (e.g. NULM, NHM) or otherwise, to be used for ground level/ community level facilitations and interpersonal communication initiatives under SBM-U 2.0

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सभी स्वयं सहायता समूहों, विशेष रूप से महिला स्वयं सहायता समूहों, या तो सरकारी कार्यक्रमों से संबद्ध (जैसे NULM, एनएचएम) या अन्यथा, एसबीएम-यू २.० के तहत जमीनी स्तर/सामुदायिक स्तर की सुविधा और पारस्परिक संचार पहलों के लिए इस्तेमाल किया जाएगा ।

Mission Implementing Strategy - 2

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All infrastructure created under the Mission, be it toilets, and waste processing facilities, as well as workplaces to have gender friendly and divyang-friendly features, for ease of access for all;

All infrastructure/ assets created under the Mission to be disaster resilient.

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मिशन के तहत बनाई गई सभी बुनियादी ढांचा, चाहे वह शौचालय हो, और अपशिष्ट प्रसंस्करण सुविधाएं हों, साथ ही कार्यस्थलों में सभी के लिए पहुंच में आसानी के लिए लिंग अनुकूल और दिव्यांग-अनुकूल विशेषताएं हों;

मिशन के तहत सृजित सभी अवसंरचना/परिसंपत्तियां आपदा लचीला होंगी।

Mission Implementing Strategy - 3

1. Elimination of hazardous entry for sewer and septic tank cleaning through mechanization of cleaning operations, provision of protective gear/ PPE kits to sanitation workers, etc;
   सफाई कार्यों के मशीनीकरण के माध्यम से सीवर और सेप्टिक टैंक की सफाई के लिए खतरनाक प्रवेश को समाप्त करना, सफाई कर्मियों को सुरक्षात्मक गियर/पीपीई किट की व्यवस्था करना आदि
2. Setting up of helpline numbers to enable citizens to register their request/ complaints and suggestions regarding desludging of septic tanks – **14420**
   सेप्टिक टैंकों को डीरल करने के संबंध में नागरिकों को उनके अनुरोध/शिकायतों और सुझावों को दर्ज करने में सक्षम बनाने के लिए हेaल्पलाइन नंबर स्थापित करना - 14420
3. Enabling social welfare benefits for all sanitation workers (formal, informal and contractual) such as life and health insurance, supporting formation of sanitation workers' collectives;
   सभी सफाई कर्मियों (औपचारिक, अनौपचारिक और संविदात्मक) जैसे जीवन और स्वास्थ्य बीमा, स्वच्छता कर्मियों के कलेक्ट्रेट के गठन का समर्थन करने के लिए सामाजिक कल्याण लाभों को सक्षम करना;

Continuead..

4. Mandatorily setting up Responsible Sanitation Authority (RSA) and Sanitation Response Units (SRUs) covering all ULBs.

4. सभी यूएलबी को कवर करते हुए जिम्मेदार स्वच्छता प्राधिकरण (आरएसए) और स्वच्छता प्रतिक्रिया इकाइयों (एसआरयू) की स्थापना अनिवार्य रूप से की गई है।

Chapter 5: Toilets

The target group for construction of Individual Household Latrines (IHHLs)/ Toilets is:

1. New independent households; नए स्वतंत्र परिवार;
2. All new households who might have migrated to urban areas; सभी नए परिवार जो शहरी क्षेत्रों में चले गए होंगे
3. All households with previous access to community toilets, who might want to have their own facility; सामुदायिक शौचालयों तक पिछली पहुंच वाले सभी परिवार, जो अपनी सुविधा चाहते हैं;
4. all households with insanitary latrines . अस्वच्छता शौचालयों वाले सभी परिवार

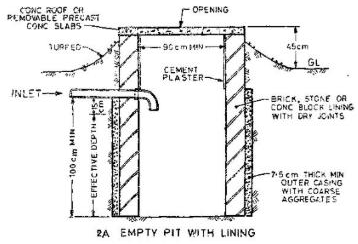
All household toilets should

1. Be connected to sewerage pipeline (available within 30 meters); सीवरेज पाइपलाइन से जोड़ा जाए (30 मीटर के भीतर उपलब्ध)
2. Connected to Septic tank designed as per IS 2470 , with soak pit; सेप्टिक टैंक से जुड़ा है के अनुसार डिजाइन 2470 , सोख गड्ढे के साथ
3. Households to be provided with water supply ; घरों में होगी जलापूर्ति
4. ULB to carry out periodic desludging of septic tank ; यूएलबी सेप्टिक टैंक की आवधिक डील्यूडिंग करने के लिए

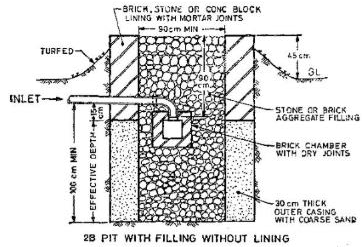
SEPTIC TANKS: Design Considerations

No. of Users	Length (m)	Breadth (m)	Liquid depth (m) (cleaning interval of)	
			2 years	3 years
5	1.5	0.75	1.0	1.05
10	2.0	0.90	1.0	1.40
15	2.0	0.90	1.3	2.00
20	2.3	1.10	1.3	1.80

- ✓ IS 2470 (Part 1):1985 – Code of Practice for installation of septic tank: design criteria and construction.
- ✓ IS 2470 (Part 2):1985 – Code of Practice for installation of septic tank: secondary treatment and disposal of septic tank effluent.
- ✓ IS 9872:1981 – Precast concrete septic tanks



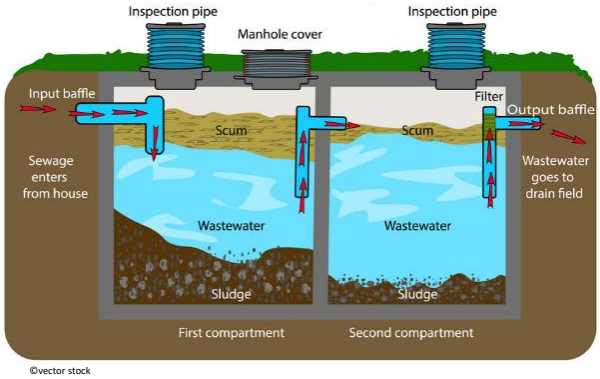
2A EMPTY PIT WITH LINING

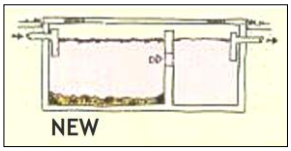


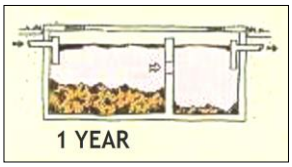
2B PIT WITH FILLING WITHOUT LINING

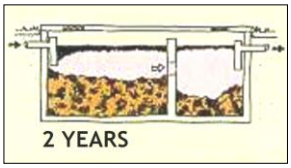
Septic tank effluent should be drained through soaks pits and not connected to drains

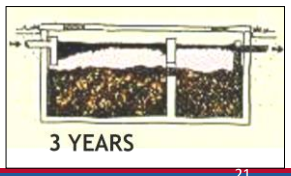
SEPTIC TANKS











Removes 40-50% BOD

CAPEX = Rs. 15,000 – Rs. 20,000

HRT = 1-2 days

SRT = 2 or 3 years

If septic tanks are not desludged in time, raw excreta will start overflowing into drains or streets causing serious public hazard.

IHHL allotment process

City sanitation action plan (Annexure 3A) - Gap analysis;
शहर स्वच्छता कार्य योजना (एनेक्सचर 3 ए) - गैप विश्लेषण

Aadhar seeding of households
परिवारों की आधार सीडिंग

Application for IHHL - Umang or mSBM app/portal
आईएचएचएल के लिए आवेदन - उमंग या एमएसबीएम ऐप/पोर्टल

Verification by ULB withing 7 days
7 दिनों के साथ यूएलबी द्वारा सत्यापन

Final verification with geo-tagged photo of construction and applicant
निर्माण और आवेदक की भू-टैग फोटो के साथ अंतिम सत्यापन

Community toilet

- Every household dependent on CTs has access to one within a maximum distance of **500 metres** from their homes (सीटी पर निर्भर हर घर अपने घरों से अधिकतम ५०० मीटर की दूरी के भीतर एक तक पहुंच है)
- ULBs should prioritise IHHL access for all households, and only in cases of land constraints should CTs be provided, with **seats earmarked for selected families** so that they the families feel a sense of ownership and maintain them as their own (यूएलबी को सभी परिवारों के लिए आईएचएचएल पहुंच को प्राथमिकता देनी चाहिए, और केवल भूमि की कमी के मामलों में सीटीएस प्रदान किया जाना चाहिए, जिसमें चयनित परिवारों के लिए निर्धारित सीटें हैं ताकि वे परिवार स्वामित्व की भावना महसूस करें और उन्हें अपने स्वयं के रूप में बनाए रखें)

Public toilet

- Every public place (bus stops, petrol pumps, metro stations, marketplaces, religious and tourist locations, health centres, citizen centres) has at least one PT/ urinal available within **500 metre distance**, and that the facilities are kept clean, functional and open for public use. (प्रत्येक सार्वजनिक स्थान (बस स्टॉप, पेट्रोल पंप, मेट्रो स्टेशन, बाजार, धार्मिक और पर्यटन स्थल, स्वास्थ्य केंद्र, नागरिक केन्द्र) में 500 मीटर दूरी के भीतर कम से कम एक पीटी/ मूत्रालय उपलब्ध है और सुविधाओं को सार्वजनिक उपयोग के लिए स्वच्छ, कार्यात्मक और खुला रखा जाता है।)
- ULBs will have to provide additional PTs in all tourist destinations/ places with high footfall/ iconic cities/ religious destinations, etc (यूएलबी को सभी पर्यटन स्थलों/स्थानों पर उच्च फुटफॉल/प्रतिष्ठित शहरों/धार्मिक स्थलों आदि के साथ अतिरिक्त पीटीएस उपलब्ध कराने होंगे ।)

Aspirational toilets

1. Walls and floors are clean and stain / graffiti free
2. Low height toilets/Indian toilets and basins for children
3. Plants / shrubs in the vicinity of toilet complex are well maintained
4. Space earmarked for advertisement for revenue generation
5. Hand dryer / paper napkin available
6. Ladies' toilets have vending machine for sanitary napkins
7. Incinerator facility available for disposal of used sanitary napkins for toilet having > 10 seats
8. Toilet identification number, name of ULB under which jurisdiction toilet is covered, ward number and maintenance authority prominently displayed for each toilet block
9. SMS based feedback with number displayed on which SMS has to be sent

1. दीवारों और फर्श साफ और दाग/भितिचित्र मुक्त कर रहे है
2. बच्चों के लिए कम ऊंचाई वाले शौचालय/भारतीय शौचालय और बेसिन
3. शौचालय परिसर के आसपास के क्षेत्र में पौधों/झाड़ियों को अच्छी तरह से बनाए रखा जाता है
4. राजस्व सृजन के लिए विज्ञापन के लिए निर्धारित स्थान
5. हैंड ड्रायर/पेपर नैपकिन उपलब्ध
6. महिलाओं के शौचालयों में सैनिटरी नैपकिन के लिए वेंडिंग मशीन है
7. 10 सीटों > वाले शौचालय के लिए उपयोग किए गए सैनिटरी नैपकिन के निपटान के लिए भस्मारती सुविधा उपलब्ध
8. शौचालय पहचान संख्या, यूएलबी का नाम जिसके तहत क्षेत्राधिकार शौचालय कवर किया जाता है, वार्ड संख्या और रखरखाव प्राधिकरण प्रत्येक शौचालय ब्लॉक के लिए प्रमुखता से प्रदर्शित
9. जिस नंबर पर एसएमएस भेजना है, उस नंबर के साथ एसएमएस आधारित फीडबैक

Necessary conditions for 1st Instalment for toilet related funding

The 1st instalment of 40% of allotted Central share from MoHUA will be released to the State/ UT provided the entry conditions specified in Section 4.2, and following additional conditions are satisfied:

1. City Sanitation Action plans (CSAP) Part 1 (approved by SLTC) along with gap analysis;
2. ULB to upload their latest progress data on the MIS portal
3. declaration from Municipal Commissioner/ EO of ULB that all existing CTs/ PTs & Urinals in the ULB are fully functional, with provision for water;
4. SLTC approved & complete proposals for a city (based on gap analysis), along with O&M plans for at least 5 years for maintaining functionality of CT/ PT;.
5. ULB has provided for encumbrance free land for construction of the CT/ PT complexes and Urinals.

मोहुआ से आवंटित केंद्रीय हिस्से की 40% की पहली किस्त राज्य/यूटी को जारी की जाएगी बशर्ते धारा 4.2 में निर्दिष्ट प्रवेश शर्तें हों, और अतिरिक्त शर्तों के बाद संतुष्ट हों:

1. गैप एनालिसिस के साथ-साथ सिटी सेनिटेशन एक्शन प्लान (सीएसएपी) पार्ट 1 (एसएलटीसी द्वारा मंजूरी) ।
2. यूएलबी एमआईएस पोर्टल पर अपने नवीनतम प्रगति डेटा अपलोड करने के लिए
3. यूएलबी के नगर आयुक्त/ईओ से घोषणा कि यूएलबी में सभी मौजूदा सीटी/पीटी और मूत्रालय पूरी तरह से कार्यरत हैं, जिसमें पानी की व्यवस्था है;
4. एसएलटीसी ने सीटी/पीटी की कार्यक्षमता बनाए रखने के लिए कम से कम 5 वर्षों के लिए ओएंडएम योजनाओं के साथ-साथ शहर (अंतर विश्लेषण के आधार पर) के लिए अनुमोदित और पूर्ण प्रस्तावों को मंजूरी दी।
5. यूएलबी ने सीटी/पीटी कॉम्प्लेक्स और यूरिनल के निर्माण के लिए भार मुक्त भूमि की व्यवस्था की है ।

SBM 2.0 Guidelines

https://sbmurban.org/storage/app/media/pdf/swachh-bharat-2.pdf

Session 2: Used Water Management (Chapter 7)

Orientation training on SBM 2.0

Session Objectives/Agenda

- ✓ List down components of used water eligible for funding
- ✓ Understand the zoning requirements for the town under the mission
- ✓ Discuss the City Sanitation Action Plan (Annexure 3A and 3B) requirements

SBM 2.0 – Used Water Management

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How much of India's urban used water is treated?

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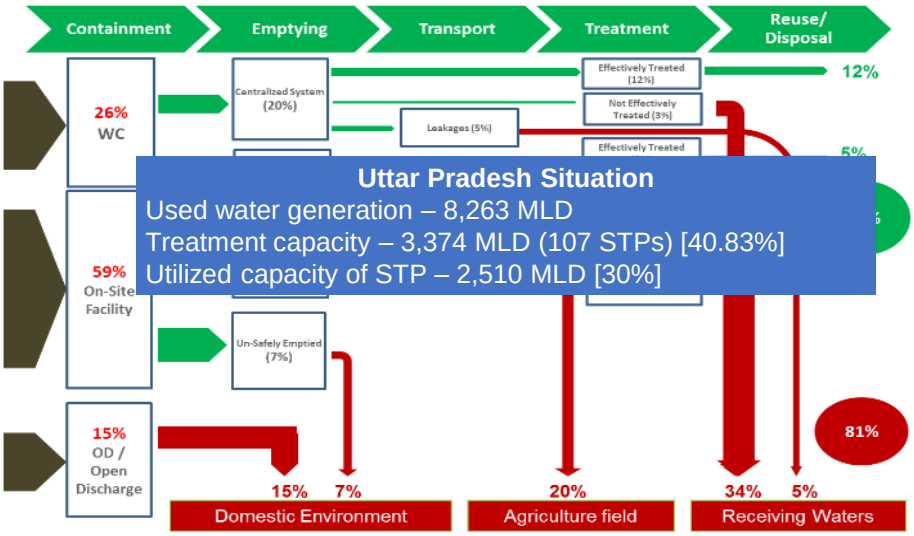
Urban Sanitation situation in India, 2011



With 80% untreated disposal

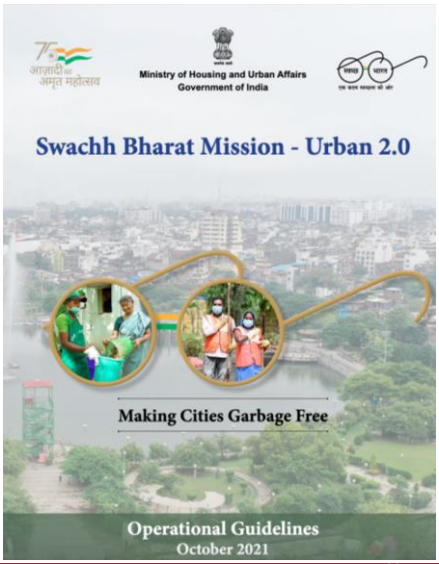
How do we provide sanitation for all?

A paradigm shift is needed

Used Water Management – SBM 2.0

- Sets out the overall approach to be taken by ULBs to put in place systems and processes to ensure that

  No untreated fecal sludge or used water is discharged into the environment, and all used water (including sewerage and septage, grey water and black water) is safely contained, transported and treated, along with maximum reuse of treated used water, in all cities with less than 1 lakh population.



Used Water Management – Objectives & Outcomes

Objectives

- 100% of all used water is safely collected, treated and reused to feasible extent and no untreated used water is discharged into water bodies or the open environment
- All faecal matter and septage is properly collected, treated and by-products reused

Outcomes

- All statutory towns with < 1 lakh population will become ODF++ certified.
- 50% of all statutory towns with < 1 lakh population will become Water+ certified.

States/UTs would be required to develop road map to achieve and sustain above outcomes and progress would be monitored periodically.

Terminologies in Used Water Management

1. Sewage (Used water)
   1. Greywater
   2. Blackwater
2. Quantity of domestic used water generated?
3. Offsite system and On-site system
4. Interception and Diversion drains
5. Sewer network
6. Septage
7. STP-cum-FSTP
8. Recycle/Reuse/Disposal
9. User fees

Used Water Management – Estimated Treatment Quantity

Class of Cities based on Population		No. of Cities*	Total Population @ 2011 Census [in crore]	STP capacity reqd (in MLD) (after adjusting for 23% decadal growth of population)	Average capacity (in MLD)
Class II	50,000-99,999	535	3.65	4,498	5.5
Clas					
Clas					
Class V	9,999	541	.43	2,826	.70
Class VI	<5,000	153	.05		
Total		3,901	10.42	12,818 (approx. 13,000)	

Uttar Pradesh
Number of ULBs (Class II to VI) – 586
Total population of all ULBs – 1.9 crores (today) in 10 year 2.5 crores
Total used water generated – 2,500 MLD

* For purpose of estimation, Census 2011 figures are considered with suitable population projections. However, all Statutory towns will get funding support from SBM (U).

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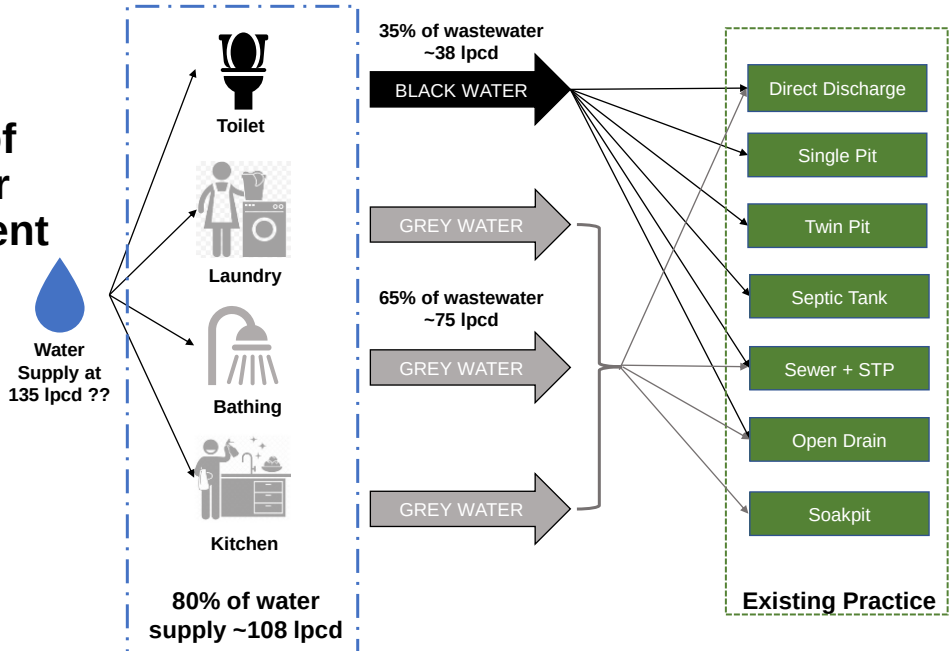
Existing methods of used water management



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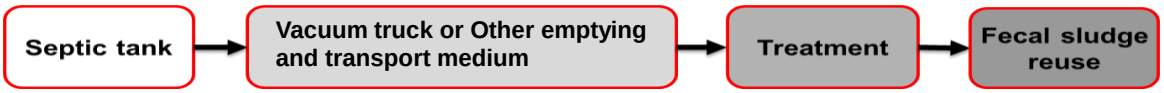
Different Wastewater Systems

Networked System

Decentralized Treatment System

FSM



Note: Single pits are insanitary and should be converted into septic tanks with soak pits

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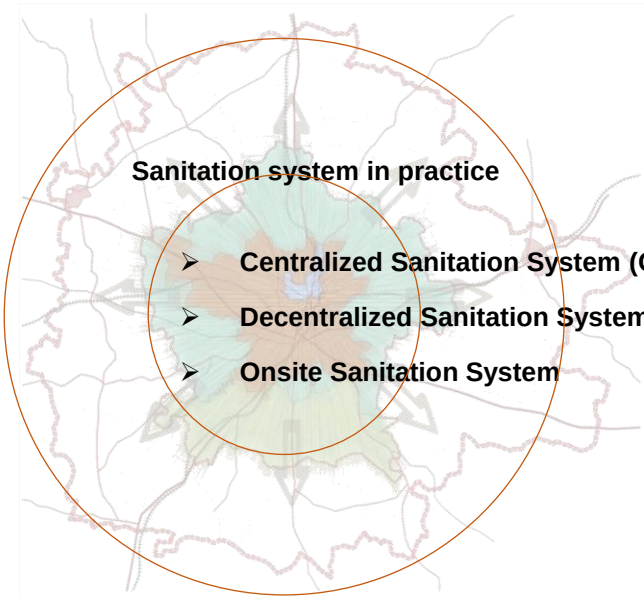

Sanitation system in practice

- Centralized Sanitation System (Offsite System)
- Decentralized Sanitation System
- Onsite Sanitation System

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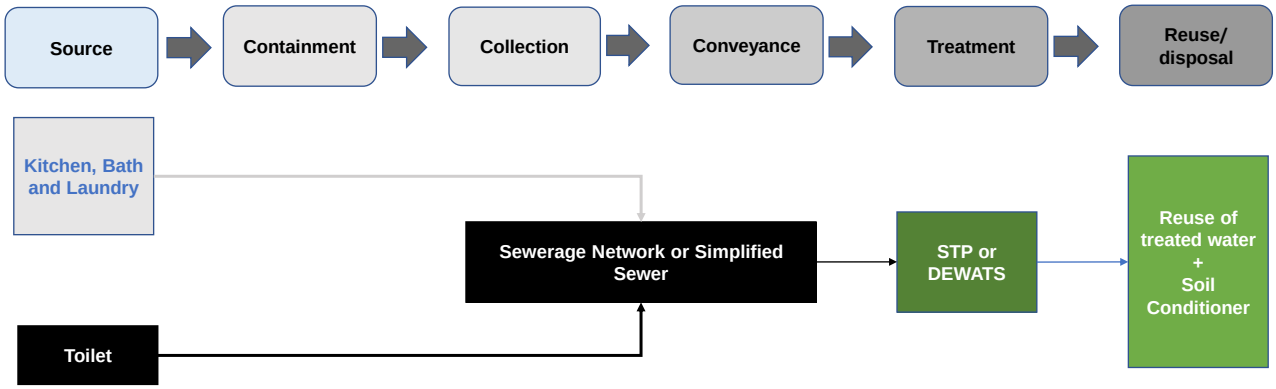
Option 1: Sewer and STP (Centralised/Decentralized)



- Convenience to user
- Human exposure, surface water and ground water are protected

- Minimum water supply requirement for technical feasibility
- High implementation risks - time and cost, design risks
- People's acceptance during implementation
- High operating costs, high skills required
- Challenges in connecting households to sewer network
- Solution is not adaptable to rapidly changing urbanization patterns

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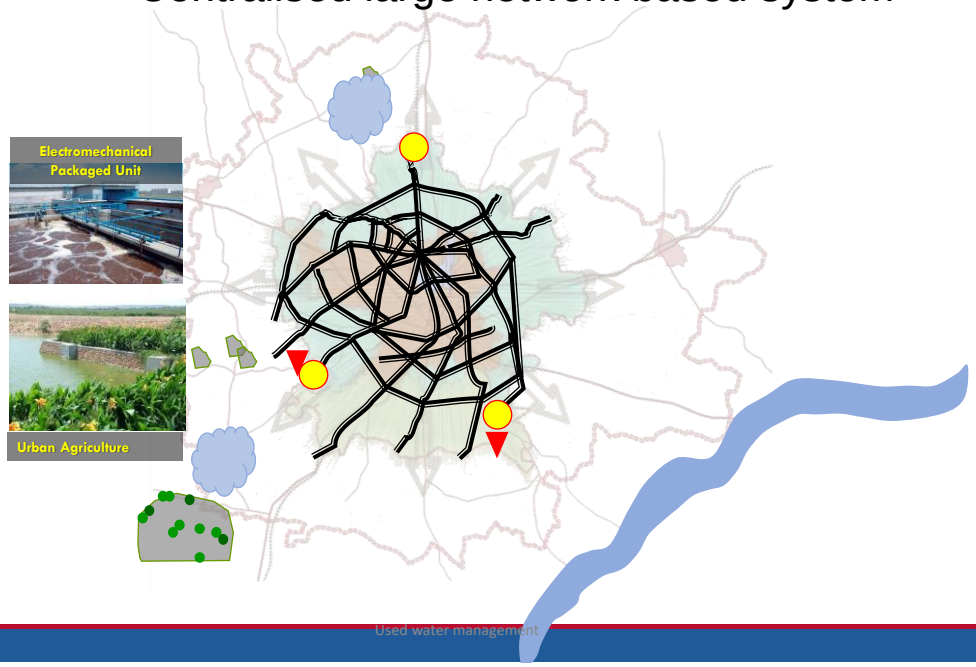
Centralised large network based system



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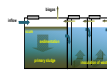
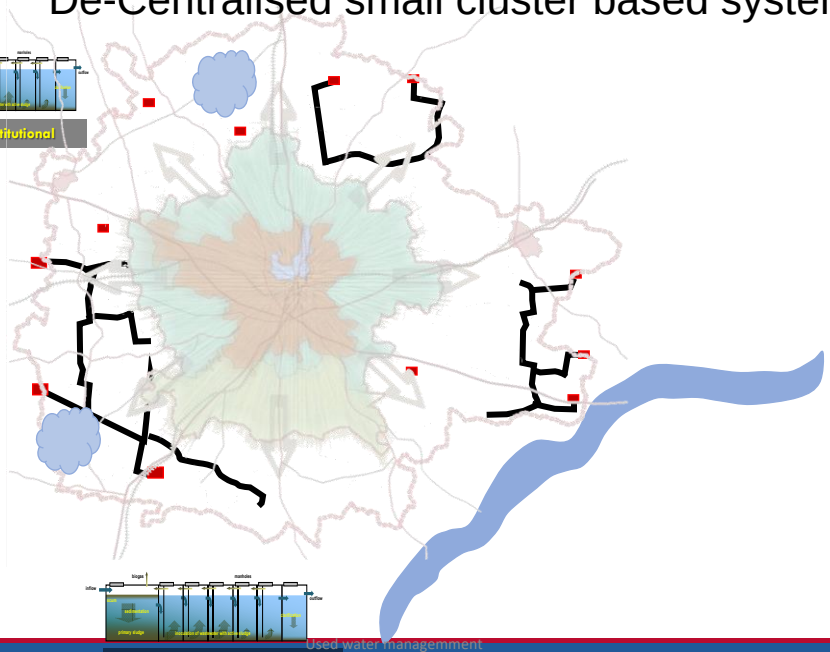
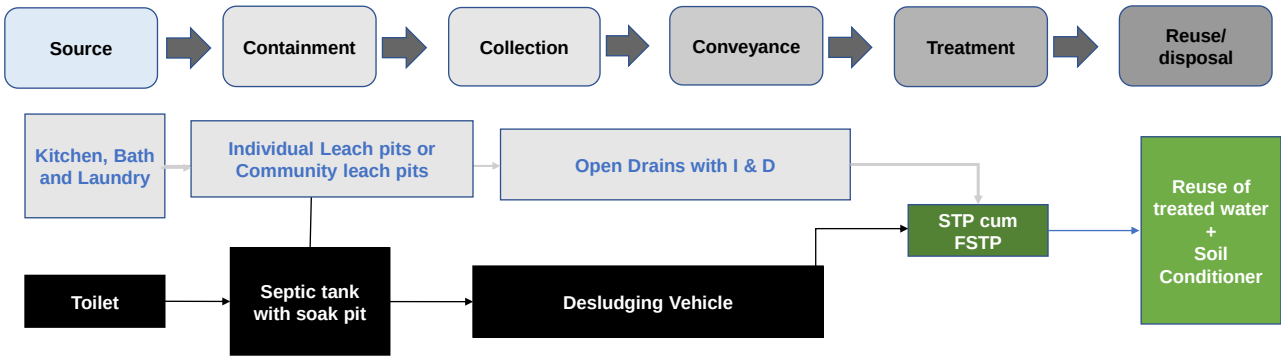
De-Centralised small cluster based system





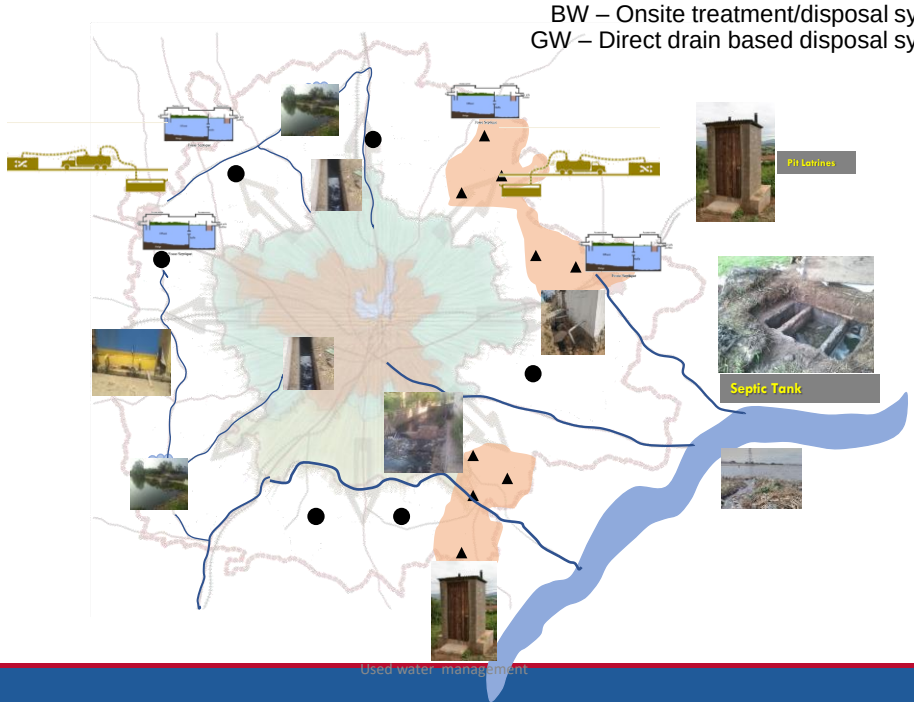
Option 2: I&D (Greywater)+ STP with Co-treatment of FS



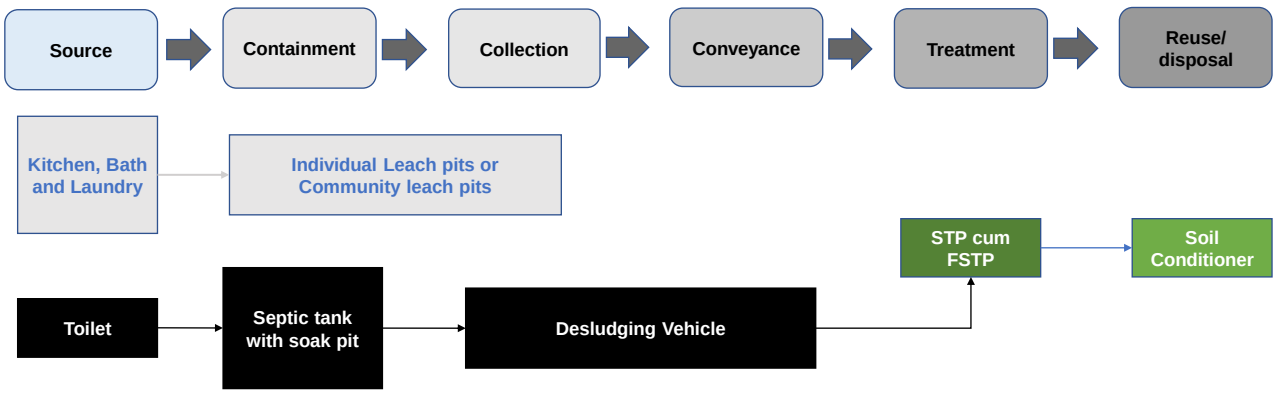
- Does not require laying of sewer network resulting in reduction of costs for implementation.
- No electrical energy required for septic tank operation

- Open drains expose population to public health risk and cause contamination of stormwater
- In septic tanks/soak pits, low reduction in pathogens, solids and organics
- Poor people may not be able to afford desludging services
- High treatment plant operating cost
- Seasonal fluctuations in quantity and quality impact STP operations
- Solid waste and silt in drains

BW – Onsite treatment/disposal system
GW – Direct drain based disposal system



Option 3: On-site solution (Greywater and FSM)



- Most resilient solution – adaptable to natural disaster
- Optimal cost to risk solution with least expenditure incurred by the government
- Polluters pays principle is applied to some extent
- Independent of quantum of water supplied

- Risk of contamination of shallow groundwater; however shallow groundwater is not used for drinking water
- Trucks contributes to additional GHG emissions
- Poor people may not be able to afford desludging services

As a temporary measure simple and cost-effective sludge drying beds can be built to dispose/treat faecal sludge. These beds should be constructed at proposed STP sites. The beds can later be used for sewage solids treatment

Focus Areas under Used Water Management

• Central Share

- Setting up of **Sewage Treatment Plants (STPs)/ STP-cum-FSTP**;
- Laying **Interception and Diversion (I&D)** structures including provision of pumping stations and pumping main/gravity main up to STP;
- Procuring adequate numbers of **septic tank desludging equipment**;
- **Deploying Digital (IT enabled) tools** for real time monitoring of efficiency parameters during the operational phase of STPs and allied equipment.

• State Share

- **Sewer Network***
- **Strengthening of Municipal Drains** - As an interim arrangement, till sewers are laid in town, strengthening of drainage networks is to be taken up and intercepted into existing/ upcoming sewer network, wherever feasible, or brought to I&D point from where, sewage/ sullage can be conveyed to STP/ FSTP cum STP.

*The entire cost of sewer network being set up in the towns to be borne by the State/ UT & ULB including those of tied 15th Finance Commission(FC) Grants.

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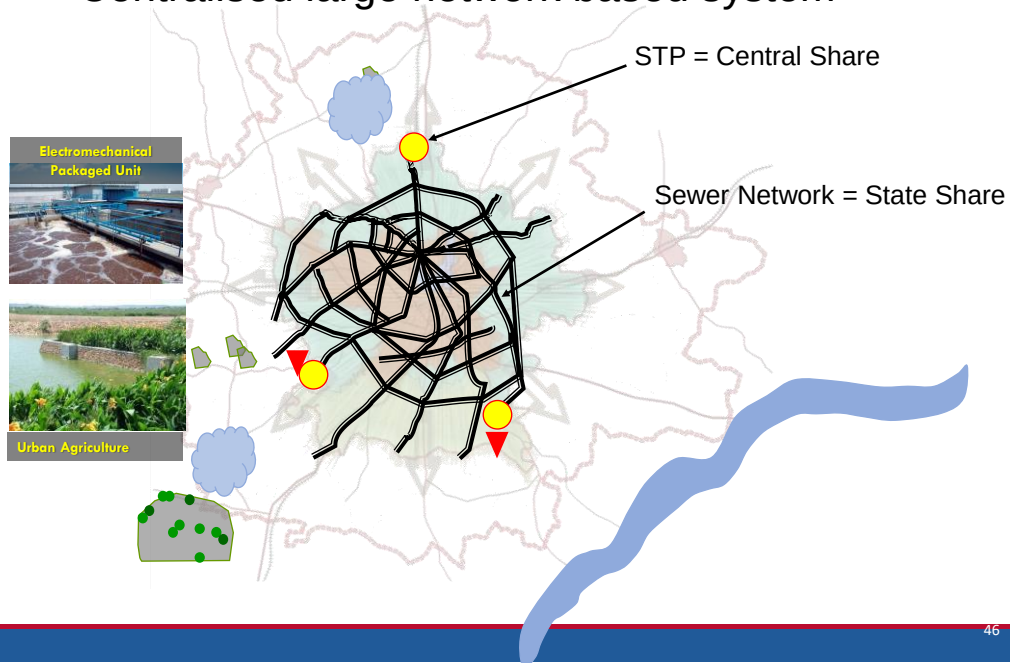
Centralised large network based system



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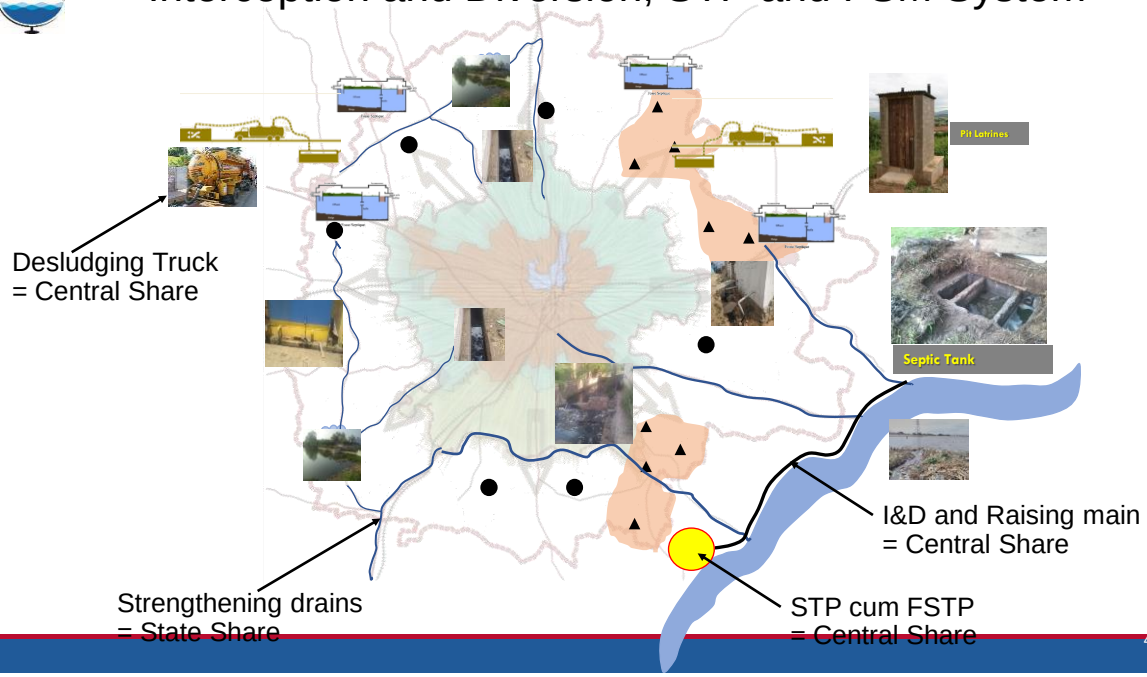
Interception and Diversion, STP and FSM System



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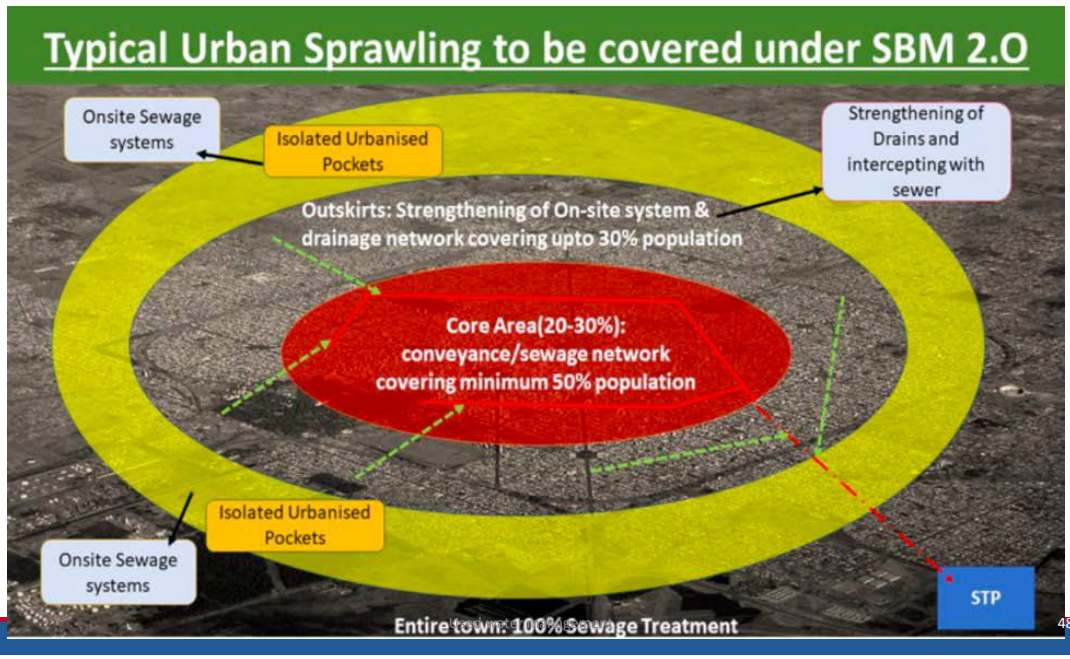
DPR Preparation Approach



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Recycle and Reuse

- Non-potable purposes like flushing toilets, gardening etc.
- Agricultural purposes
- Horticulture purposes
- Industrial purposes
- Municipal purposes like dust mitigation, road washing, construction activity, etc.
- 20% of treated used water must be reused

Used Water Management – Detailed Funding Pattern

Funding Pattern - Central share will be disbursed as per following cost sharing pattern:

- 90% for ULBs in NE/Himalayan States,
- 100% for UTs without legislature,
- 80% for UTs with legislature,
- **50% for ULBs with less than 1 lakh population**

Costing calculations for Used water management - maximum per capita allocations:

Class of town	Maximum limit of per capita allocation for STP and I&D (including Central share + State/UT/ULB share)
II	₹3,000
III	₹2,000
IV	₹2,000
V	₹2,000
VI	₹2,000
For NE & hilly States	Class II - ₹4,000
Class III and below- ₹3,000	

- Depending on needs at ground, States/UTs may sanction higher per capita funds for some town's projects, provided that State/UT ensures that all the towns in Class II to VI are also covered with suitable sewage collection and treatment facilities.
- **In no case should allocated used water funds for all notified towns in the state be utilized in some selected towns while others are left unattended**. In such a scenario, Central share allocation would be proportionately restricted commensurate to the number of towns attended.

Fund release structure – Milestone/outcome based

1st Instalment – 40% of central share	2nd Instalment – 40% of central share	3rd Instalment – 20% of central share

• RSA notified
• SHPC approved CSAP – Part 2 submitted (ANNEX 3B)
• SLTC approved proposal
• State annual progress plan
• Action plan for non-functional existing STPs/FSTPs
• Encumbrance free land
	• Functional SRU
	• 75% UC of state and central share
	• O&M recovery through user fees
	• ODF+ certified at least once
	• Work commencement – geo tagged
	  • 20% I&D
	  • 10% STP
	  • Existing STP/FSTP functional or work awarded
		• 75% UC of state and central share of 2nd instalment
		• I&D completed at least 80%
		• STP work completed at least 60%
		• Non-functional STP/FSTP are functional

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Fund release structure – Milestone/outcome based

- The 1st instalment of 40% of allotted Central share from MoHUA will be released to the State/ UT for a ULB provided the entry conditions specified in Section 4.2, and following additional conditions are satisfied:
  - ➢ Responsible Sanitation Authority (RSA) notified across the State/ UT at District level/in big municipal corporations
  - ➢ Submission of City Sanitation Action plans (CSAP) part 2 (approved by SHPC) for sewage management along with gap analysis
  - ➢ Receipt of SLTC approved proposals for a city along with at least 5 years' O&M contract post commissioning, and its funding arrangements
  - ➢ Annual progress plan of State/UT of ODF++ and Water+ cities
  - ➢ Action plan for revamping all non-functional existing STPs/FSTPs in ULBs having less than 1 lakh population (if any- as recorded in the City MIS).
  - ➢ ULB has provided for encumbrance free land for setting up STP/ STP-cum- FSTP.

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ANNEX 3B: CITY SANITATION ACTION PLAN (CSAP): FOR USED WATER MANAGEMENT

(As referred in Chapters 2 and 7)

(To be filled in only for Cities below 1 Lakh Population, as referred in Chapters 2 and 6)

S.No.	Description	Particulars	Detailed description	Remarks
A	**GENERAL INFORMATION**			
1	**Location and Physical aspects**			
1.a	Location	Name of the City, District, State		
1.b	Physical Aspects	Municipal Area in sq. km and Class of Town		
		Number of Wards		
		Geographical description -Hilly area, river, Environmental sensitive area etc.		
1.c	Maps	Map depicting administrative boundaries, roads and railways, water bodies, Important landmarks etc. (if not available, to be prepared)		
		Topo-Sheet *(ref: Survey of India, Scale - 1:50000)* (if not readily available, get it)		

Fund release structure – Milestone/outcome based

- The 2nd instalment of 40% of allotted Central share from MoHUA will be released to the State/ UT for a ULB provided the following conditions are satisfied:
  - Functional Sanitation Response Units (SRU) set up;
  - UC submitted for 75% of first instalment of Central and State shares;
  - Portion of O&M being recovered through user charges;
  - City is certified ODF+ at least once;
  - State will certify along with geo-tagged photos and other documentary evidence that:
  - Work has commenced for the drainage system development/ installation/ revamping duly completed (with geo-tagged photos and other documentary evidence);
  - The Interception & Diversion drain &related conveyance system has reached 20% physical progress;
  - The STP/FSTP (in case of co-treatment) sub-project has achieved at least 10% physical progress on ground
  - Existing STP/FSTPs are made functional to treat used water, at least to the level as per their original design.
  - Work awarded for non-functional STPs/FSTPs requiring major repairs/ rehabilitation

Fund release structure – Milestone/outcome based

- The 3rd instalment of 20% of allotted Central share from MoHUA will be released to the State/ UT for a ULB provided the following conditions are satisfied:
  - UC submitted for 75% of second instalment of Central and State shares;
  - The Interception & Diversion drain & related conveyance work has been completed to the extent of at least 80% of physical process;
  - The STP sub-project work has been completed to the extent of at least 60%;
  - Non-functional STPs/FSTPs made functional. It may be noted that proposals should be in compliance with checklist provided in Annex 6

ANNEX 6: CHECKLIST FOR PROPOSAL PREPARATION

(As referred in Chapter 6,7)

Check List for Preparation of Sewerage and Faecal Sludge & Septage Management (FSM) DPR seeking funding under Swachh Bharat Mission (Urban) 2.0

S.No.	Description	Remarks
1.	**Introduction**	
i.	Background (Description of SBM 2.0, State and City)	
ii.	Location and connectivity of City	
iii.	Temperature, Rainfall and climate details of the city	
iv.	Topography and natural resources	
v.	Soil strata	
vi.	Depth of water level	
vii.	Socio economic conditions:	
viii.	Objectives of the project (describe the goals of SBM 2.0 which are targeted through proposed project)	
ix.	Structure of the report indicating contents/chapters	

S.no.	Census Year	Population	Decadal growth rate

ix. Structure of the report indicating contents/chapters

Session 3: Zoning of a city

Orientation training on SBM 2.0

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Session Objectives/ Agenda

- ✓ Understand the different approaches to wastewater management in the city – zoning
- ✓ Discuss the criteria to creates zones in a town
- ✓ Discuss a case study pertaining to zoning of a town

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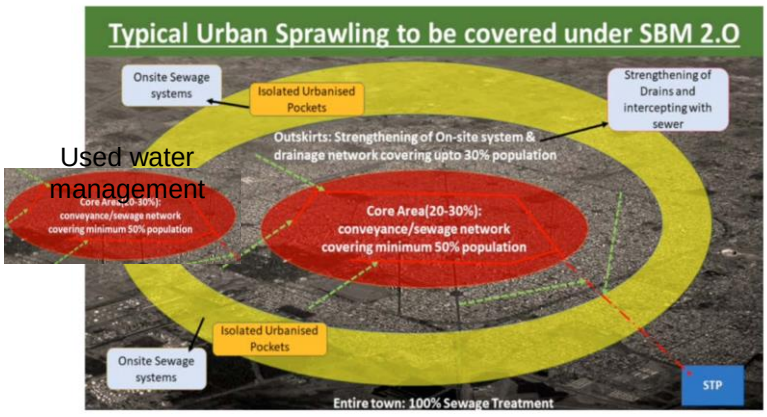
Implementation strategy

- Preparation of City Sanitation Action Plan
  - Existing status of used water (wastewater) management – Existing sewer networks, STP's, FSTP's, municipal drains
  - Gap analysis in respective infrastructure (demand – supply gap analysis)
  - Proposed project along with block estimate as per the standard template provided in Annex 3B
- Proposed DPR preparation Approach are
  - Collection and conveyance of used water through robust sewer network followed by STP
  - Collection and conveyance of used water through Municipal pucca drain as an interim arrangements followed by I&D and STP to treat Used water and Septage
- DPR preparation and Implementation of above components should be based on suitable zoning

Criteria for zoning as per SBM 2.0

Approach 1 – DPR Preparation for adopting sewer network and STP – Core zone



Used water management

Large cluster or Centralised System

1. Sewer network in Core Sanitation Zone (CSZ)-high density population
   - Detailed topo and population survey of the town
   - Delineate different sewerage zone
   - Demarcate zone which has **at least 50% of cities current population**
   - Settled over an area of **20-30% of towns spread**
   - CSZ will be provided with sewer network to connect it directly to the STP (approved by CPHEEO)
   - Cost for sewer network will be borne by state/ULB
     - 15th FC, SFC, own funds

Criteria for zoning as per SBM 2.0

Approach 1 - DPR Preparation for adopting sewer network and STP for **small clusters**

Used water management

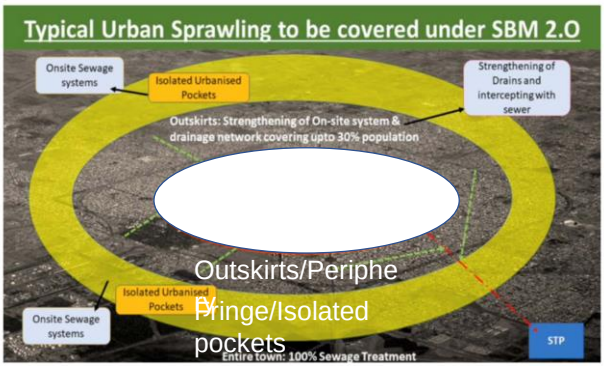
1. Used water management in upcoming new green field area or existing area in and around town
   - Demarcate these areas
   - Plan for **decentralized cluster based system** with STP for treatment
   - Reuse of treated used water within the premises for non-potable use

Small cluster or De-Centralised System

Criteria for zoning as per SBM 2.0

Approach 2 - DPR Preparation for adopting I&D structure and STP – peripheral/fringe area

Used water management for drain wastewater

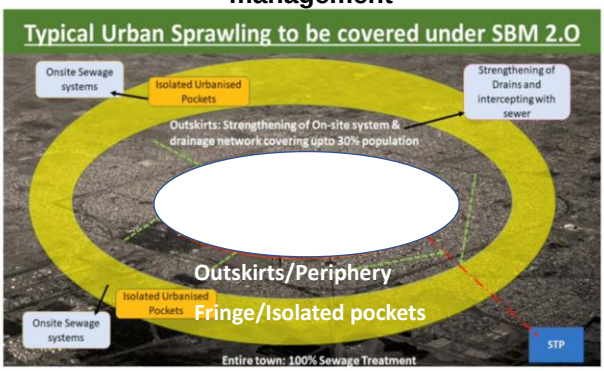


1. Intercepting **used water** from open drains to sewer network/STP for periphery (outside CSZ)
   - Strengthen (repair/continuity) the existing drain network to collect greywater, black water (raw sewage, supernatant from septic tank)
   - Provide I&D structure (screen at different intervals, settling basin) leading to STP (approved by CPHEEO)
   - STP to be designed to treat at **least 50% of current used water generation** from this area/town

Criteria for zoning as per SBM 2.0

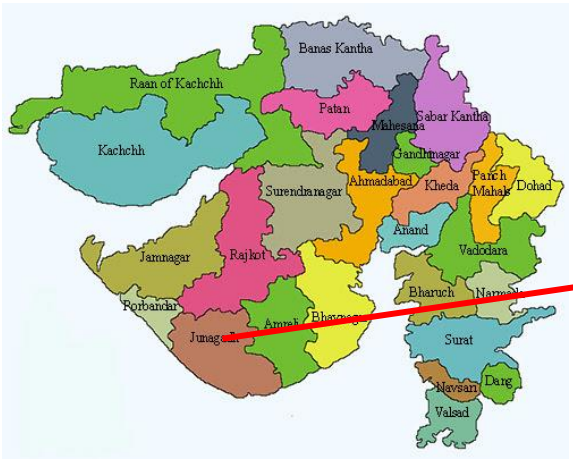
Approach 2 - DPR Preparation for adopting I&D structure and STP – peripheral/fringe area

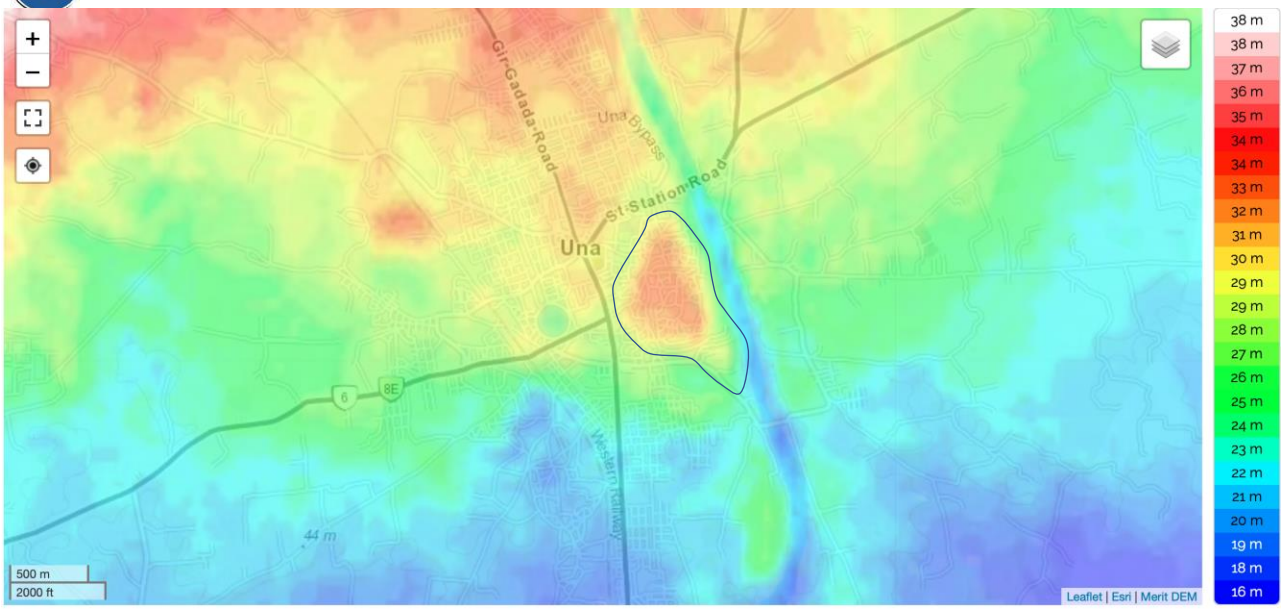
Fecal sludge management



- DPR Preparation approach for adopting I&D structure and STP
  1. **<u>Fecal sludge treatment</u>** approach for periphery/Fringe area not covered with sewer network
     - Town with existing STP – **<u>Cotreatment</u>** - Separation and dilution method
     - Town without STP – New STP with **<u>co-treatment</u>**
     - Town with FSTP without STP

Example Case





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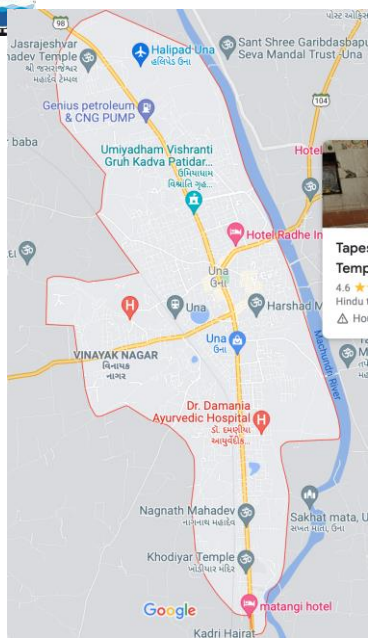

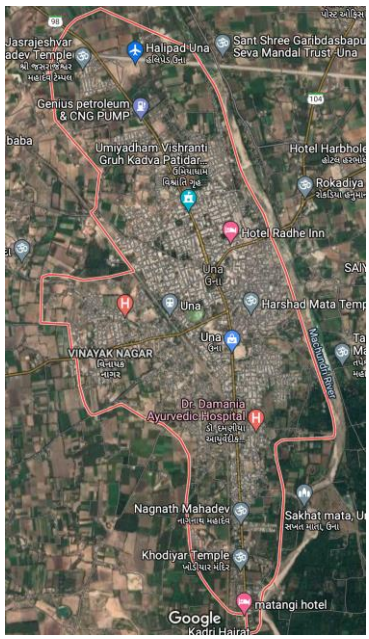

Salient Features

- One main road crosses the town
- The population is living mostly on two side of the road
- River flows adjacent to the boundary of the town
- The town slopes towards eastern and southern side
- Town is surrounded with agricultural land
- The town has totally 12 wards with Population approximately 62,300 as per senses 2011
- Presently used water discharged into the SWD leading to river

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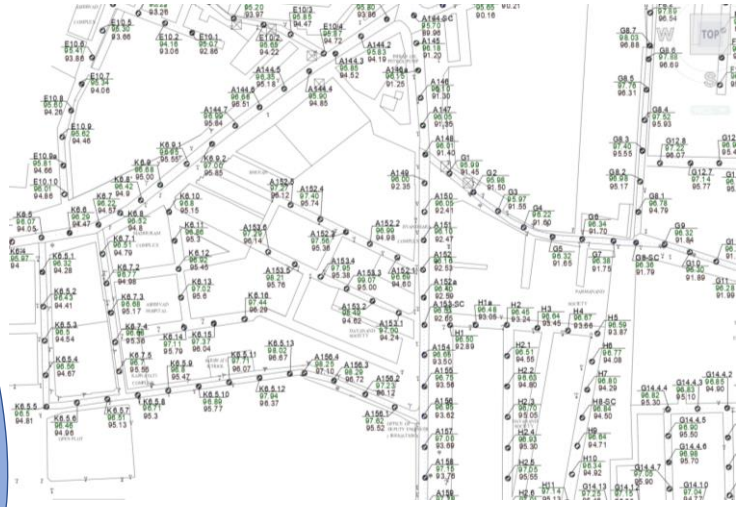
ANNEXURE NO.- 3
WARDWISE PROJECTED POPULATION FOR DIFFERENT HORIZON YEARS

Ward No.	Area Ha	Year 2001		Percentage w.r.t. Total Area	Year 2011		Year 2026		Year 2041	
		Population	Density		Population	Density	Population	Density	Population	Density
		51261								
W1	1730.14	4033	2.00	46.53	6906	4.00	14980	9.00	24862	14.37
W2	883.84	4521	5.00	23.77	6641	8.00	8500	10.00	14010	15.85
W3	110.90	4329	39.00	2.98	4990	45.00	11050	100.00	13540	122.09
W4	330.06	4561	14.00	8.88	5920	18.00	10115	31.00	15055	45.61
W5	38.43	4303	112.00	1.03	4612	120.00	5390	140.00	6150	160.03
W6	28.23	4663	165.00	0.76	4940	175.00	5220	185.00	5500	194.83
W7	11.69	4514	386.00	0.31	4600	393.00	4630	396.00	4675	399.91
W8	6.16	4120	669.00	0.17	4150	674.00	4200	682.00	4315	700.49
W9	33.62	4377	130.00	0.90	4700	140.00	5050	150.00	5375	159.88
W10	37.55	3954	105.00	1.01	4506	120.00	5634	150.00	6400	170.44
W11	371.49	4060	11.00	9.99	5311	14.00	9600	26.00	17350	46.70
W12	136.29	3826	28.00	3.67	5027	37.00	7957	58.00	16050	117.76
Total	**3718.40**	**51261**		**100.00**	**62303**		**92326**		**133282**	

How to arrive at zoning for SBM 2.0 – Proposed method

- With reference and in alignment with City Development Plan or City Master Plan - ULB prepares a City Sewerage Master Plan – covering all areas under jurisdiction.
- Based on detailed sewerage zones – Zones are analysed and demarcated as per the SBM guideline
  - Core area (20-30% of the city area, covering at least 50% of the population)
  - Outskirts or peripheral area (approx. 30% of population - newly developing area)
  - Fringe area or Isolated urban pockets (rest of the population along/near the boundary)



Detailed topo survey

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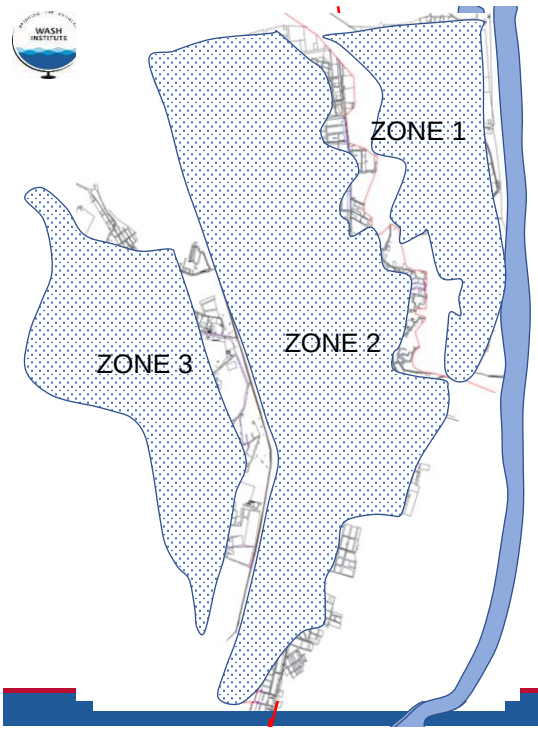

TABLE NO. 4.3 :- ZONEWISE AREA AND PROJECTED POPULATION FOR DIFFERENT HORIZON YEARS

Zone No.	Ward No.	Percentage of Ward	Area Ha	Ward Wise Population			
				2001	2011	2026	2041
Population				51261			
Zone-I	W1	50.00	865.07	2016.50	3453.00	7490.00	12431.00
	W2	90.00	795.46	4068.90	5976.90	7650.00	12609.00
	W6	25.00	7.06	1165.75	1235.00	1305.00	1375.00
	W7	90.00	10.52	4062.60	4140.00	4167.00	4207.50
	W8	60.00	3.70	2472.00	2490.00	2520.00	2589.00
	W9	20.00	6.72	875.40	940.00	1010.00	1075.00
Sub-total			1688.52	14661.00	18235.00	24142.00	34287.00
Zone-II	W1	35.00	605.55	1411.55	2417.10	5243.00	8701.70
	W2	10.00	88.38	452.10	664.10	850.00	1401.00
	W3	100.00	110.90	4329.00	4990.00	11050.00	13540.00
	W5	100.00	38.43	4303.00	4612.00	5390.00	6150.00
	W6	75.00	21.17	3497.25	3705.00	3915.00	4125.00
	W7	10.00	1.17	451.40	460.00	463.00	467.50
	W8	40.00	2.46	1648.00	1660.00	1680.00	1726.00
	W9	80.00	26.90	3501.60	3760.00	4040.00	4300.00
	W10	100.00	37.55	3954.00	4506.00	5634.00	6400.00
	W11	10.00	37.15	406.00	531.10	960.00	1735.00
	W12	100.00	136.29	3826.00	5027.00	7957.00	16050.00
Sub-total			1105.95	27780.00	32332.00	47182.00	64596.00
Zone-III	W1	15.00	259.52	604.95	1035.90	2247.00	3729.30
	W4	100.00	330.06	4561.00	5920.00	10115.00	15055.00
	W11	90.00	334.34	3654.00	4779.90	8640.00	15615.00
Sub-total			923.92	8820.00	11736.00	21002.00	34399.00

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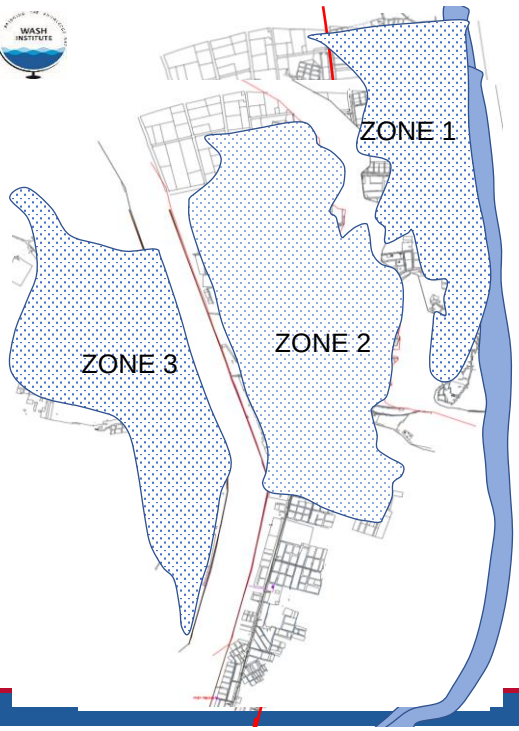
Sub-total			923.92	8820.00	11736.00	21002.00	34399.00

Zone 2 accounts to 49% of the population and 30% of the area

Zone 1 and 3 has balance population

71



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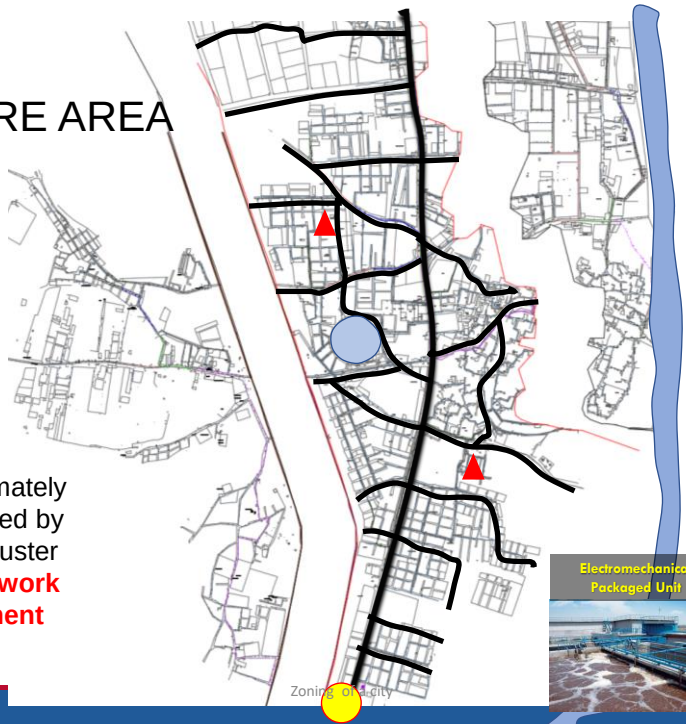
Zone 2 – CORE AREA



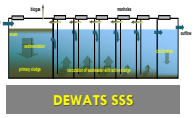
CORE AREA approximately 50% population covered by Centralised / Large cluster based **Sewerage network** with **Sewage treatment facility**

Zoning of a city

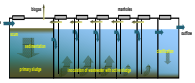
73

73

Faecal sludge/septage management
Cotreatment at STP



Decentralised wastewater management



Interception, diversion and treatment

Zone 1, 3 – Outskirts area, isolated urban pockets

Oniste containment
Septic tank/Pit system

Zoning of a city

74

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Zone 2 – CORE AREA

CORE AREA approximately 50% population covered by Centralised / Large cluster based **Sewerage network** with **Sewage treatment facility**
If adequate funds not available

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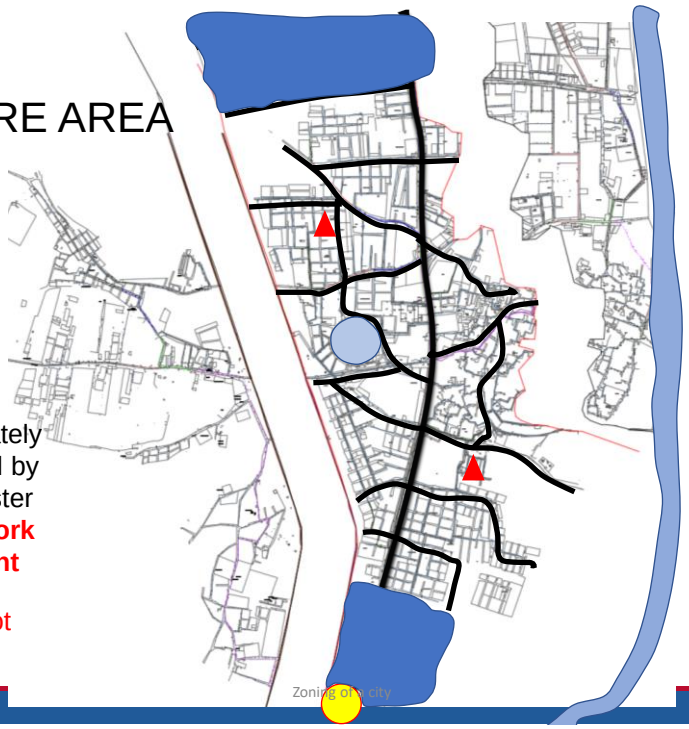
Zone 2 – CORE AREA

CORE AREA approximately 50% population covered by Centralised / Large cluster based **Sewerage network** with **Sewage treatment facility**
If adequate funds not available



Decentralsed system I&D system and FSM

76

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Session 3: Feasibility and components of Sewerage Systems

Orientation training on SBM 2.0

Session Objectives/ Agenda

- ✓ Understand the different components of sewerage systems
- ✓ Discuss the types of sewerage systems and their feasibility
- ✓ List down the parameters affecting the design of sewerage system
- ✓ Understand the process of planning of a sewerage system

Terminologies

- **Greywater:** is the used water that comes from sinks, washing machines, bathtubs and showers. It contains lower levels of contamination, making it easier to treat and process.
- **Blackwater:** is the used water from bathrooms and toilets that contains faecal matter and urine.
- **Sewage:** is the liquid waste originating from the domestic uses of water.
- **Sewer:** It is an underground conduit or drain through which sewage is carried to a point of discharge or disposal.
- **Sewerage:** The term sewerage refers the infrastructure which includes device, equipment and appurtenances for the collection, transportation and pumping of sewage, but excluding works for the treatment of sewage.
- **Sewage Treatment Plant** is a facility designed to receive the waste from domestic, commercial and industrial sources and to remove materials that damage water quality and compromise public health and safety when discharged into water receiving systems or land.

Sewerage

- Underground hydraulic conveyance structures that collects and carry or transport the used water by gravity or by force to the sewage treatment plant or for safe disposal.
- It includes sewer pipes, machine hole chambers, gravity mains, pumps, raising mains, air valves etc.
- Main role of sewer system:
  - Improvement in the environment by removing the sewage from where it originates
  - Preventing inundation of low-lying areas that may be otherwise caused by not sewering
  - Prevention of vector propagation by sewage stagnation
  - Avoiding cross connection with fresh water source by seepage

Types of sewer system

Commonly practiced approaches:

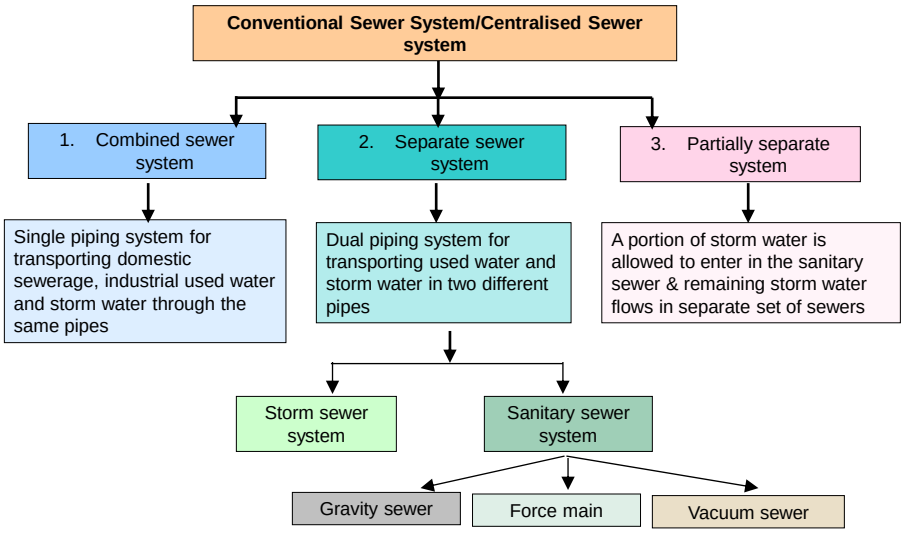
- **Conventional sewer system**
  - For collection of used water from larger tributary area and transport it to centralised used water treatment location.
  - Used for Centralised or large cluster based sewerage system
  - Separate sewer system or partially separate sewer system
- **Simplified sewer system:**
  - Constructed using smaller diameter pipes laid at a shallower depth and at a flatter gradient than conventional sewers.
  - Used for small cluster or De-centralized sewerage system
  - Shallow sewer system and small bore sewer system

Types of sewer system

Different types of sewer system in practice

- Conventional sewer system
  - Combined sewer system
  - Separate sewer system
  - Partially separate/combind sewer system
- Simplified sewer system:
  - Shallow sewer system
  - Solid free sewer system/Small bore sewer system
- Other types
  - Vacuum sewer system
  - Pressurised sewer system
- Stormwater drain/channels

Conventional sewer system

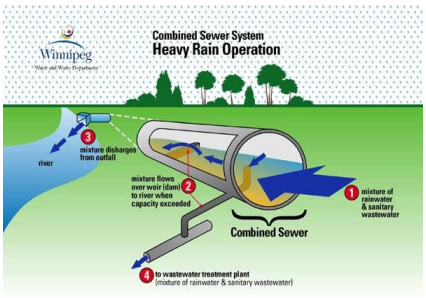


Conventional sewer system

Combined sewer system

A combined sewer system is a sewer that accepts storm water, sanitary water/sewage, then the sewage is treated in STP(sewerage treatment plant). This system is mainly used in the towns where streets are narrow and rain fall is less than the moderate

Normally in India, this system is practiced mainly using the stormwater drain



SBM 2.0 does not encourage use of combined sewer system

Combined sewer system

Advantage

- The cleaning of sewers is easy as they are of large in size.
- The maintenance cost is less.
- The stormwater reduces the strength of sewage by dilution.
- The self-cleaning velocity is easily achieved
- In congested areas it is easy to lay only one pipe rather than two pipes as required in other systems

Dis-advantage

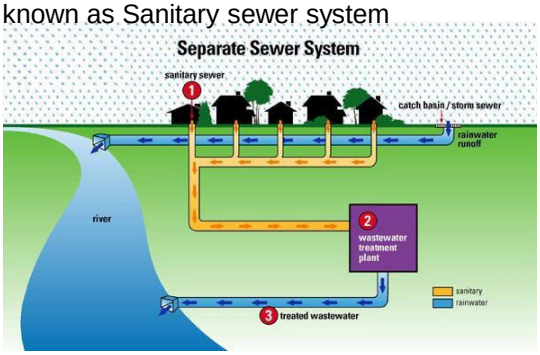
- The load on the treatment plant becomes high.
- The stormwater is unnecessarily polluted.
- The sewers are large in diameter.
- This system proves to be uneconomical when pumping is required for the lifting of sewage

Conventional sewer system

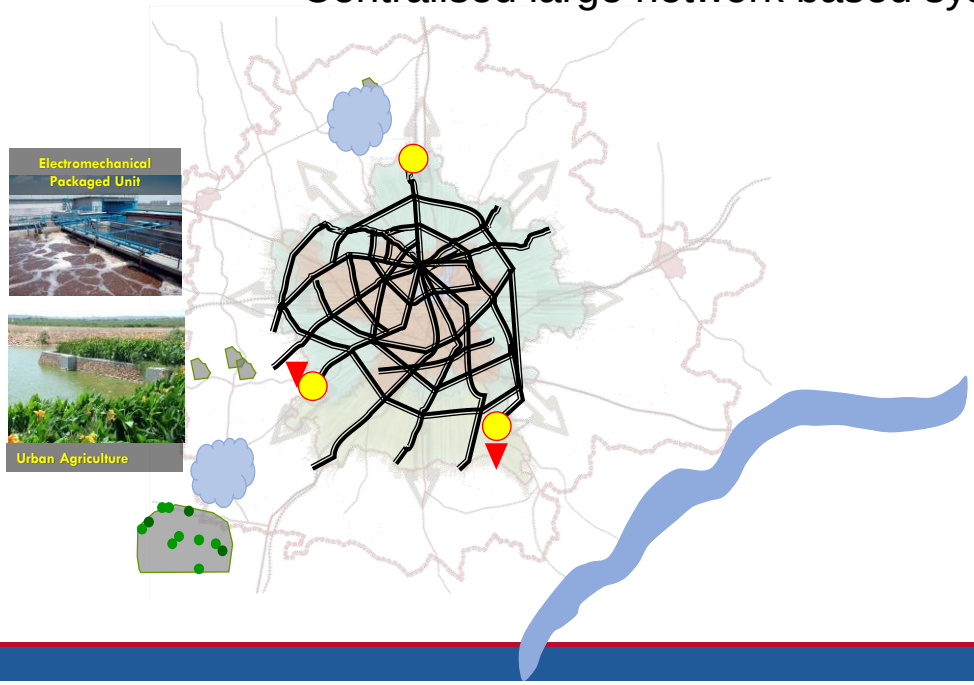
Seperate sewer system

In this system the sanitary sewage and storm water are carried separately in two sets of sewers. The sewage is conveyed to used water treatment plant (WWTP) and the storm water is discharges into rivers without treatment

Also known as Sanitary sewer system



Centralised large network based system



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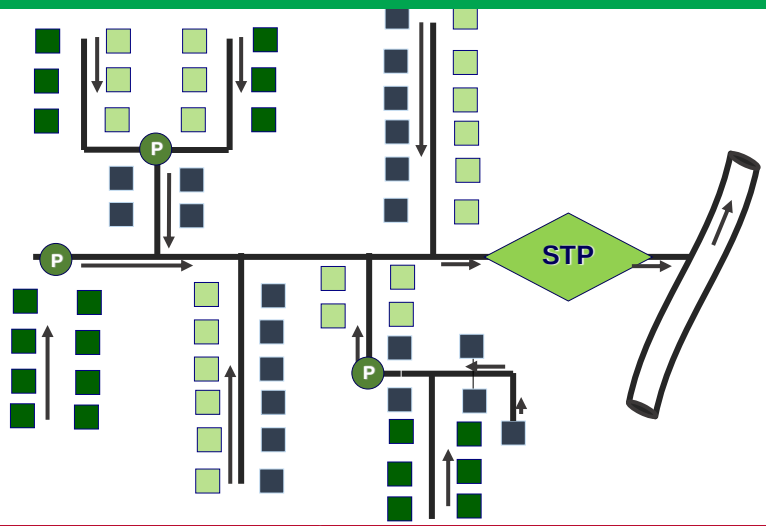
CENTRALISED USED WATER COLLECTION AND TREATMENT



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Seperate sewer system

Advantage

- As the sewage flows in separate pipe, this system may be less costly for laying and also the quantity to be treated at sewage treatment plant is a small resulting in economy of treatment
- When pumping is required, this system is economical due to less flow
- Natural/storm water is not unnecessarily polluted by sewage

Dis-advantage

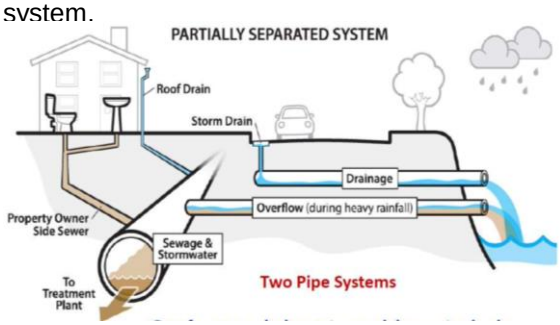
- Self cleansing velocity may not develop at certain locations in sewers and hence flushing of sewer may be required
- The system requires laying two sets of pipe which will be difficult in congested areas
- The system will require maintenance of two sets of pipelines hence maintenance cost will be more

Conventional sewer system

Partially separate sewer system

A partially separate system is a combination of a combined sewerage system and separate sewerage systems.

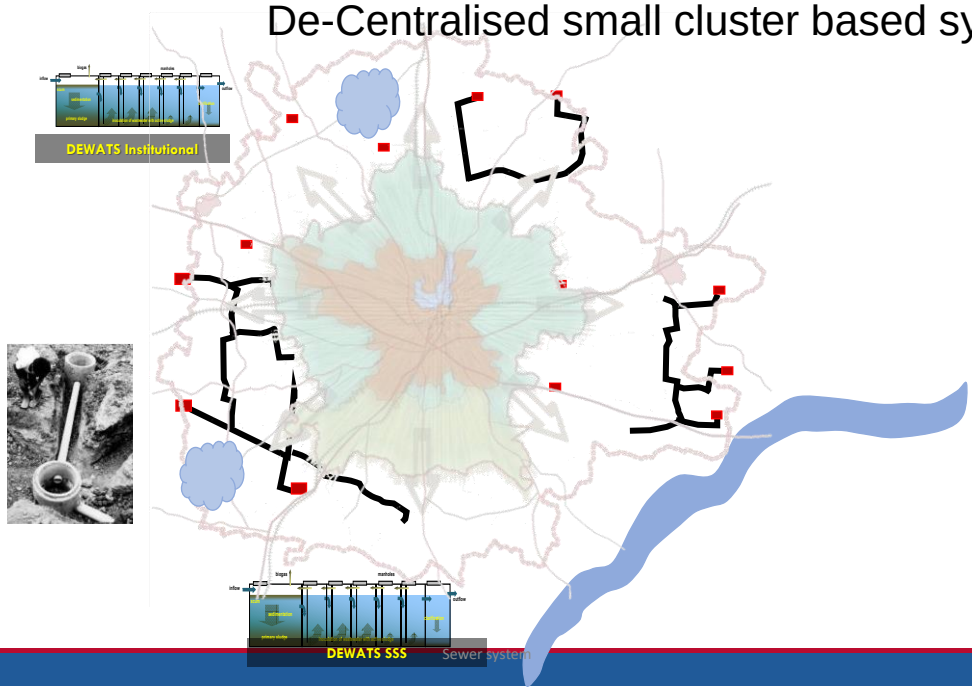
This type of sewerage system helps decrease the load from a combined sewerage system because only the water from initial rain falls(water from acid rain) is added to sewage water and after than this system work as separate system.



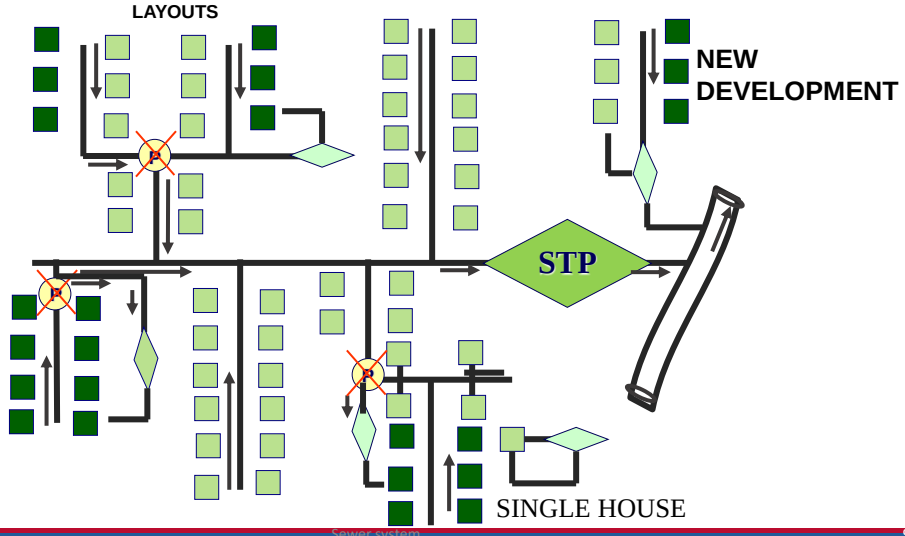
Simplified sewer system

- Simplified sewer system, conceptually same as conventional sewer system, but with conscious efforts made to eliminate unnecessarily conservative design features and to match design standards to the local situation.
- Simplified Sewers describe a sewerage network that is constructed using
  - Smaller diameter pipes
  - Laid at a shallower depth
  - Laid at a flatter gradient

De-Centralised small cluster based system



DECENTRALISED USED WATER COLLECTION AND TREATMENT



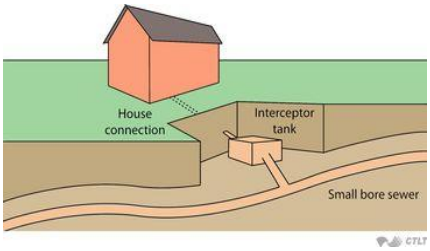
Simplified sewer system

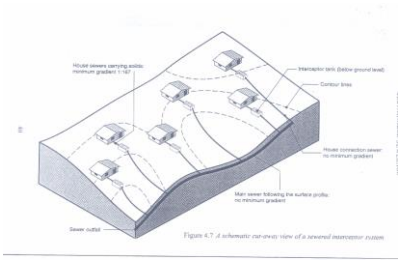
- Small Bore sewer system
  - Developed and practiced by Technical Advisory Group (TAG) under the United Nations Development Programme (UNDP)
- Shallow sewer system/ Condominial Sewerage:
  - Developed in Brazil by R&D Division of CAERAN (Water and Sewerage Company of the State of Rio Grande do Norte)
- Both approaches have been in practice in various countries and in the Sewerage and Sewage Treatment Manual of Ministry of Urban Development, Government of India.

Simplified sewer system

Small bore/settled sewer system

- Designed to collect and transport only the liquid portion of the domestic used water for offsite or onsite treatment and safe disposal
- Solids are separated from the used water in septic tanks or interceptor tanks installed at the upstream near each of the households





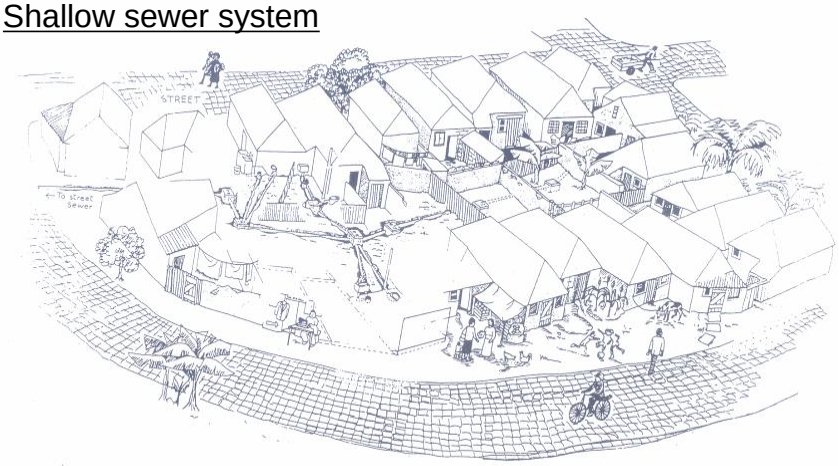
Simplified sewer system

Shallow sewer system

- It is a separate sewer system used to convey all the used water from the household environment at a shallow depth for offsite and onsite treatment and safe disposal
- It's a network of small diameter sewer pipes laid in flat gradients in locations away from heavy imposed loads, usually at the backyards or on the sides of both planned and unplanned settlements
- Short lengths of pipe work to be laid in shallow trenches with shallow inspection chambers for maintenance
- Shallow sewer system is also called as in-block system, whereas conventional sewerage is in-road system.

Simplified sewer system

Shallow sewer system



Shallow block sewer and house connection at the densely populated area

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Simplified sewer system

Shallow sewer system

Figure 5.1 *Model of the layout of a small condominial sewerage scheme similar to the one used for demonstrations in Rio Grande do Norte, Brazil*

Shallow block sewer and house connection layout for planned and unplanned human settlements

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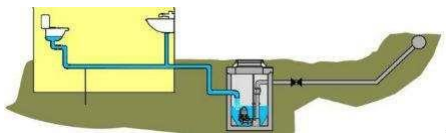
Other types of sewer system

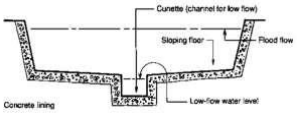
Pressurised sewer system



- Use pumps instead of gravity to transport used water
- The primary effluent is delivered to the collection tank by gravity, where it is grinded (pressed) before being transported into the pressurised system by pumps
- can be built with only shallow trenches and relatively small - diameter pipes
- in rocky, hilly or densely populated areas, or areas with a high groundwater table

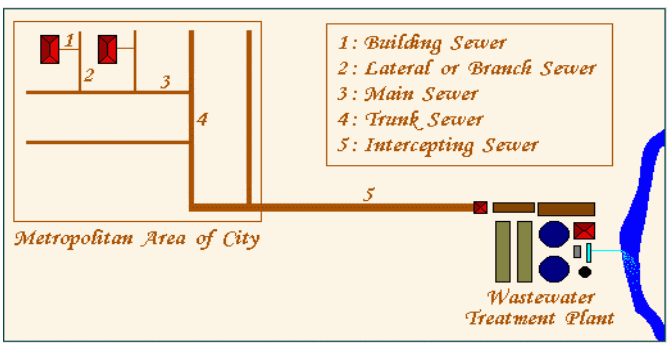
Stormwater drain/channel system

Advantages	Disadvantages
Less expensive	High health risk due to illegal discharge of wastewaters and solid waste
Simple to construct	Breeding ground for insects and pests
Construction materials are often locally available	Regular cleaning service required to remove solids and blockages which usually causes spill-over and flooding



Components of sewer system

- Trunk Sewer (or Transmission Main)
- Collection Main Sewer (or branch sewers)
- Service Lateral Sewer (or house sewers)
- machine hole chamber
- Intercepting sewer / Pump station / Force main



Design criteria

Estimation of sanitary sewage

Population forecast method	Peak Factor
Arithmetic increase	Large and old towns
Incremental increase	Average size town
Geometric increase	Towns with high growth and migration

- Design period – 30 years
- Population forecast
- Tributary area – Drainage zone, sewerage service area - Use of map
- Per capita sewage flow – Water supply data (80% water supply)
- Flow calculation - peak usage hours, peak factor
- Ground water infiltration (average 5% of sewage contribution)
- Stormwater runoff

Contributing Population	Peak Factor
Up to 20,000	3
20,000 – 50,000	2.5
50,000 – 75,000	2.25
Above 75,000	2

CPHEEO Manual should be followed for the design of the sewer system

Design criteria

Design period

Design Component	Design Period	Remarks
Land Acquisition for STP, SPS, sewers etc	30 Years	Land acquisition in future could be difficult
Sewer network (laterals, Trunk mains, Outfall et)c	30 Years	Replacement of laid pipe line will be difficult and costly
Pumping mains	30 Years	Cost may be economical
Pumping Stations-Civil Work	30 Years	
Pumping Machinery	15 Years	Life of pumping machinery is 15 years
Sewage Treatment Plants	30 Years	The construction shall be modular in phased manner as actual population less than design population and in Indian cities initially flows are much less due to connectivity problems.
Effluent disposal and utilization	30 Years	Provision of design capacities in the initial stages itself is economical

Design criteria

Hydraulic of sewer

- Formulae used for determining flow velocities
  - (Mannings, Chezys-Gravity flow and Hazen, Darcy-Pressure flow)
- Design velocity – min 0.6m/s (self cleansing velocity), max-3mps (scouring velocity)
- Depth of flow – not exceeding 0.8 full at ultimate peak flow
- Selection of Sewer slope – 1:170 to 1:1000

Sewer size	Minimum slope (%)	1 in
150 mm	0.6	170
200 mm	0.4	250
300 mm	0.22	450
> 525 mm	0.10	1000

Design criteria

Hydraulic of sewer

- Minimum pipe diameter – 150mm in public road, 100mm for house sewer
- Trench section, Minimum cover – 1m above the pipe, max depth 6m.
- Manholes type, size and spacing - < 0.9m – max 30m, … > 2m – upto 300m
- Pumping main and pumping hours – more pumping hours smaller pipe size
- Rising mains/Force mains – max velocity 3m/s at ultimate peak flow
- Sewer transition – connection of different dia sewers, bends junctions, vertical drops

Sewer size	machine hole spacing
Sewer < 900 mm	Maximum 30 m
900 –1,500mm	90 – 150 m
1,600 – 2,000 mm	150 – 200 m
> 2,000 mm	Up to 300 m

Design and Planning

Planning process

- Detailed survey – Boundaries, underground structure, used water generation, topography (spot level, contours, finished road level), soil type etc
- Formation of zone based on detailed topo survey of the areas to be covered and population density
- Sewer network alignment and marking for different zones
- Sewage quantity estimation for each zone and for each sewer line
- Flow velocity calculation
- Sewer section calculation – Diameter of pipe
- Grade determination of sewers – Pipe slope

Design and Planning

Requirement of Design and Planning of Sewerage Systems

Following should be considered while designing the system

- For evaluating the proper diameter of the sewer, correct estimation of sewage discharge is necessary
- The flow velocity inside the sewer should neither be so large as to require heavy excavation and high lift pumping nor should be too small
- The sewage in sewer should flow under gravity with 0.5 to 0.8 full at designed discharge, ie at maximum estimated discharge
- The sewage is conveyed to a point usually located in low –lying area where the treatment plant is located
- Sewer provided should be adequate in size to avoid overflow and possible health hazards

Design and Planning

Design of Sewer Systems

- Sewer system of a town or city involves design of number of sewer lines.
- The sizes and slopes of all the various sewers are to be calculated for carrying the estimated sewage flow at the self cleansing velocities.
- This work involves large calculation work, which is very tedious and laborious.
- The work of designing is simplified by the use of various tables or monograms and charts which have been prepared on the basis of empirical formulae.
- There are also software available for the design like – Sewer gem

Design and Planning

Table used for calculation

Name of Main	Manhole		GL at MH	Length	Population			Discharge (q Actual)		Dia. of pipe	Type and quality of Pipe	Manning's Constant	Slope 'S' assumed for full flow (Q)	Velocity	Invert Level of PIPES	
	From	To			Present	Ultimate	Floating	Present Peak	Ultimate Peak						Upper End	Lower End
	No.	No.	m	m	nos	nos	nos	lps	lps	mm			1 over	m/s	m	

Sewer construction

Factors considered for selecting material for sewer

Following should be considered before selecting material for manufacturing sewer pipes

- **Resistance to corrosion**
  - Sewer caries used water that releases gases such as H2S. This gas in contact with moisture can convert into sulphuric acid
  - The formation of acids can lead to corrosion. Hence selection of corrosion resistance material is a must for long life of pipe.
- **Resistance to abrasion**
  - Sewers contains considerable amount of untreated solids part of which are inorganic and lead to abrasion and hence resistance to abrasion is important

Sewer construction

Factors considered for selecting material for sewer

- **Strength and durability**
  - The sewer pipe should have sufficient strength to withstand all forces.
  - This was a subject to considerable extreme loads of backfill material and traffic load if any
  - They are not subjected to internal pressure of water
  - To withstand the external load safely without failure, sufficient wall thickness of the pipe reinforcement is essential
- **Weight of the material**
  - The material selected for sewer should have less specific weight which will make pipe light in weight. The lightweight pipes are easy for handling and transport
- **Imperviousness**
  - To eliminate chances of sewage seeping from sewer to surrounding material selected for the pipe should be impervious

Sewer construction

Materials used for sewer

- Brick sewer – particularly for larger diameter
- Plain cement concrete or reinforced cement concrete
- Vitrified clay or stoneware sewers – 90cm length
- Asbestos cement sewers
- Cast iron and Steel pipe sewer – Pressure sewers
- Ductile iron pipes
- UPVC pipe
- HDPE pipe

Sewer construction

Laying of sewer pipes

- Sewers are generally laid starting from their **outfall ends towards their starting points**.
- It is common practice, to first locate the points where manholes are required to be constructed as per drawing i.e. L-section of sewer, and then laying the sewer pipe straight between the two manholes
- Central line of the sewer is marked on the ground and an offset is also marked
- The lining can be drawn by fixing pegs at 15 metre intervals and can be used for finding out Center line of the sewer simply by off setting
- The trench of suitable width is excavated between the two manholes and sewer is laid between them. Further excavation is then carried out by laying the pipes between the next consecutive manholes
- The process is continued till the entire sewer is laid out

Sewer construction

Laying of sewer pipes

- In ordinary or softer grounds sewers are laid embedded in concrete
- The trench is excavated up to a level of the bottom embedding concrete or up to the invert level of the sewer pipe plus the pipe thickness if no embedded in concrete is provided
- After bedding concrete is laid in required alignment and levels. The sewer pipes are then lowered down into trench either manually or with the help of machines for bigger pipe diameters
- The sewer pipe lengths are usually laid from lowest point with their sockets facing up the gradient on desired bedding. Thus, the spigot end of the new pipe can be easily inserted on the socket end of the already laid pipe

Sewer commissioning

Hydraulic testing of sewers

Test for leakage or water test

- The sewer are tested after giving sufficient time for joints to set in for no leakage
- For this sewer pipe section are tested between the manholes to machine hole under a test pressure of about 1.5 m water head
- To carry this the downstream end of the sewer is plugged and water is filled in the machine hole at the upper end
- The depth of the water in the man hole is maintained at about 1.5 m

Test for straightness of alignment

- This can be tested by placing a mirror at one end of the sewer line and a lamp at the other end
- If the pipe line is straight full circle of light will be observed

Backfilling the trench: After the sewer line has been laid and tested the trenches are backfield

Sewer Appurtenances

- Machine holes, drop manholes
- House sewer connections
- Lamp holes, gully traps,
- grease traps, inverted sipholes
- flushing tanks
- Ventilation shafts
- Catch basins, clean outs etc.

Machine holes

Manholes / Machine hole

Manholes is an opening by which a person may enter a sewer for inspection, cleaning and others maintenance and fitted with a removable cover on top to withstand traffic loads in sewer

- Machine holes are classified as:
  - Shallow machine hole or inspection chamber
  - Normal machine hole
  - Deep machine hole
- Shape of machine holes
  - Rectangular
  - Circular
- Construction material
  - Brick work
  - Reinforced Cement Concrete
  - HDPE, UPVC, FRP

Range of Depths, m	Internal Diameter
Above 0.9m upto 1.65m	0.9m
Above 0.9m upto 2.30m	1.2m
Above 2.3m upto 6.00m	1.5m

Manholes

Location and Spacing of machine holes

- The machine holes are generally provided at every bend, junction, change of gradient or change of sewer pipe diameter.
- Unless there are practical difficulties, the sewer line between two manholes is laid straight with even gradient. Even straight manholes are provided at regular interval.
- The spacing between the machine holes depends mainly upon the size of the sewer pipe. The larger is the diameter of the sewer pipe the greater will be the spacing between the manholes.
- 30m spacing is adopted for the sewer pipe lines with diameter 150mm.

Manholes

Types of Manholes

- **Straight-Through machine holes** – machine hole built on a straight run of sewer with no side junctions
- **Junction machine holes** – machine hole built at every junction of two or more sewers
- **Side entrance machine hole** – machine hole built to large sewer where it is difficult to obtain direct vertical access to the sewer from ground level

Manholes

Types of Manholes

- **Drop machine holes** – machine hole built where sewer connects with another at different level (level difference of more than 600mm depth)
- **Flushing machine holes** – machine hole built where it is not possible to obtain self cleansing velocity
- **Scraper type machine hole** – machine hole built at a level where regular maintenance required, hence should be in a reachable limit to facilitate lowering of buckets.

Costing

Cost, timeline, and expertise required to plan and implement sewerage network

- **Cost:** The detailed cost estimates should be prepared based on the applicable SOR
  - For the preliminary investment understanding, the cost could be considered such as;
  - Rs. 8-10 K/capita
- **Timeline:** Generally the sewerage project takes 2- 3 years for completion depending on the size of the town.
- **Technical Expertise:**
  - Hydraulic Designer/Engineer
  - Structural Engineer
  - Mechanical Engineer
  - Electrical Engineer
  - Social Safeguard/Environmental Specialist

Role of ULB in sewerage network planning, design, implementation, and O&M

1. Master Plan/Land use plan of the town
2. Underground Utility map
3. Land demarcation for Pumping Stations (To ensure the sewerage planning according to identified pumping locations)
4. Ward wise population data and forecast
5. Identification of outfall locations for discharge
6. Public consultation of ward parshad/representative of ULBs with HHs
7. Prepare and implement a Traffic Management Plan during implementation
8. Coordinate with Traffic Police for temporary road diversions
9. Inform the affected local population 1-week in advance about the work schedule
10. Implementation of taxes/fees for the service
11. Collection efficiency od revenue
12. Capacity Building and training on the system
13. Monitoring of treated used water quality from STP
14. Sludge quality and suitability as manure
15. Pipeline network to sustain operational efficiency and avoid clogging and early occurrence of leakages

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O&M of sewerage systems -

- Sewerage facilities to be operated and maintained include sewers, intermediate pump stations (IPSs) and sewage treatment plants (STPs). Initially, it's O&M are undertaken by Contractors and post O&M period it's handed over to ULB for operations.
- Cost Requirement - generally considered as 1.5 to 2% of capital cost
    1. Human resource
    2. Maintenance of Sewerage
    3. Maintenance of Pumping station
    4. Maintenance of equipment's
    5. Power

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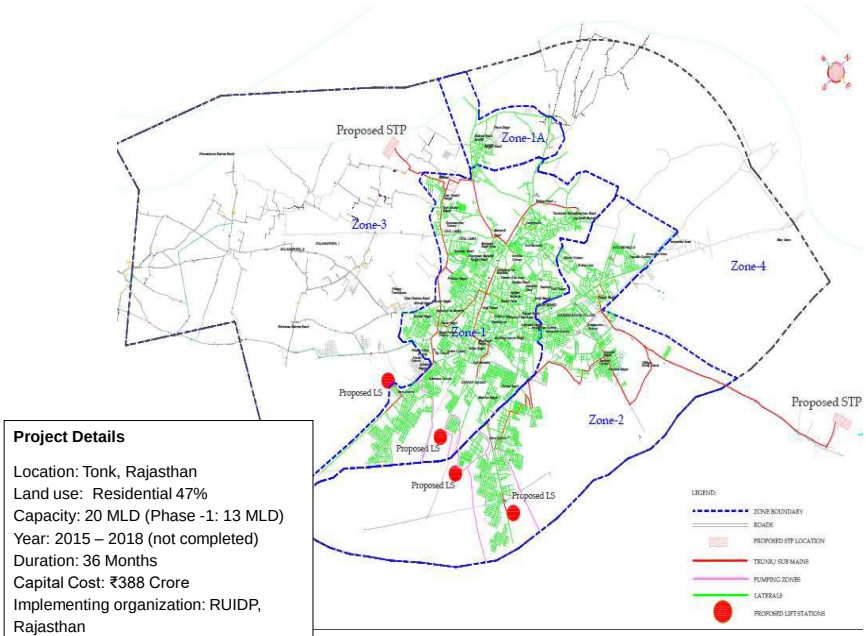
Case Study: Tonk, Rajasthan Sewerage System

- **Comprehensive sewerage system** – sewage collection and conveyance network and a facility to treat the sewage to disposal standards, is being implemented for Tonk town.
- Sewerage system will cover entire town, excluding areas with low population density (100 persons/hectare). Of the total base year population (2016) of 177,676, the subproject will cover 80% of the population and the rest 20% population, residing in the outer areas with low population density, will continue to depend on individual septic tank and soak pit arrangements.
- The sewer system is designed as a **separate sewer system** that carries only the domestic used water, the open drain system that exists in the town will cater to storm runoff.
- The sewage treatment facility (with SBR technology) will be constructed in the already identified government land to meet the future demand of 19 MLD in 2011 and 32 MLD by 2046
- **Cost:** 388 Cr. (including 10 years of O&M cost)
- **Timelines:** 2015-18 (36 months)

Project Components	Quantity
Sewer network of DWC pipes of dia 200-900 mm	Appx 254 KM
House service connection	Appx 22000 nos.
Pumping station	16 MLD at Molaipura and 4 MLD at Soron
STP (SBR based)	13 MLD



Project Details

Location: Tonk, Rajasthan
Land use: Residential 47%
Capacity: 20 MLD (Phase -1: 13 MLD)
Year: 2015 – 2018 (not completed)
Duration: 36 Months
Capital Cost: ₹388 Crore
Implementing organization: RUIDP, Rajasthan
Funding Agency: Asian Development Bank

Additional reading materials (name and links to the materials):

1. CPHEEO Manual for Sewerage
2. Structural Design of Sewers IS Code 4127-1967, 783-1959
3. Steel Fiber Reinforced Concrete Covers (SFRC) conforming to IS 12592 (heavy duty HD-20 Grade designation) or cast iron machine hole covers and frames conforming to IS 1726 (part 1 -7)

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Session 4: Faecal Sludge Management

Orientation training on SBM 2.0

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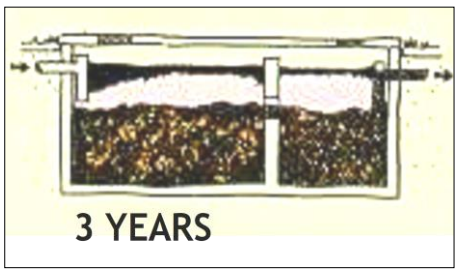
Session Objectives/ Agenda

- ✓ Introduction to Faecal sludge management and terminologies
- ✓ Estimating faecal sludge generation for a city
- ✓ Key tasks to be performed by ULB in FSSM for non-core areas of the city

What is faecal sludge?



Sludge accumulated inside onsite containment systems (such as septic tank, pits) is called faecal sludge.
ऑनसाइट रोकथाम प्रणालियों के अंदर जमा कीचड़ (जैसे सेप्टिक टैंक, गड्ढे) को मल कीचड़ कहा जाता है

How much faecal sludge is generated?

As per CPHEEO , Sludge accumulation rate is 0.21 liters / person/day
सीपीएचईईओ के अनुसार, कीचड़ संचय दर 0.21 लीटर/ person/day

Faecal sludge generation for town (in M^3) = $\frac{\text{Population of the town} \times 0.21}{1000}$

शहर के लिए मल कीचड़ पीढ़ी (M3 में) = $\frac{\text{शहर की जनसंख्या} \times 0.21}{1000}$

Role of ULB in FSSM (under SBM 2.0)

1. Standard containment systems
   मानक रोकथाम प्रणाली
2. Regular desludging
   नियमित रूप से विलवणीकरण
3. Licensing of private operators
   निजी ऑपरेटरों का लाइसेंस
4. Regulation of sludge disposal
   कीचड़ निपटान का विनियमन

Containment Systems – as per SBM

Twin Pit

Septic tank with leach/soak pit

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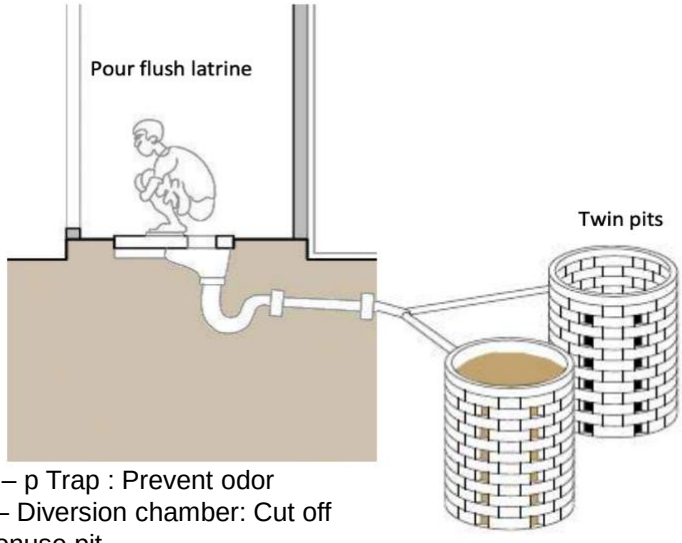
Twin Pit



1 – p Trap : Prevent odor
2– Diversion chamber: Cut off nonuse pit
3 – Opening : Water to leach

This technology consists of two alternating pits connected to a Pour Flush Toilet. The blackwater and greywater is collected in the pits and allowed to slowly infiltrate into the surrounding soil. Only one of the two pits is used at any time. The pits should be of a size to accommodate a volume of waste generated over one or two years. Then the second pit is used. This allows the contents of the full pit enough time to transform into Pit Humus (a partially sanitized soil-like material) that can be manually excavated.

CAPEX: Rs. 8,000 – Rs. 15,000

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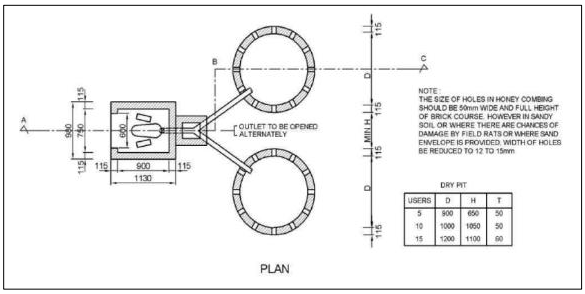
TWIN PITS: Design

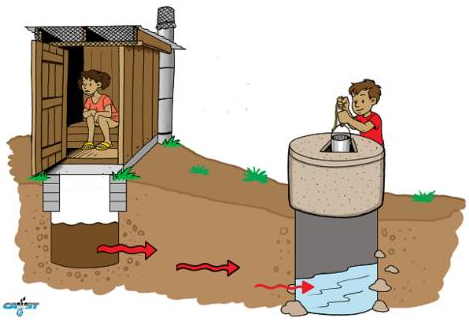


	5 Users		10 Users		15 Users	
	Dia	Depth(A)	Dia	Depth(A)	Dia	Depth(A)
Dry Pits	900	1,000	1,100	1,300	1,300	1,400
Wet Pits	1,000	1,300	1,400	1,400	1,600	1,500

- Distance between pits should be at least 1 m. गड्ढों के बीच की दूरी कम से कम 1 मीटर होनी चाहिए
- Should not be built in high ground water table areas उच्च भूजल स्तर वाले क्षेत्रों में नहीं बनाया जाना चाहिए
- Diversion chamber to be provided for users to operate easily. उपयोगकर्ताओं को आसानी से संचालित करने के लिए डायवर्जन चैंबर प्रदान किया जाएगा
- At least 1-year time to be provided for pit which is not in use. गड्ढे के लिए कम से कम 1 साल का समय दिया जाए जो उपयोग में नहीं है
- Pits should not be interconnected. गड्ढों को आपस में नहीं जोड़ा जाना चाहिए

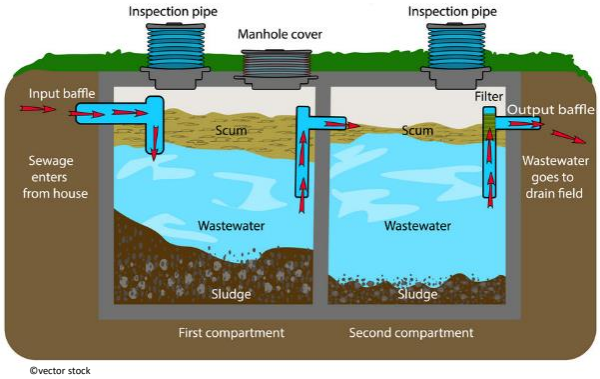
CPHEEO Manual on Sewerage and sewage treatment : Chapter 9: Onsite sanitation systems

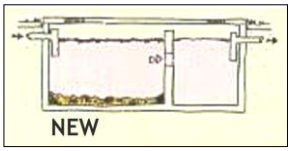
How to build twin pits in areas with high ground water table?

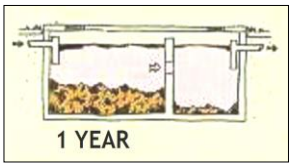


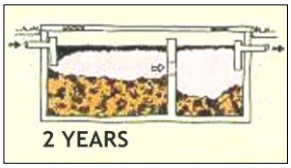
Distance between bottom of the pit and the maximum groundwater table	Effective size of the formation soil	Minimum horizontal distance from drinking water source	Modification needed
> 2 m	< 0.2 mm (fine sand, clay and silt)	3 m	None
> 2 m	> 0.2 mm (coarse sand)	3 m	Provide envelope of sand and impermeable pit bottom
< 2 m	> 0.2 mm (coarse sand)	10 m	Provide envelope of sand and impermeable pit bottom
< 2 m	< 0.2 mm (fine sand, clay and silt)	10 m	None

SEPTIC TANKS









Removes 40-50% BOD

CAPEX = Rs. 15,000 – Rs. 20,000

HRT = 1-2 days

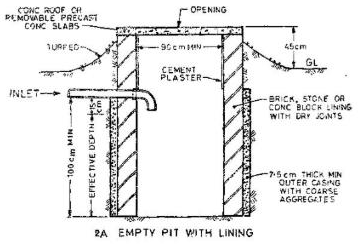
SRT = 2 or 3 years

If septic tanks are not desludged in time, raw excreta will start overflowing into drains or streets causing serious public hazard.

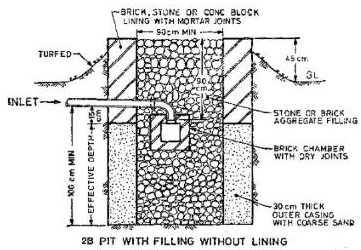
SEPTIC TANKS: Design Considerations

No. of Users	Length (m)	Breadth (m)	Liquid depth (m) (cleaning interval of)	
			2 years	3 years
5	1.5	0.75	1.0	1.05
10	2.0	0.90	1.0	1.40
15	2.0	0.90	1.3	2.00
20	2.3	1.10	1.3	1.80

- ✓ IS 2470 (Part 1):1985 – Code of Practice for installation of septic tank: design criteria and construction.
- ✓ IS 2470 (Part 2):1985 – Code of Practice for installation of septic tank: secondary treatment and disposal of septic tank effluent.
- ✓ IS 9872:1981 – Precast concrete septic tanks



2A EMPTY PIT WITH LINING



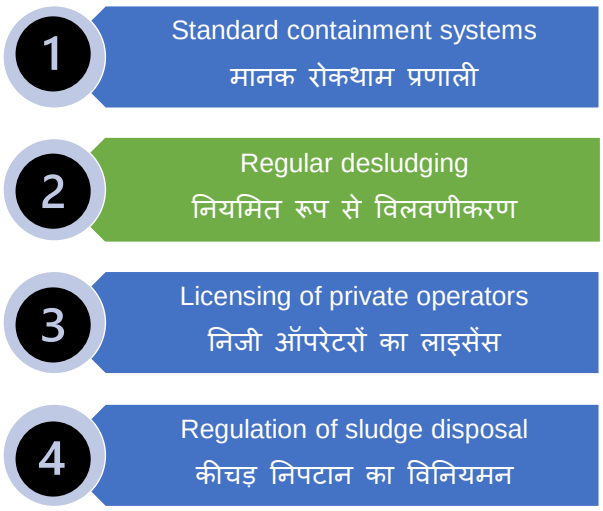
2B PIT WITH FILLING WITHOUT LINING

Septic tank effluent should be drained through soaks pits and not connected to drains

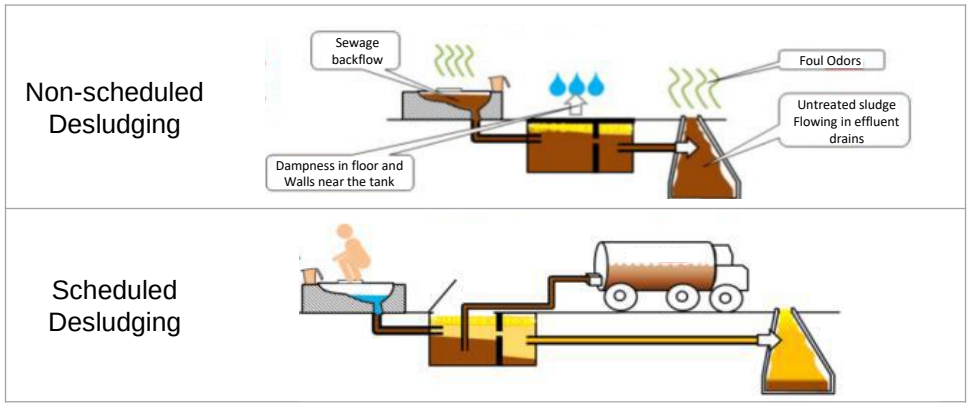
Role of ULB- Standard containment units

1. All future containment systems to be either twin pit or septic tank. भविष्य के सभी रोकथाम सिस्टम या तो जुड़वां गड्ढे या सेप्टिक टैंक हो
2. Septic tank to be built as per IS 2470 with soak pit. सेप्टिक टैंक के अनुसार बनाया जाएगा 2470 सोख गड्ढे के साथ
3. ULB by-laws and penalty for direct disposal of black water into drain. नाले में काले पानी के सीधे निपटान के लिए ULB द्वारा कानून और जुर्माना
4. Single pits (insanitary) to be converted into twin pit or septic tanks. एकल गड्ढे (अस्वच्छता) को जुड़वां गड्ढे या सेप्टिक टैंक में परिवर्तित किया जाएगा
5. At least 25 % of all septic tanks to have soak pits

Role of ULB in FSSM (under SBM 2.0)



CONCEPT: SCHEDULED DESLUDGING



Source : Presentation on "Toilets and Beyond: How to implement ODF in small towns in India" at FSM4 by PAS, CEPT University, Ahmedabad

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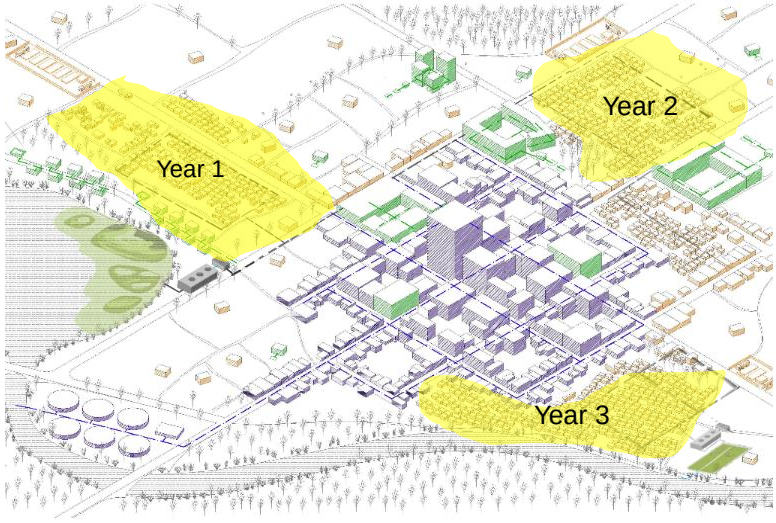
CONCEPT: SCHEDULED DESLUDGING



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STEPS TOWARDS SCHEDULED DESLUDGING

Household Survey घरेलू सर्वेक्षण

Digitizing database डिजिटाइजिंग डाटाबेस

Creating preliminary schedule प्रारंभिक कार्यक्रम बनाना

Operationalizing scheduled desludging अनुसूचित डिप्लगिंग का संचालन

Updating database and schedule during operation

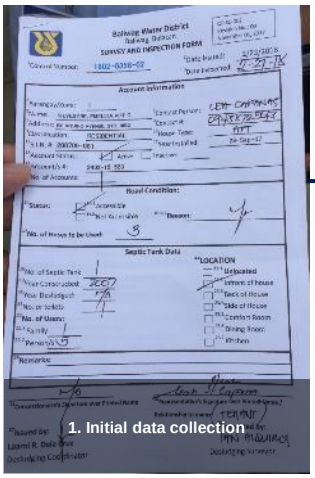
ऑपरेशन के दौरान डेटाबेस और शेड्यूल अपडेट करना

Source : FSSM Plan of Phulera – Sambhar by IPE Global

USAID FROM THE AMERICAN PEOPLE

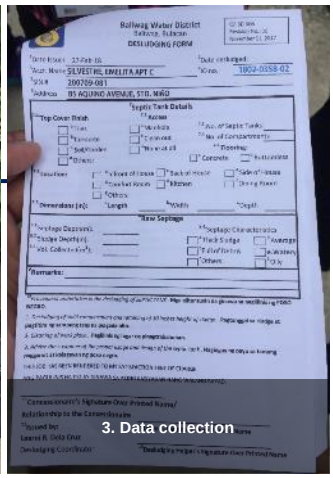
BILL & MELINDA GATES foundation

DATA COLLECTION & DIGITIZATION



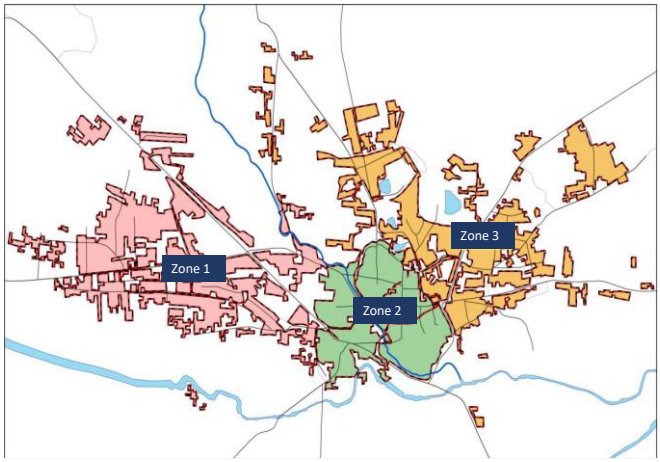
1. Initial data collection

2. Desludging



3. Data collection

ZONING FOR SCHEDULED DESLUDGING: Example: Sinnar, Maharashtra



Source : Presentation on "Toilets and Beyond: How to implement ODF in small towns in India" at FSM4 by PAS, CEPT University, Ahmedabad

Role of ULB – Regular Desludging

1. By-laws for mandatory desludging by household once in 3 years. 3 साल में एक बार घर द्वारा अनिवार्य desludging के लिए ससुराल द्वारा कानून
2. Register of onsite sanitation systems and their cleaning schedule. ऑनसाइट सफाई प्रणालियों और उनके सफाई कार्यक्रम का रजिस्टर
3. Sanitation tax for households (not connected to sewer) for scheduled desludging. अनुसूचित डीस्ल्यूडिंग के लिए घरों के लिए स्वच्छता कर (सीवर से जुड़ा नहीं)

Role of ULB in FSSM (under SBM 2.0)

1. Standard containment systems
   मानक रोकथाम प्रणाली
2. Regular desludging
   नियमित रूप से विलवणीकरण
3. Licensing of private operators
   निजी ऑपरेटरों का लाइसेंस
4. Regulation of sludge disposal
   कीचड़ निपटान का विनियमन

Licensing of private operators

Government

Will implement rules for better FSM
बेहतर एफएसएम के लिए नियम लागू करेंगे

Private operators will be charged for getting license
निजी ऑपरेटरों से लाइसेंस लेने के लिए शुल्क लिया जाएगा

Private operators

Rules will mandate desludging operation to be done by licensed operators only
नियमों में लाइसेंस प्राप्त ऑपरेटरों द्वारा ही की जाने वाली कार्रवाई को डीरल्यूडिंग करना होगा

Registration of private operators

Appendix 6: Form of application for the license of collection, transportation and disposal of FS/septage

Paste Self-Attested Recent Passport Size Photograph

1. Name of the applicant: Mr/Ms_____
2. Nationality: Indian_____Other_____
3. Address: Regd. Office:_____
   Headoffice:_____
4. Telephone No.: (O)_____Mobile No._____
   Email ID_____
5. Registration No. of Vehicle :_____
6. Pollution certificate of the vehicle valid up to:_____
7. Insurance of the vehicle valid up to:_____
8. Fitness of the vehicle valid up to:_____
9. Vehicle, whether fitted with GPS:_____
10. Details of the vehicles indicating model, type, capacity, leak proof, odour and spill proof having proper vacuum/ suction and discharging arrangement (Document proof of any may be enclosed).
11. Processing fee for license Rs. 1000/- (Non-refundable)
    D.D. No._____Date_____
    Bank_____

I/We certify that information given by me/us in column 1 to 11 are true to the best of my knowledge and belief. I also certify that I have read and understood the attached terms and conditions 1 to 13 and agree to abide by them. I agree that if any information given by me is found wrong the application for license will be liable for cancellation at any time.

Signature(s) of applicant(s) Date: _____

No. of document attached: _____

Annexure 7: License for collection and transportation of FS/Septage

In accordance with all the terms and conditions of the By-laws/ Regulations, Municipal Corporation Act rules, the special license conditions accompanying this license and applicable rules and laws of Government of Uttar Pradesh, the permission is hereby granted to:

NAME OF LICENSEE.....

ADDRESS.....

Licence No.....

For the disposal of FS/septage from septic tanks in city

This license is based on information provided in the FS/Septage Collection and Transportation License Application. This license is effective for a period of five years from date of issue, set forth below.

EFFECTIVE DATE

EXPIRATION DATE

The license may be suspended or revoked for condition of Non-Compliance and is not transferable. The original license shall be kept on file in the Licensee's office. A copy of this license shall be carried in every registered vehicle used by the Licensee.

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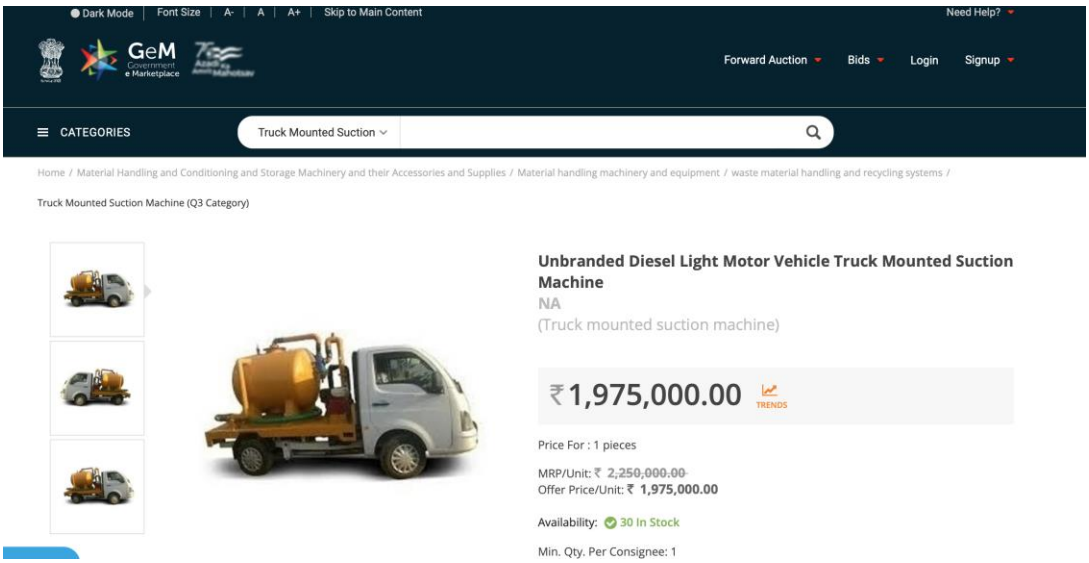

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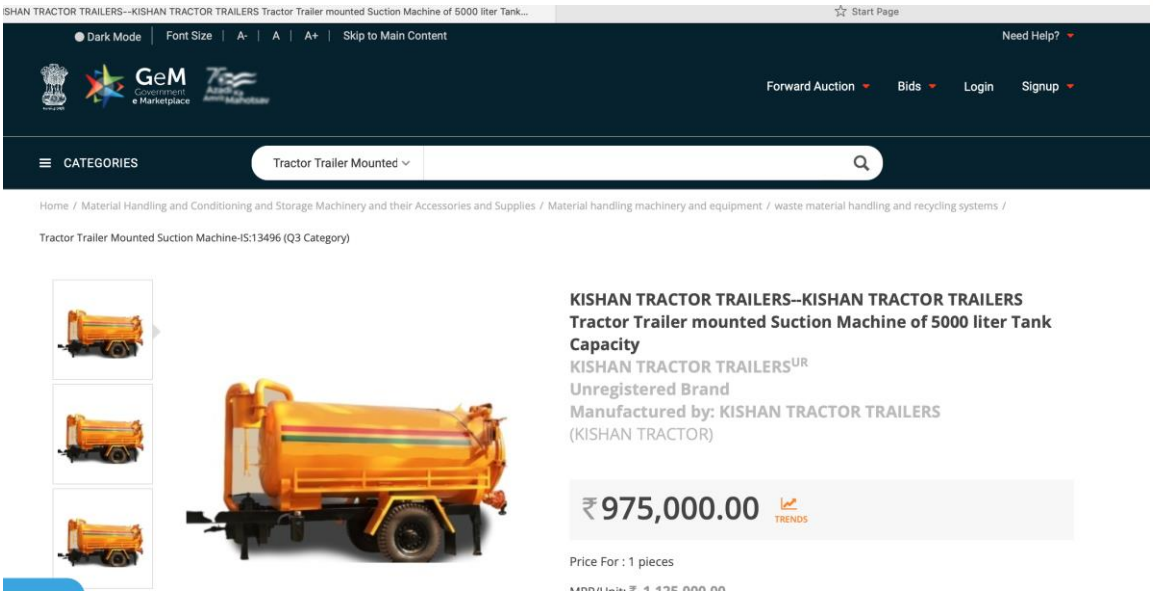

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Role of ULB – licensing private operator

1. Notification of Licensing in Local newspapers and banners. स्थानीय समाचार पत्रों और बैनरों में लाइसेंसिंग की अधिसूचना
2. Yearly renewal of licenses of private operators – checking their fitness. निजी ऑपरेटरों के लाइसेंस का वार्षिक नवीकरण - उनकी फिटनेस की जांच
3. Citizen engagement for feedback on operators and penalty for unlicensed operators. ऑपरेटरों पर प्रतिक्रिया और बिना लाइसेंस के ऑपरेटरों के लिए दंड के लिए नागरिक सगाई
4. Estimate number of trucks required for the population and make necessary arrangements. जनसंख्या के लिए आवश्यक ट्रकों की अनुमान संख्या और आवश्यक व्यवस्था करना

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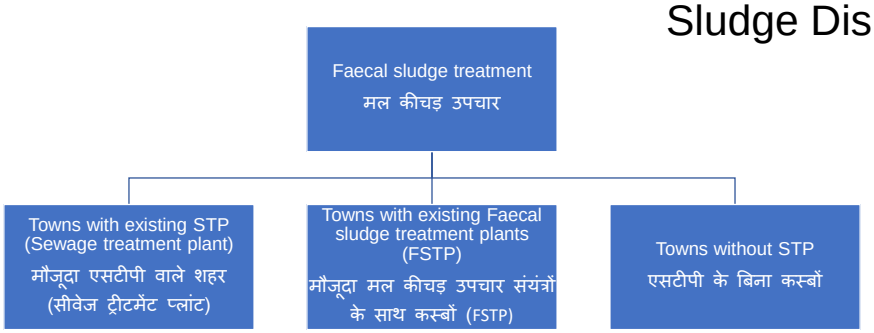
Role of ULB in FSSM (under SBM 2.0)

1. Standard containment systems
   मानक रोकथाम प्रणाली
2. Regular desludging
   नियमित रूप से विलवणीकरण
3. Licensing of private operators
   निजी ऑपरेटरों का लाइसेंस
4. Regulation of sludge disposal
   कीचड़ निपटान का विनियमन

Sludge Disposal



Co-treatment in existing STP

1. New STP with co-treatment facility. सह उपचार सुविधा के साथ नया एसटीपी
2. Intermediate – Dispose in nearby STPs. इंटरमीडिएट - पास के एसटीपी में निपटाएं

By-laws to be passed to penalize illegal disposal of faecal sludge
मल कीचड़ के अवैध निपटान को दंडित करने के लिए पारित किया जाएगा द्वारा कानून

Recap

1. Standard containment systems
   मानक रोकथाम प्रणाली
2. Regular desludging
   नियमित रूप से विलवणीकरण
3. Licensing of private operators
   निजी ऑपरेटरों का लाइसेंस
4. Regulation of sludge disposal
   कीचड़ निपटान का विनियमन

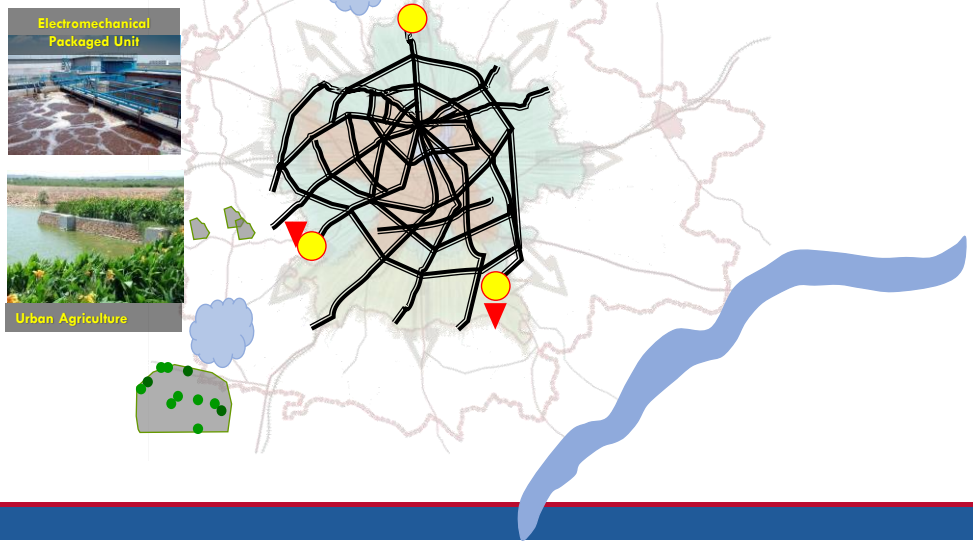
Session 5: Drain based conveyance models- Design and feasibility

Orientation training on SBM 2.0

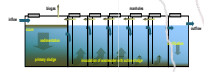
Session Objectives/ Agenda

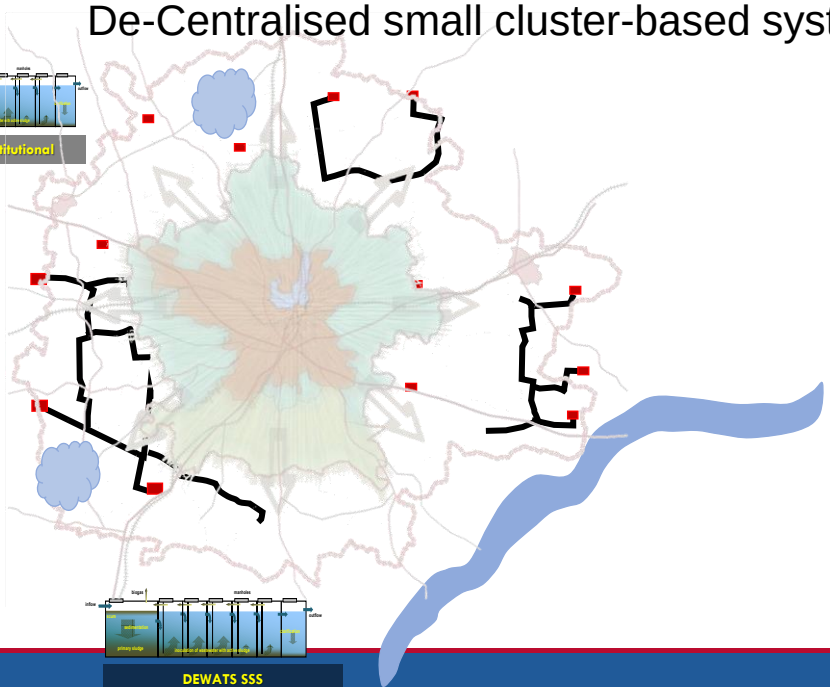
- ✓ Understand the conveyance mechanism of wastewater through drains – types of drains
- ✓ Design considerations for interception and diversion-based treatment
- ✓ Case study of I&D based system for treatment of wastewater flowing through drains

Centralised large network-based system

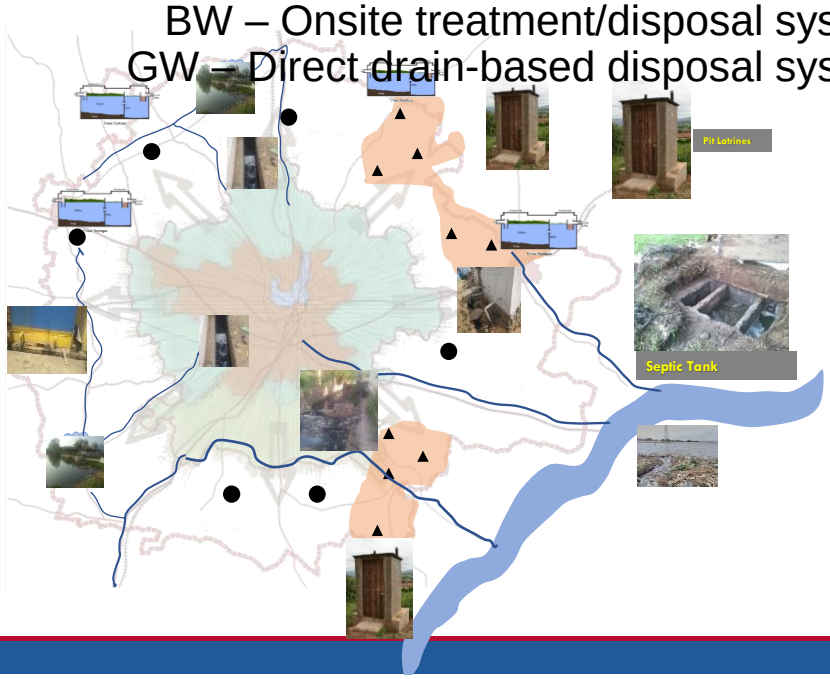


De-Centralised small cluster-based system

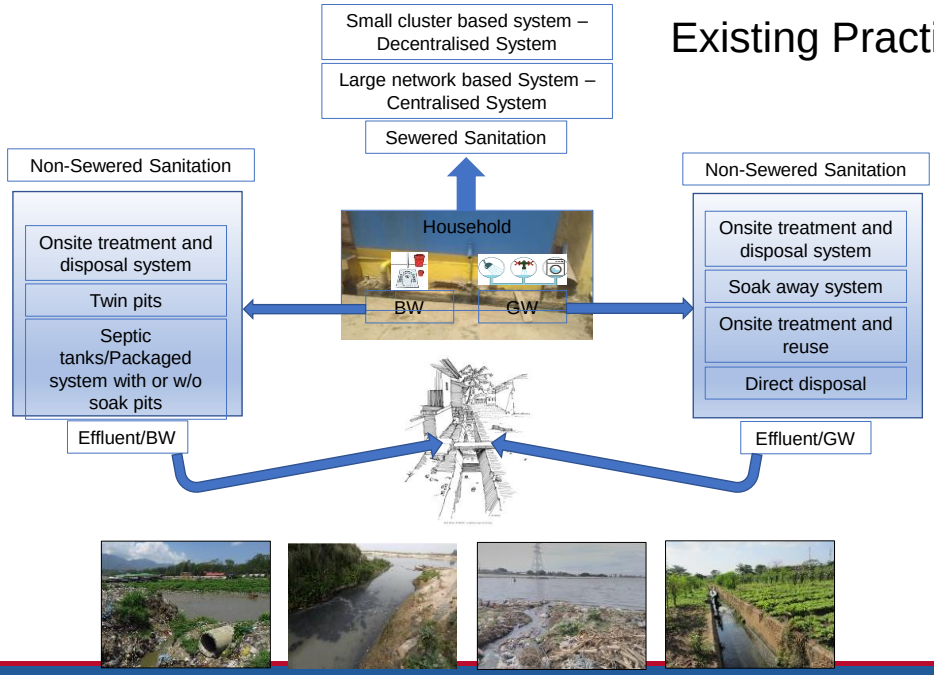




Onsite non sewered system
BW – Onsite treatment/disposal system
GW – Direct drain-based disposal system



Existing Practice



Need & Impacts of Drain based used water management

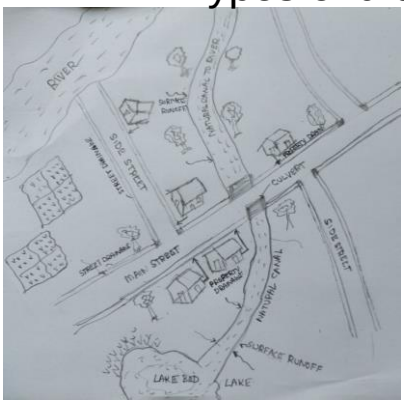
- Non availability of appropriate resources for management of WW at HH level
- Non availability of sewer network for conveyance of used water
- Poor regulations and its enforcement
- Easy method to get rid of used water from the household

Used Water

Ponding in low lying area causing nuisance	Contamination of river	Contamination of ponds/lakes	Irrigation with untreated sewage posing health risks

- Contamination of freshwater resource – Surface water and ground water
- Environment and Public health risk
- Threat to biodiversity and ecology system
- Affect socio-economic and cultural aspects of the project area
- Public nuisance

Types of drain and its usage practice



Types of street Drains

Trunk drains/Nalla

Disposal at household

Discharge into waterbodies

Technology options

Commonly practiced methods for management of used water flowing in the drains are :

1. Interception and Diversion system
   - Screening, Sedimentation, Interception, Diversion with overflow, Conveyance (channels/pipes), Treatment and Disposal
   - Applicable for large used water volume
   - For wet weather flow

2. Inline treatment
   1. Screening, Sedimentation, diversion with overflow, treatment (wetland system)
   2. Applicable for small used water volume
   3. Preferably for dry weather flow

Interception, Diversion system and offline treatment

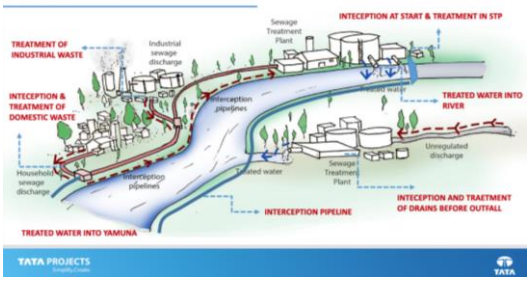


Photo Ref: Restoration of Dravyavati River in Jaipur, Rajasthan by TATA Projects

Type 1 - Interception, Diversion system and offline treatment

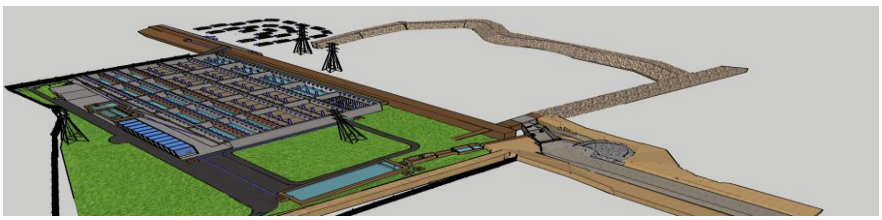


Photo Ref: Mahadevapura Lake Rejuvination project, Bangalore, CDD Society

Type 2 - Inline treatment

Photo reference: NEERI, Nagpur

Photo reference: CDD Society Bangalore

Design considerations

Design consideration for I&D and Treatment

- Flow quantification and verification
- Quality of used water flowing in the drains
- Decision on location of I&D

Flow quantification and verification

Flow quantification/estimation

- Catchment area of drain
- Population in the catchment area
- Water supply and used water generation
  - Wet weather flow
  - Dry weather flow
- Types of drain and losses
- Evaporation, transpiration, infiltration, exfiltration rate

Flow measurement method for verification

- Float method
- Velocity meter
- V and Rectangular notch

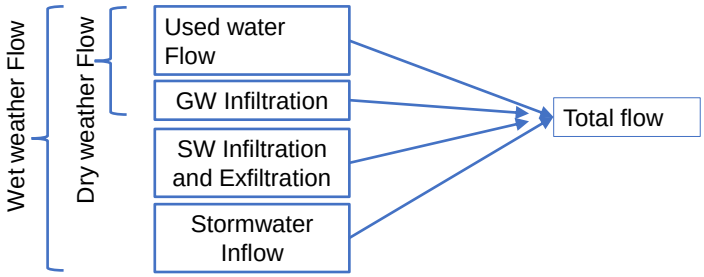
Dry and Wet weather flow

- **Dry weather flow (DWF)** is the average daily flow of sanitary sewage flowing in the the stormwater drain to a Sewage treatment plant (STP) during a period without stormwater
- **Wet weather flow (WWF)** is the combined flow of sanitary sewage and stormwater flowing in the stormwater drain in the rainy season to a Sewage treatment plant (STP) during a period

Characteristics
Low velocity and volume
• Low TSS
• High BOD ~ 100 – 150 mg/L
• Solid waste restricts the flow

Characteristics
• High velocity and volume
• High TSS
• Low BOD ~ 50 mg/L– 100 mg/L
• Drain overflows into the rivers/streams

Dry and Wet weather flow



- Used water flow is the flow generated by routine water usage for different purpose of City's residential, commercial, and industrial uses. The flow has a diurnal pattern that varies with land use categories.
- Infiltration is stormwater and ground water that enters the drains/sewer system by percolating through the soil and then through defects in pipelines, manholes, and joints.
- Inflow is stormwater that enters the drains/sewer system via a direct connection to the system, such as roof drain and downspout connections, leaky manhole covers, and storm drain connections.

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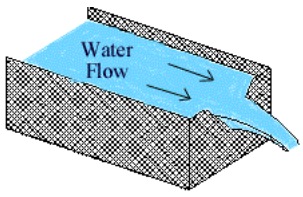
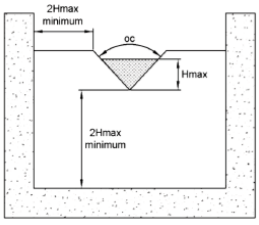
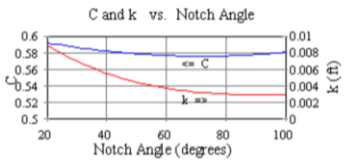
Flow quantification using V-Notch method





$$Q = 4.28\, C \tan\left(\frac{\theta}{2}\right)(h+k)^{5/2}$$

where Q = Discharge (cfs)
C = Discharge Coefficient
θ = Notch Angle
h = Head (ft)
k=Head Correction Factor (ft)



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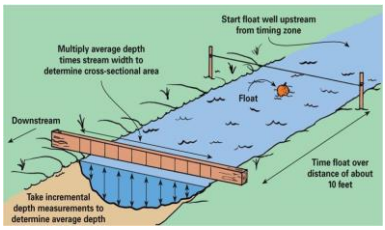
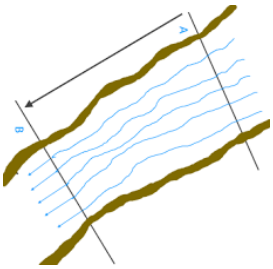
Flow quantification using Float method





Flow Equation

$Q = A \times V$

- Q = flow in ft^3/sec
- A = cross sectional area of pipe in ft^2
- V = water velocity in ft/sec

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Flow quantification using Velocity meter

Flow Equation

$Q = A \times V$

- Q = flow in ft^3/sec
- A = cross sectional area of pipe in ft^2
- V = water velocity in ft/sec

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Quality of used water flowing in the drains

Characteristics of WW flowing the Drain

- Used water generated from different sources (kitchen, laundry, washroom) of household collected and conveyed in a common plumbing system and discharged into the nearby drain
- Supernatant from septic tank discharged into the drain
- Mixing of external contaminants - mixed stream - organic, inorganic contamination, including solid waste and waste from commercial and industrial establishment if any.

The characteristics of this used water can be termed as "Low to high strength" depending on the source of contamination

Consolidated Values for Different Streams

Type	Parameter	Category 1 Separate streams				Category 2 Combined streams	stream
		Shower	Wash basin	Kitchen	Laundry	Combined	Mixed stream
Physical	Turbidity (NTU)	123	84	347	109		
	TS	426	450	1,468	586		1246.1
	TSS	123	89	399	141	100–283	239.7
	TDS	288	473	633	710	573	
	Oil and grease	53	66	233	13	7	4.1
Chemical	pH	7.4	7.2	6.9	9.1	7.3 - 8.1	7.5
	EC (µS cm^{-1})	147	199	432	642		
	Hardness (as$CaCO_3$)	49	47	358	721		
	BOD_5	135	139	932	187	100–188	**178.2**
	COD	358	341	1123	1546	250–375	**592.9**
	TOC	65	61	542	189		
	DO	ND	ND	3.9	ND		
Nutrients	Tot-N	11	9	31	19		
	Total KJN	10	9	24	21		
	Ammonia–N (NH_3-N)	1.4	0.6	5.4	3.7		57.8
	Nitrate (NO_3-)	0.11	0.06	1.2	0.3	0.67	
	Nitrite (NO_2-)	ND	ND	1.6	0.2		
	TP	1.2	1.1	48	19	0.012	25.3
	Phosphate ($PO_4$3–)	11	14	26	38		
Total coliform	1.72–1.87	2.94–6.95	3.38–5.11	3.04–5.6	6.99–7.71		
E. coli	0.85–1.15	2.81–2.95	ND	ND	3.54–6.3		

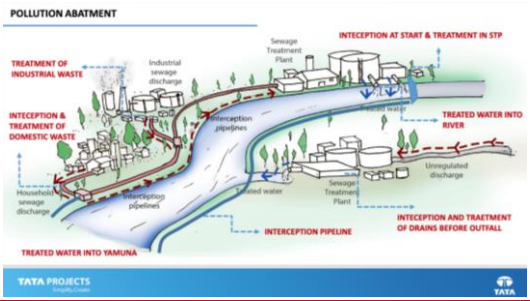
Discharge standards for used water in India

S. no.	Parameters	General norms 11986				Draft norms November 2015**	MoEFCC Notification, October 2017**	NGT order 2019** (for mega and metropolitan cities)
		Inland Surface Water	Public Sewers	Land Irrigation	Marine Coastal areas			
1	BOD [mg/l]	30	350	100	100	< 10	< 30 < 20 (metro cities)	<10
2	COD [mg/l]	250	–	–	250	50	Not more than 50 (for new STP design)	< 50
3	TSS [mg/l]	100	600	200	100 process water 10% of influent cooling water	< 20	< 100 < 50 (metro cities)2	< 20
4	TKN [mg/l]	100	–	–	100	< 10	Not more than 10 (for new STP design)	< 10
5	NH3-N [mg/l]	50	50	–	50	< 5	Not more than 5 (for new STP design)	–
6	Dissolved phosphorus [mg/l]	5	–	–	–	–	–	<1
7	Faecal coliform [MPN/100ml]	–	–	–	–	< 100	< 1000	Permissible

Location of I&D

Decision parameters for locating I&D

- Topography of the catchment area and availability of space
- Drain alignment and its continuation
  - End of the drain
  - Location of reuse
- Drainage outfall - surface water bodies



Component of I&D System

Screening removes objects such as rags, paper, plastics, and metals to prevent damage and clogging of downstream equipment, piping, and appurtenances

Stilling basin/Sedimentation tank
a depression in a channel or reservoir deep enough to reduce the velocity or turbulence of the flow

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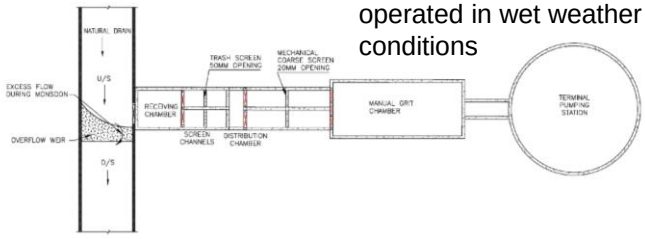
Component of I&D System

- Guide wall diverts the flow towards diversion drain
- Interception channel Directs the used water to the pump station or treatment system
- Diversion/Overflow system directs the excess used water
- Gates hold the water and are operated in wet weather conditions



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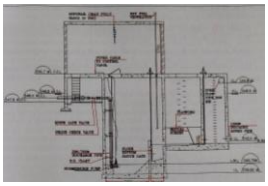
Component of I&D System

- Sewage Pump station
- Raising main or I&D network and – To convey used water to the STP
- Sewage Treatment Plant



Challenges and Advantages

Challenges

Planning and design
- Data collection & estimation
- Accuracy and reliability

Variation in flow
- Design and operation of biological processes

Risk of over design
- No regulations regarding overflow events
- Over design to accommodate wet weather flow

Integration with sewerage master plan
- Total investment for covering complete city can be costly

Advantages

Low on capital cost
- Leverage existing surface drains

Ease of implementation
- No works to be done on roads

Less duration for implementation
- Can be completed in a year

Stakeholders Engagement and IEC

Behavior change –
- reduces frequent need of raking of solid waste

Rainwater Harvesting –
- reduces wet weather flow
- reduces probability of combined sewer overflow

Desludging of septic tanks every 2-3 years –
- reduces frequent desilting of drains

Stormwater management at community level–
- delays peak flow in wet weather
- reduces wet weather flow

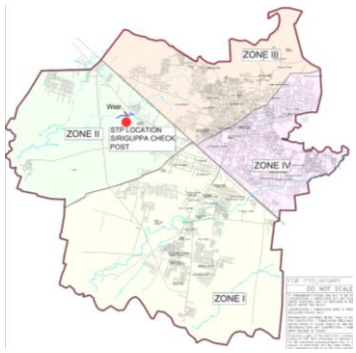
Reuse opportunities
- Reuse of treated used water

Operation and Maintenance

Household Level	Surface Drains	I&D Structure	Pumping Station	STP
• Regular desludging of septic tank • Inspection for illegal connection from commercial properties or small scale factories	• Raking of screens at regular interval • Desilting of drains at regular interval • Inspecting drains for structural failure • Repairing the drains if necessary	• Inspection of gates on regular basis • Inspecting walls and weir for structural failure • Greasing of moving parts of gates • Desilting of the approach channel	• Raking of screens at regular interval • Preventive maintenance of pumps • Remove grit and desilting	• Follow SOP • Monitoring of influent is key for fine tuning the operations • Monitoring the biological processes

CASE STUDY

Treatment of used water flowing in drains and cotreatment of faecal sludge



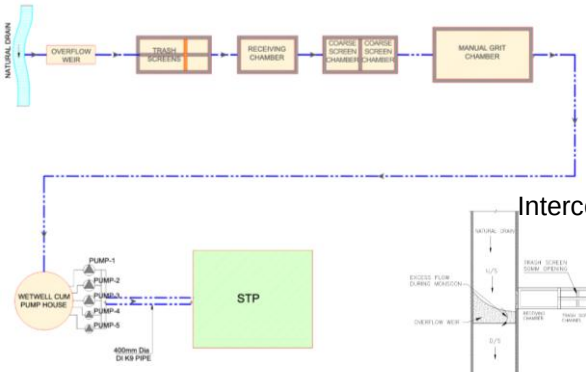
- Adoni is city and a Municipality in Adoni district of the Indian state of Andhra Pradesh
- The population of Adoni Municipal Corporation is 166537 as per 2011 census
- At Present, 22.05 MLD of sewage generated, but there is no existing Sewage Network in Adoni town including STP. Open drain system is available for discharge of both sullage and storm water.
- The generated sewage is getting discharged to the open area and to water bodies untreated

Figure 2-1: Existing open drain in Adoni

- Under AMRUT scheme, it is proposed 5 MLD capacity of STP which can treat present sewage generated from the town and the sewage is conveyed to STP through proposed interceptor drains
- In order to divert and treat the sewage, a small concrete weir type structure is proposed in the Avvadhoddi Vanka Drain which will be intercepted and diverted to the inlet of the receiving chamber of pumping station.

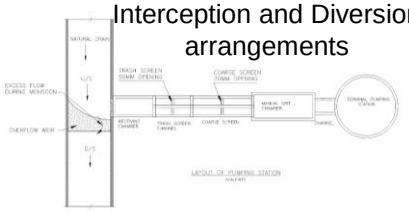
Ref: DPR for sewage treatment including septage for Adoni Municipality, TATA Consulting Engineers Limited

Treatment of used water flowing in drains and cotreatment of faecal sludge



Overall scheme for interception, diversion and treatment

Interception and Diversion arrangements



HYDRAULIC FLOW DIAGRAM OF 5 MLD PUMPING STATION AT ADONI

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Ref: DPR for sewage treatment including septage for Adoni Municipality, TATA Consulting Engineers Limited

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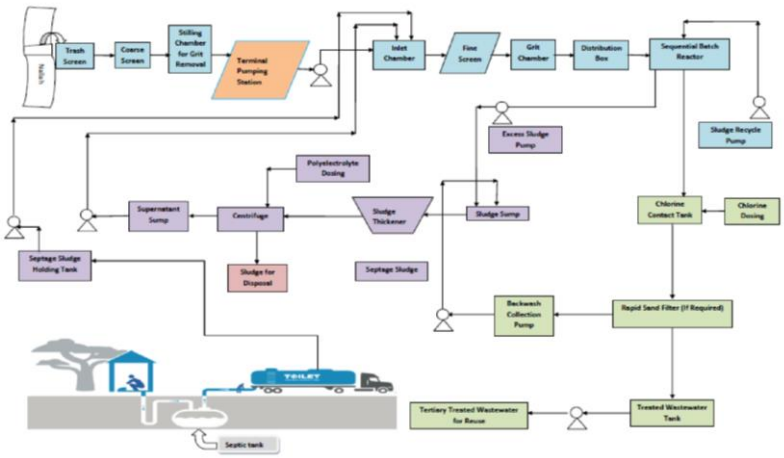
Treatment of used water flowing in drains and cotreatment of faecal sludge

Overall scheme for interception, diversion and treatment of used water and co-treatment of faecal sludge in the STP



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Ref: DPR for sewage treatment including septage for Adoni Municipality, TATA Consulting Engineers Limited

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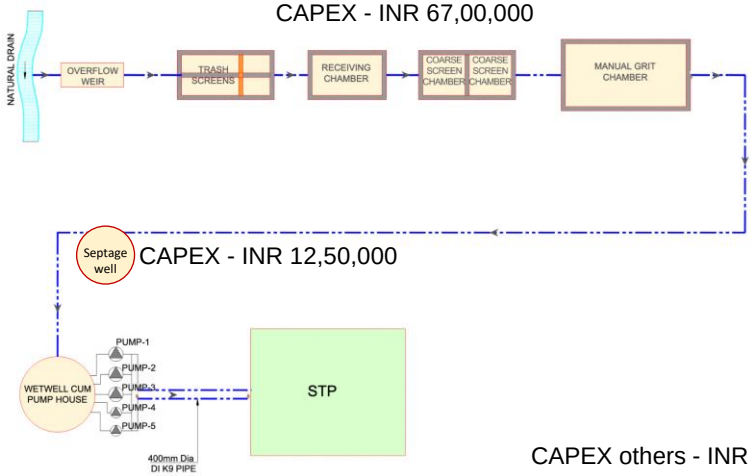
Treatment of used water flowing in drains and cotreatment of faecal sludge

CAPEX - INR 67,00,000



CAPEX - INR 12,50,000

CAPEX - INR 72,50,000

CAPEX - INR 83,00,000

CAPEX others - INR 13,00,000
Total CAPEX – 2.35 Crore
OPEX for 10 years – 41.5 lakhs

Ref: DPR for sewage treatment including septage for Adoni Municipality, TATA Consulting Engineers Limited

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Treatment of drain used water entering the lake in Mahadevapura

- Mahadevapura located in the eastern side of Bangalore city near to Bagmane Tech Park
- The lake is spread across 26 acres
- Total amount of used water treated per day – 1MLD
- Used water is intercepted and diverted at the mouth of the lake into the STP
- Nature based STP proposed (DEWATS) which treats the WW to the required quality and discharge into the lake
- Treated used water helps in pollution abatement, water balance maintenance, ground water recharge, and also enhance the micro-climate of the lake area

Ref: Approach to Waterbody Rejuvenation-A perspective, CDD Society

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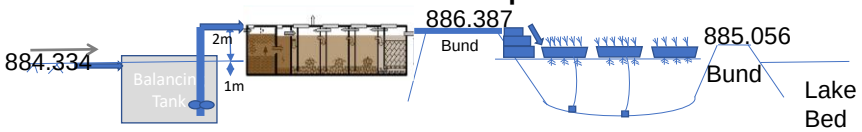
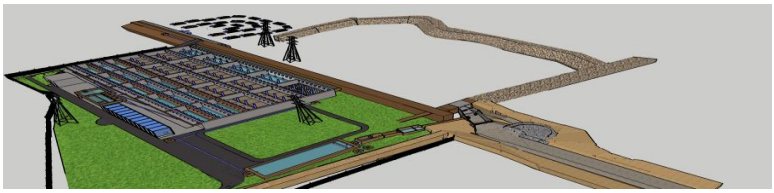
Treatment of drain used water entering the lake in Mahadevapura

Ref: Approach to Waterbody Rejuvenation-A perspective, CDD Society

Treatment of drain used water entering the lake in Mahadevapura





Ref: Approach to Waterbody Rejuvenation-A perspectiave, CDD Society

Treatment of drain used water entering the lake in Mahadevapura

PROJECT OUTCOMES

- Ensure the lake receives water throughout the year by treating the used water inflow and discharging the treated effluent into the lake
- Aid in ground water recharge
- Enhance micro-climate benefits in the area
- Improve urban aesthetics

SALIENT FEATURES

- Source: Open Channel Flow
- Design Capacity: 1 MLD
- Influent Quality: BOD-200 mg/l & COD-400 mg/l
- Expected Effluent Quality: BOD 30-20 mg/l

Funding: CSR Funds
Construction Period: 12 months Total
Cost of the plant: Rs.2.01 Crore
Start of Operation: March 2019

Ref: Approach to Waterbody Rejuvenation-A perspective, CDD Society

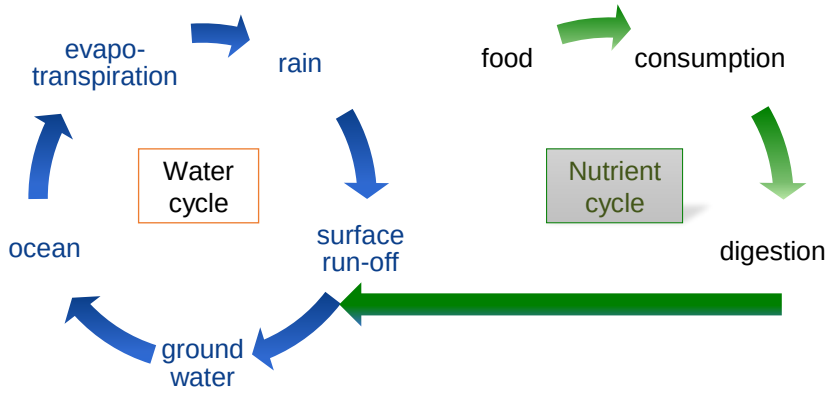
Session 6: Treatment options for Used water (STPs)

Orientation training on SBM 2.0

Session Objectives/ Agenda

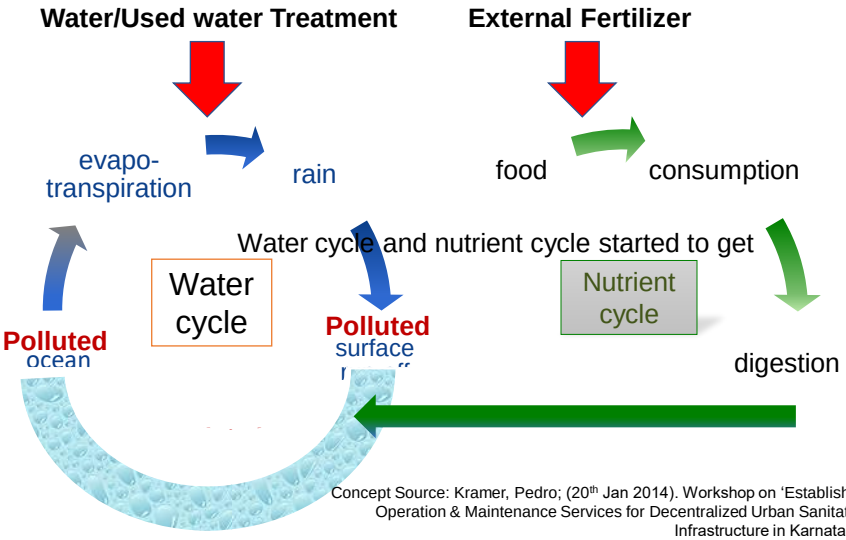
- ✓ Establish a need for treatment of used water
- ✓ Understand the different types of technologies available for used water treatment (STPs)
- ✓ Understand the process of Co-treatment of faecal sludge in sewage treatment plants
- ✓ Discuss the CAPEX, OPEX and Land area requirement for the discussed technologies

Water cycle and nutrient cycle started to get mixed



Concept Source: Kramer, Pedro; (20th Jan 2014). Workshop on 'Establishing Operation & Maintenance Services for Decentralized Urban Sanitation Infrastructure in Karnataka', CDD Society-BORDA, Bangalore, India

Water cycle and nutrient cycle started to get mixed



Concept Source: Kramer, Pedro; (20th Jan 2014). Workshop on 'Establishing Operation & Maintenance Services for Decentralized Urban Sanitation Infrastructure in Karnataka', CDD Society-BORDA, Bangalore, India

Used water Treatment

- Used water treatment is a process used to remove contaminants from used water and convert it into an effluent that can be returned to the water cycle.
- There are several kinds of used water which are treated at the appropriate type of used water treatment plant.
  - For domestic used water (also called municipal used water or sewage), the treatment plant is called a sewage treatment plant.
  - For industrial used water, treatment either takes place in a separate industrial used water treatment plant (also called Effluent Treatment Plant)
  - Further types of used water treatment plants include leachate treatment plants.

Characteristics of used water

Parameters	Grey water	Black water	Septic Tank Effluent*	Septic Tank Effluent**	Mixed Wastewater***	Sewage
BOD (mg/L)	100-300	600-1000	300-600	80-160	150-400	250-400
COD (mg/L)	200-500	1000-2000	600-1000	200-400	300-600	500-800
TSS (mg/L)	100-300	800-1200	300-500	200-400	150-350	600-1000
Fecal Coliforms (MPN/100 ml)	102 -103	106 -107	105 -106	103 -105	104 -105	105 -107
Total Coliforms (MPN/100 ml)	102 -103	107 -108	106 -107	104 -106	105 -106	105 -107

Source: MoDWS, 2015

Treatment Stages

- Preliminary Treatment
  - To prevent blockages in the following treatments processes by removing heavy solids
- Primary Treatment
  - To remove organic and inorganic solids by the physical process of sedimentation and floatation
- Secondary Treatment
  - To remove the biodegradable matter (dissolved and suspended) from used water by microorganisms
- Tertiary Treatment
  - To remove specific substances from used water using biological, chemical and physical treatment methods

Technology Selection Criteria

- Affordability – low on CAPEX and OPEX
- Local suitability
  - Land use types, Population density, Road types,
  - Climate adaptability, High ground water table, Soil condition, Topography
- Cultural acceptability
  - Land availability, location of STP
- Treatment efficiency
  - Compliance
  - Reuse opportunity
- Easy to Construct, Operate and Maintain
  - No/less energy requirement for operations
  - Locally available resources for construction and maintenance

Technology Options

Technology options – used water Treatment

Technology Options

Pre-Treatment

Pre-treatment methods

Screening – Physical treatment

- The screens are installed to remove the floating and unwanted solid waste materials from used water
- Screens are operated either by manually or by mechanical means
- The screens are installed in an inclined position to used water flow
- The collected screens will be removed either manually or Automatically

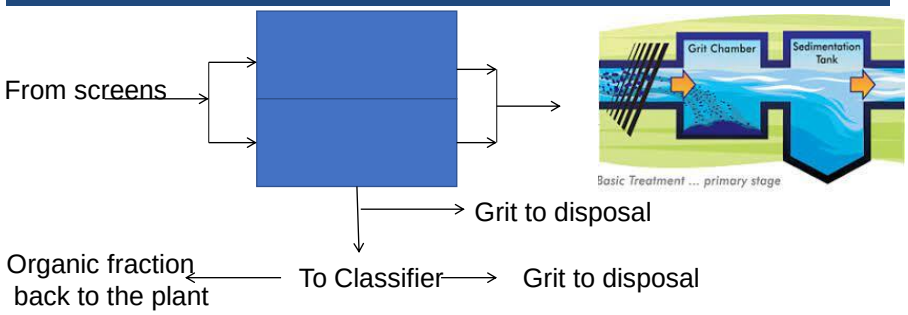
Pre-treatment methods

DESIGN CRITERIA FOR SCREENS

	HAND CLEANED (MANUAL)	MECHANICALLY CLEANED (AUTOMATIC)
- BAR SIZE	5 - 15 MM	5 - 15 MM
- DEPTH	25 - 75 MM	25 - 75 MM
- CLEAR SPACING BETWEEN BARS	25 - 50 MM	15 - 75 MM
- SLOPE	45° - 60°	60° - 90°
- APPROACH VELOCITY	0.3 - 0.6 M/S	0.6 - 1.0 M/S
- ALLOWABLE HEAD LOSS	150 MM	150 MM
- APPLICATION	VERY SMALL PLANTS	MEDIUM AND LARGE PLANTS

Pre-treatment methods

Grit Removal – Physical treatment



- The Grit chambers are long narrow rect tank designed to slow down the flow to allow the settling of sand, stone etc from the used water (detention time 60sec)
- Grit chambers are operated either manually or/and mechanically
- Grit may harm the treatment as well as cause problems to pump
- The collected grit shall be disposed safely

Pre-treatment methods

Technology Options

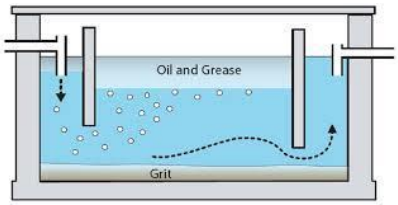
Primary-Treatment

Primary treatment methods

Oil and Grease removal - Physical treatment

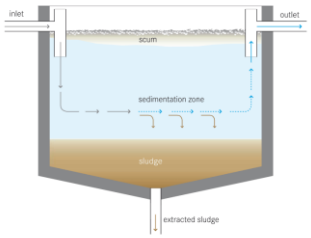
Oil and Grease Chamber Design Basis:

- Flow: Horizontal
- Retention Time: 30 Mins
- Length to Width Ratio:3:1
- Calculation of Volume:(Flow x Retention time)

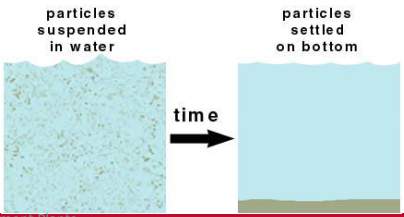


Primary treatment methods

Sedimentation – Physical



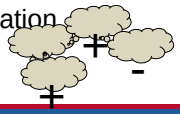
- Sedimentation tanks are used to remove the solids from used water based on the density of particle
- Sedimentation tanks are installed either pre or post secondary treatment modules
- Retention time varies between 1.5-2.5 hrs, 2-2.5 for primary settling, 1.5 to 2 hours for secondary settling



Primary treatment

Coagulation/Flocculation - Chemical treatment methods

- Very fine suspended particles can be removed by changing the size of them into flocculated particles
- Chemical compounds are added to increase the size of these particles (coagulants)
- Process of mixing of chemicals is called coagulation– Aluminium./ Ferric suplphate
- The coagulated sewage is then made to pass over a sedimentation tank, where flocculated particles settled down and get removed



Treatment System - Secondary treatment

Electro-mechanical operated system

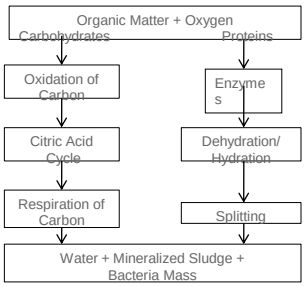
Nature based system (Bio-STP)

Biological Treatment

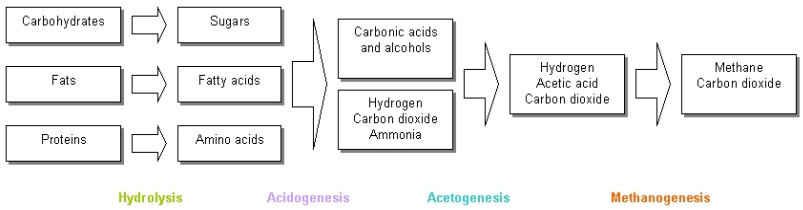
Biological treatment process

- Mostly secondary treatment
- Biological organic and suspended solids removal
- Biological nutrient removal

Aerobic digestion



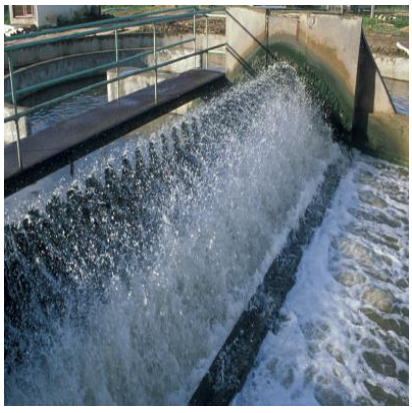
Anaerobic digestion



Electro-mechanical operated system

Secondary treatment methods

Aerobic treatment



Submerged Pump-Aerator and Surface-Aerator

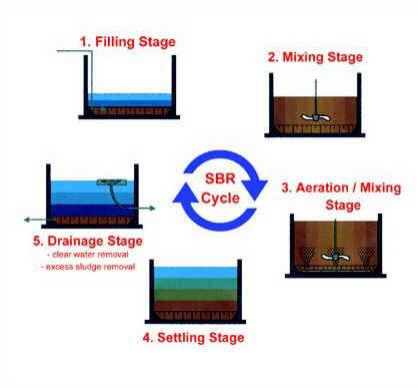
Secondary treatment methods

Activated Sludge Process

- Also known as continuous flow reactor
- Activated Sludge is a multi-chamber reactor unit that works under aerobic conditions to degrade organics in used water and to produce a high-quality effluent.
- Sludge is decanted and (partly) returned to the aeration tank
- High reduction of BOD and pathogens
- High Capital cost; high operation cost

Secondary treatment methods

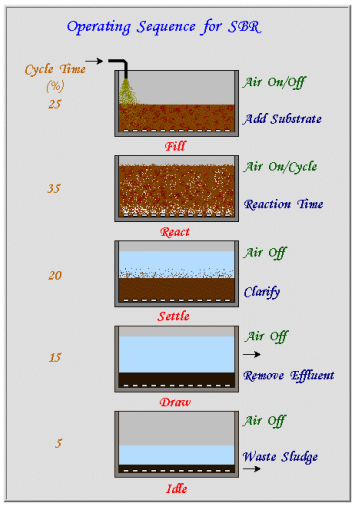
Sequencing Batch Reactor



- Modification of ASP
- Sequencing batch reactor or cyclic system
- All treatment steps are carried out in sequences but within the same reactor
- Continuous and discontinuous operation schemes are possible (one or two parallel lines)
- treatment efficiency is better
- Smaller footprint compared to conventional activated sludge process because of absence of primary, secondary clarifiers and digester

Secondary treatment methods

Sequencing Batch Reactor



The Sequencing Batch Reactor (SBR) is another modification of the ASU. All treatment steps are carried out in sequences but within the same reactor

- Step 1: The reactor containing active biomass is filled with influent while aerated.
- Step 2 & 3: The tank operates as a batch fully aerated to allow oxidation of organic matter.
- Step 4: Aeration is stopped to allow sludge settling.
- Step 5: Treated water is discharged from the top of the tank, while sludge is removed at the bottom.

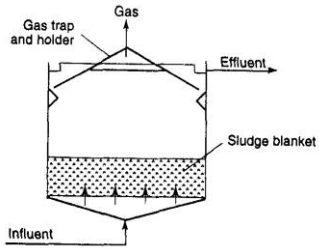
Secondary treatment methods

Fluidised Aerobic Bio-Reactor

- Fluidised Aerobic Bio-Reactor (FAB) as the name indicates consists of floating media of cylindrical shapes and different sizes. As compared to conventional technologies FAB reactors are compact, energy efficient and user friendly.
- Space requirement Reduced to one-third that of conventional ASP due to increase in surface area by special media
- Reduced power and operating costs, No sludge recycle required hence no sludge recycle pumps.

Secondary treatment methods

Upflow Anaerobic Sludge Blanket Reactor (UASB)

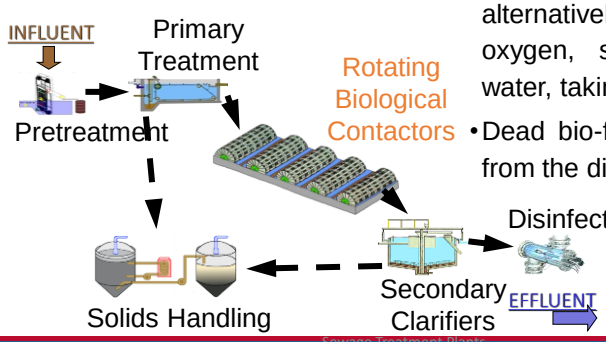


- Deep tank in which used water flows upwards
- Equally distributed over its total area
- In the lower part a sludge blanket is maintained in suspension
- Adsorption of organic waste matter and biological conversion to CH4 and CO2 (biogas).
- The gas forms bubbles and escape from the blanket providing the circulation of the sludge mass.
- Excess sludge is removed regularly.

Secondary treatment methods

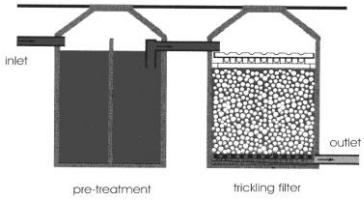
Rotating Biological contractor

- Series of closely spaced circular discs which provide high surface area for micro-organism growth.
- Submerges about 50 % in the used water tank and rotates slowly.
- Covered with aerobic biological film, alternatively exposed to air, taking up oxygen, submerged in the used water, taking up nutrients.
- Dead bio-film drop off automatically from the discs



Secondary treatment methods

Trickling Filter



- Column filled with coarse carrier material (crushed rock, slag, gravel, plastic element)
  - The filter column height is 1.5 - 3 m
  - Highly permeable filter material
- used water is distributed evenly on the filter surface and percolates downwards into the filter column.
  - On the filter material a bio-film develops
  - The micro-organisms degrade used water pollutants
- Aeration of the filter media takes place from the bottom through natural air flow due to temperature difference.

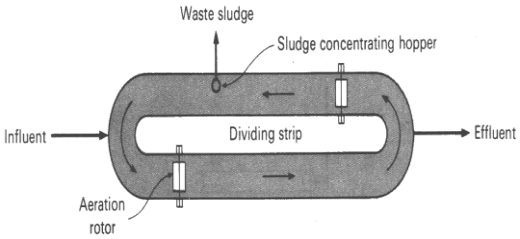
Secondary treatment methods

Trickling Filter

Secondary treatment methods

Oxidation Ditch

- In a closed loop used water is mixed with active sludge
- biological treatment process that utilizes long solids retention times (SRTs) to remove biodegradable organics.
- Horizontally or vertically mounted aerators provide circulation, oxygen transfer, and aeration in the ditch.
- Operation can be continuous or intermittent



Nature based Biological Treatment System

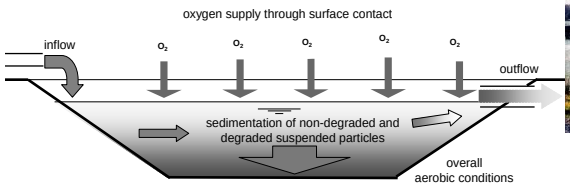
- Pond based system
- Constructed wetland system

SBM 2.0 strongly recommends nature-based system, given their low O&M, skill requirement and robustness

Secondary treatment methods

Aerobic Lagoon

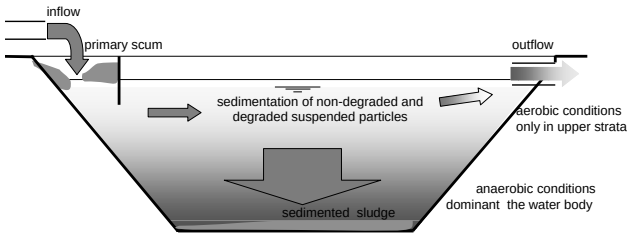
- It is an artificial lake: 1 – 1.2 m deep earthen basin
- HRT: 3 –20 d; High area requirements
- Treatment process is similar to process in nature
  - Oxygen intake through the water surface and photosynthesis of algae
  - Sedimentation
  - Disinfection (UV radiation)
- Aerobic lagoons are simple in construction, operation and maintenance.
- Sludge removal required (load dependent).
- Efficient for low loaded used water (sullage or for post-treatment of domestic used water)
- Series of two or three lagoons for a full scale treatment.



Secondary treatment methods

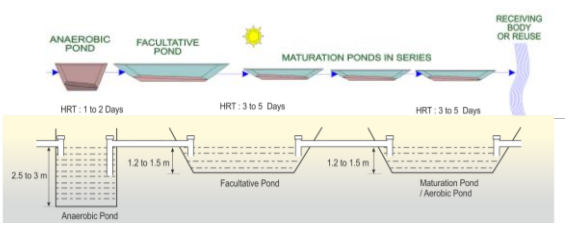
Anaerobic Lagoon

- It is an artificial lake: 2 to 5 m deep earthen basin
- Area requirements: less than aerobic lagoons (HRT: 1 –30 d; 0.5 to 3 m² per person)
- Treatment process
  - Sedimentation
  - Anaerobic degradation
- Sludge removal required



Secondary treatment methods

Waste Stabilization Ponds

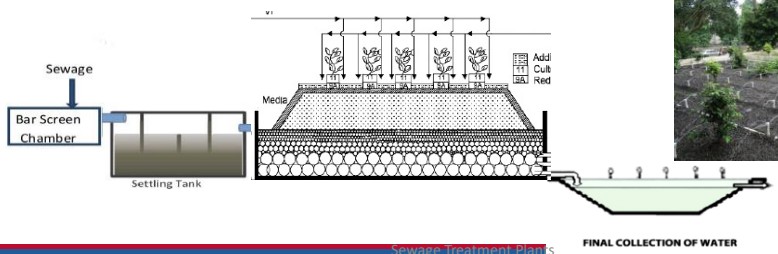


- Waste Stabilization Ponds (WSPs) are large, human-made water bodies in which used water are treated by naturally occurring processes under the influence of sun light, wind, microorganisms and algae .
- The ponds can be used individually, or linked in a series for improved treatment. There are three types of ponds, (1) anaerobic, (2) facultative and (3) aerobic (maturation), each with different treatment and design characteristics.
- WSP is appropriate for town or cities having large, open and unused lands, away from residential areas and public spaces.
- WSPs are particularly well suited for tropical and subtropical areas with good sun light and temperature.

Secondary treatment methods

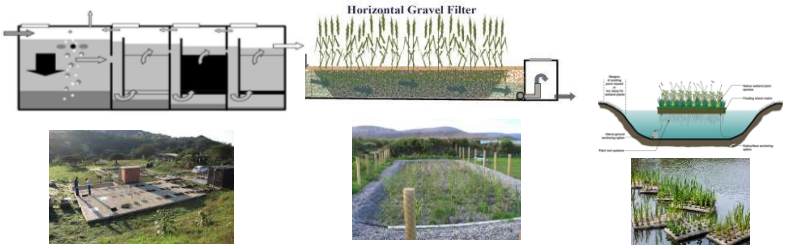
Soil Biotechnology

- The technology relies on soil ecology and microorganisms / organisms to break down the organic load in sewage, and specifically designed media to filter and treat the used water.
- Soil Bio- technology is a terrestrial system for used water treatment which is based on the principle of trickling filter.
- It consists of raw water tank/settling tank, bioreactor containment (soil filter bed), treated water tank, piping and pumps.
- The filter bed mainly consist of impermeable tank with filter media mainly formulated from soil, bacteria culture, different species plants



Secondary treatment methods

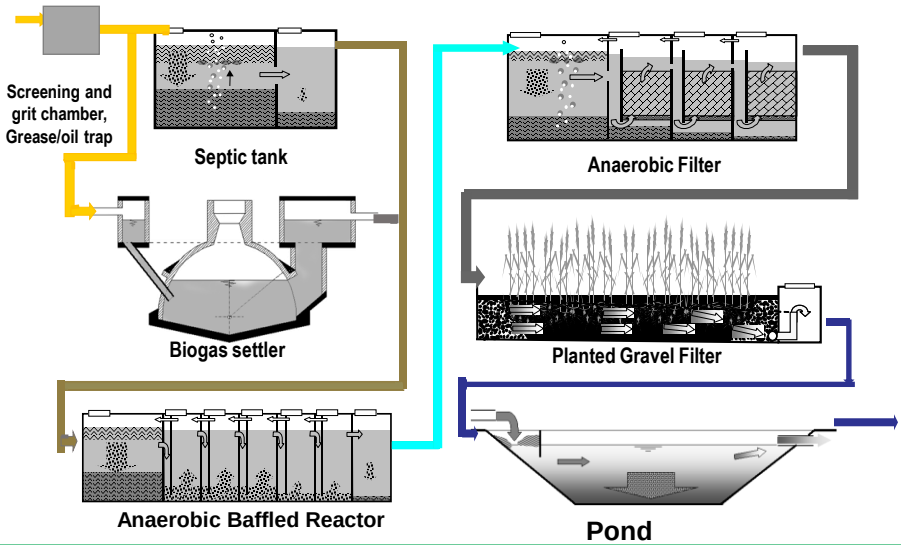
DEWATS



- DEWATS systems are based on modular technical configuration concept.
- Modules chosen for used water treatment consist of Settling tank (ST) for primary treatment, Anaerobic baffle reactor (ABR) with integrated filter (AF) for secondary treatment and Horizontal flow planted filter (HFPF) for tertiary treatment, polishing pond (if required for post treatment).
- used water is passed through all these modules in sequence for treatment.
- DEWATS applications are based on the principle of low maintenance.

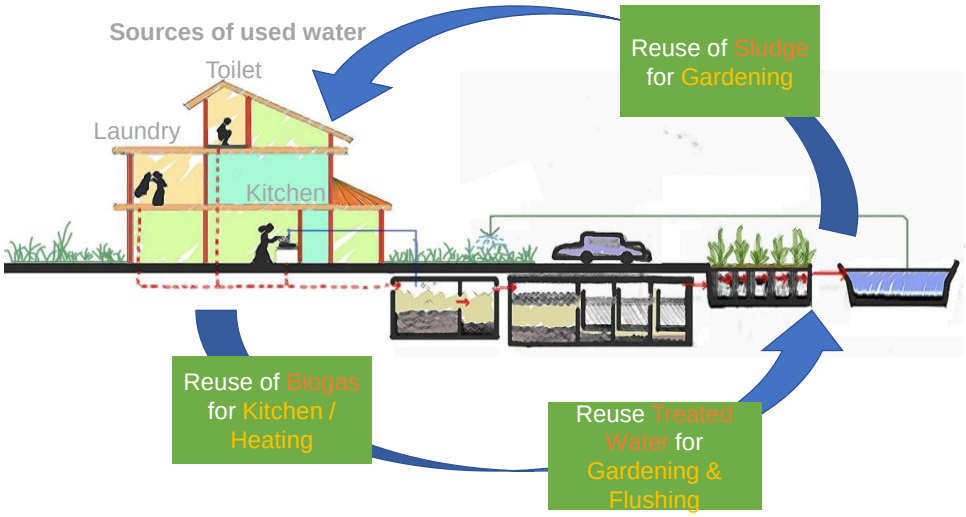
DEWATS

Secondary treatment methods

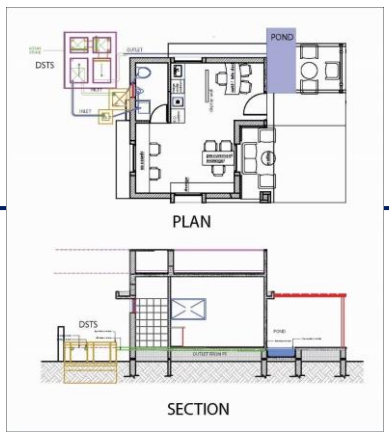


Right Combination of DEWATS modules makes efficient/successful treatment system.

Using the By-Products



DEWATS Application



Secondary treatment methods






DEWATS

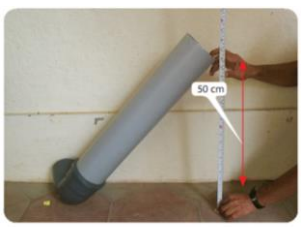
BILL & MELINDA GATES foundation

Simple O&M Activities


Removal of obstacle from the sewer pipeline


Cleaning of inspection chambers


Removal of scum



Measuring the level of swivel pipe top

Weeding and cleaning of litter

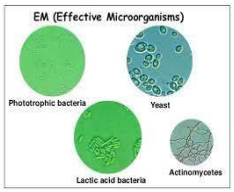
Trimming the plants

Trained Semi-skilled person can maintain the systems; De-sludging: every 2-3 years

Low O&M ≠ No O&M

Effective Microorganism

- EM mixture of groups of organisms that induces the growth of beneficial microorganisms which is responsible for treatment of used water
- The concept of effective microorganisms was developed by Japanese horticulturist, Teuro Higa of the University of Ryukyus in Japan
- Bacteria in the EM solution can **increase dissolved oxygen (DO)**, stabilize pH in water, reduce odor, reduce nutrients in the pond, reduce sediment or sludge, lowering the level of BOD, COD



Co-Treatment

Treatment of Faecal sludge at STP

- Addition of faecal sludge and septage in sewage
  - At the sewer appurtenances
  - At the STP
- Treating the solid and liquid fraction of faecal sludge and septage at STP

Advantage

- Maximizes utilization of hydraulic and organic loading of STP
- Lowest cost to benefit ratio!
- Improves the efficiency of treatment units

SEWAGE	SEPTAGE
> 99 % water	**Septage** : generally from septic tanks : settled sludge. **Faecal sludge** : from pits, vaults: material accumulatiang after percolation
dissolved and suspended solid material	• **About 95 - 99 % water**
pathogens	• dissolved and suspended solid material
organic matter	• pathogens
nutrients	• organic matter
Others	• nutrients
sewage reaches the treatment facility in a matter of hours, and it is still fresh	• Garbage, silt

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SEWAGE

SEPTAGE

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Co Treatment

Co-treatment in Sewage Treatment Plant

When?
Immediately or prior to setting up new FSTP.

Where?
- Underutilized Sewage treatment facility, performing well (adhering to standards), in the vicinity (20-30 min travel time).
- A sewage pumping station connected to underutilized STP
- New Sewage Treatment Plant

How?
1. Dilution: Mixing faecal sludge and sewage directly before treatment
2. Solid liquid separation: Removing the solids from faecal sludge prior to mixing with sewage.

It is essential that a detailed analysis of the incoming faecal sludge and the sewage treatment plant be carried out before arriving at how much Faecal sludge to add!

Co-Treatment

Co Treatment

CO-TREATMENT, Puri, Odisha

FSTP Details

Faecal sludge inflow Capacity: 50 KLD

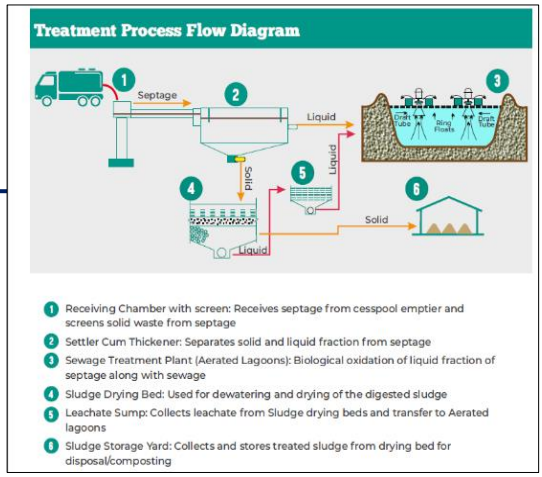
STP Details:

Capacity: 15 MLD

Present flow : 12 MLD

Technology : Aerated Lagoon

https://scbp.niua.org/sites/default/files/PuriBrochure_.pdf



Capital, O & M, Energy requirement for Different STPs

Sl. No.	STP Process	Energy Requirement	Capital Cost, Rs. Million/MLD	O&M Cost, million/year/MLD
1	Waste Stabilisation Pond System (WSPS)	Negligible.	Rs. 2.5 - 5.0 Million/MLD	Rs. 0.09-0.15 million/ year/MLD Rs. 0.25-0.41/m³
2	Duckweed Pond System (DPS)	Negligible.	Rs. 2.5 - 5.0 Million/MLD	Rs. 0.25 million/MLD/year. Rs. 0.68 /m³
3	Facultative Aerated Lagoon (FAL)	18 KWh/ML	Rs. 2.2 to 3.0 Million/MLD	0.15 to 0.2 million/ MLD/yr. Rs. 0.41 to 0.55/m³
4	Trickling Filter (TF)	180 KWh/ML	Rs. 4 to 5 Million/MLD	Rs. 0.5 million/MLD/year. Rs. 1.40/m³
5	Activated Sludge Process (ASP)	180 - 225 KWh/ML	Rs. 5 to 6 Million /MLD	Rs. 0.5 to 0.7 million/MLD/Year Rs. 1.40 to 1.92/m³
6	BIOFOR Technology (Biological Filtration and Oxygenated Reactor)	220 - 335 kWh/ML	Rs. 10 to 12 Million/MLD	RS 1.2 million/mld/Year Rs. 3.30/m³
7	High Rate Activated Sludge Biofor - F Technology	180 kWh/ML	Rs. 7.5 Million / MLD	Rs. 0.80 million/ MLD /Year Rs.2.20/m³
8	Fluidized Aerated Bed (FAB)	99 to 170 kWh/ML	Rs 6 to 8 Million/MLD	Rs. 0.9 to 1.0 million/MLD/ year Rs. 2.47 to 2.74/m³
9	Submerged Aeration Fixed Film (SAFF) Technology	390 kWh/ML	Rs. 9 Million/MLD	Rs. 1.4 million/MLD/year Rs. 3.84 /m³
10	Cyclic Activated Sludge Process (CASP)	150 - 200 kWh/ML	Rs. 11 Million/MLD	Rs. 1.4 million/MLD/year
11	Upflow Anaerobic Sludge Blanket (UASB) Process	10 - 15 KWh/ML	Rs.3.0 to 4.0 Million/MLD	Rs. 0.12 to 0.17 million/MLD/Year Rs. 0.33 to 0.47 m³

CAPEX and OPEX

S. No.	Assessment parameter	ASP	TF	WSP	UASB+FPU	UASB+EAS	MBBR	SBR	MBR	KT	OD
1	Design	1	2	3	4	5	6	7	8	9	10
	Process Type	Aerobic	Aerobic	Anaero -Aero	Anaero –Aero	Anaero -Aero	Aerobic	Aerobic	Aerobic	Aerobic	Aerobic
	Overall HRT (Complete Cycle)	12 - 14 hrs	13 - 14 hrs	8 - 15 days	1.4 - 2.4 days	14 - 16 hrs	8 - 12 hrs	14 - 16 hrs	12 - 14 hrs	NA	6 - 30 hrs
2	Performance for parameters										
	BOD, %	85 - 98	80 – 90	75 - 85	80 - 88	80 - 95	85 - 95	90 - 95	95 - 98	N/A	85 - 95
	COD, %	80 - 90	85 – 90	70 - 85	80 - 85	80 - 90	80 - 90	88 - 96	95 - 100	N/A	80 - 90
	SS, %	85 - 90	75 – 85	70 - 85	80 - 85	85 - 90	85 - 95	90 - 96	98 - 100	N/A	85 - 95
	DO, mg/l (Final Effluent)	< 2	< 2	< 2	< 1	< 2	< 2	< 1.5	< 2	N/A	< 2
	Faecal coliform, log unit	Up to 3 < 4	Up to 2 < 3	Up to 4 < 5	Up to 1 < 2	Up to 2 < 4	Up to 2 < 4	Up to 2 < 4	Up to 6 < 7	N/A	Up to 2 < 4
	Helminth Removal %	-	-	yes							
3	Area Requirement										
	Average Area (ha/mld)	0.18~0.2	0.16~0.2	0.8~1.0	0.17~0.2	0.11~0.14	0.05	0.03	0.08	2	0.22
4	Works Cost										
	Civil Works, % of Capital Costs	60 %	80 %	95 %	65 %	55 %	40 %	40 %	30 %	90 %	60 %
	E & M works, % of Capital Costs	40 %	20 %	5 %	35 %	45 %	60 %	60 %	70 %	10 %	40 %
5	Annual Repair Cost										
	Civil Works Maintenance, % of Civil Works	1 %	1 %	0.5 %	1 %	1 %	1 %	1 %	1 %	2 %	2 %
	E & M Works Maintenance, % of E & M Works	3 %	3 %	0.5 %	3 %	3 %	3 %	3 %	15 %	1 %	2 %
6	Daily Energy Requirements										
	Avg. Process Power (kWh)	225	187.50	4.00	30.00	75.00	282.50	250	300	3.00	225
	Avg. Non-Process Power (kWh)	7.50	7.50	5.50	7.50	7.50	4.50	4.50	4.50	4.00	7.50
	Total Power Requirement, (kWh)	232.5	195	9.50	37.50	82.5	287.0	254.50	304.5	7.00	232.5
7	Daily Energy Cost										
	Power Cost @ Rs 5.0 per kWh	48.4	40.6	2.0	2.8	17.2	60.4	53.6	64.1	1.46	48.4
8	Interest										
	Rate of compound interest, (adopted), % per year	12	12	12	12	12	12	12	12	12	12
9	Daily Bio Energy Generation										
	Biogas Generation m^3	55 – 70	55 - 70	Nil	35 - 50	35 - 50	Nil	Nil	Nil	Nil	Nil
	Bio - Energy Generation (kWh)	25 – 35	25 - 35	Nil	20 - 30	20 - 30	Nil	Nil	Nil	Nil	Nil

CAPEX and OPEX

Nomenclature	Technology types	Per capita Cost/Cum (Min)	Per capita Cost/Cum (Max)	Per capita Cost/Cum (Min)	Per capita Cost/Cum (Max)	Per capita Cost/Cum (Min)	Per capita Cost/Cum (Max)
DT1 - Nature based constructed system	DEWATS	1755	2048	1346	1570	1342	1565
	Soil Bio Technology	1463	1755	1121	1346	1118	1342
DT2 - Nature based pond system	Stabilisation Pond	380	468	292	359	291	358
	Aerated Lagoon	380	439	292	336	291	335
DT3 - Electromechanical system	Electro mechanical system	761	878	583	673	581	671

Treatment technology	Foot print per Unit	Opex per volume
Treatment capacity – 1000Cum/day		
DEWATS	3 - 5 Sqm/Cum	4.5 - 5.5 Lakhs
Soil Bio Technology	2- 3 Sqm/Cum	8.0 - 9.0 Lakhs
Stabilisation Pond	8 - 10 sqm/Cum	3.5 - 4.5 Lakhs
Aerated Lagoon	6 - 8 Sqm/Cum	5.0 - 6.0 Lakhs
Surface flow Constructed wetland	8 - 10 Sqm/Cum	3.5 - 4.5 Lakhs
Electro mechanical system	1.8 - 2 Sqm/Cum	14 - 16 Lakhs

Acknowledgements

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