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Government of Maharashtra

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Open Defecation Free City

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Making Cities Open Defecation Free

Systematic Approach in Maharashtra

Handbook
Vol 1
Feb, 2016

Swachh Maharashtra Mission (Urban)
Urban Development Department, Government of Maharashtra

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Swachh Maharashtra Mission

A Systematic Approach by Government of Maharashtra

Vision

Under Swachh Maharashtra Mission (Urban), Government of Maharashtra envisages "ODF Communities" moving towards "ODF+ and ODF++ Communities" by addressing entire service chain of sanitation and not focusing only on number of toilets constructed in the cities.

Government of Maharashtra has adopted a systematic approach by keeping in view city as a unit and encouraging city managers for moving towards improved sanitation by prioritising access and use of own toilets and implementing plans for safe management of faecal waste

स्वच्छ महाराष्ट्र अभियान
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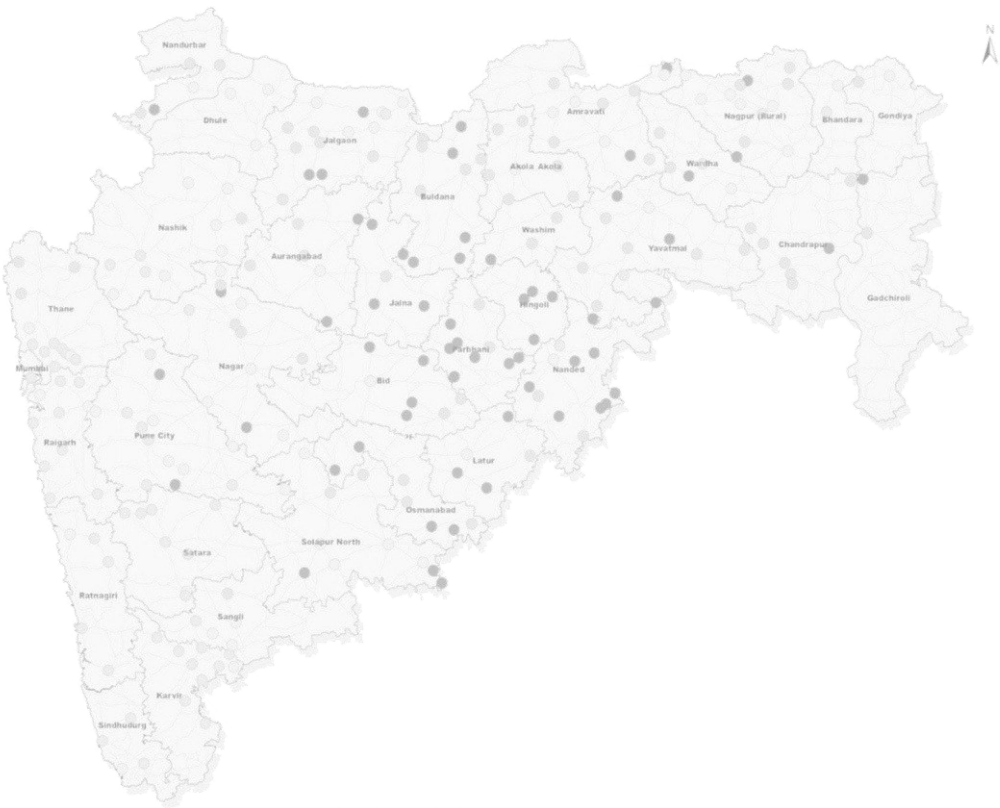
About this Handbook

In Maharashtra, nearly one in three urban households do not have a toilet on premise. This was due to constrains related to space, finance, tenure, building permission, lack of awareness etc. Since the launch of Swachh Maharashtra Mission, Urban (SMMU) in 2015 by Government of Maharashtra, the focus has been on encouraging use of toilets than just constructing toilets . While guidelines and directives are in place at the Central as well as State level, the process of implementing such a program in urban areas needs to be more clearly spelt out. This handbook seeks to address this gap by focusing on the planning and implementation of making cities ODF.

The handbook explicates objectives of SMMU and a roadmap for achieving Open Defecation Free (ODF) Cities envisaged under the mission. It also compiles various innovative initiatives and actions taken by ULBs in Maharashtra to facilitate implementation of mission at the Urban Local Body (ULB) level. This handbook is intended to be a reference guide for all ULBs, state governments and other partners engaged in Swachh Bharat Mission.



Launch of SMMU

Divisional Workshops

Led by the Hon. Chief Minister of Maharashtra

On the 15th May 2015, GoM issued a Government Resolution (GR) for launching 'Swachh Maharashtra Mission Urban (SMMU)'

- Through this GR, GoM declared additional subsidy of Rs. 8000 per toilet to address affordability related issues at household level.
- The GR was followed by the division level workshops led by Mr. Devendra Fadnavis, Hon. Chief Minister of Maharashtra.
- Workshops aimed at triggering the city level activities by briefing all the ULBs about targets envisaged under the mission and their responsibilities to achieve the same.
- Presidents and Chief Officers of all the ULBs participated in these workshops.
- "Swachh Maharashtra Mission- Implementation Guidelines", were issued as a further step which enabled city managers to take steps towards achieving of targets systematically

Mumbai

Nagpur

Kolhapur

Nashik

Further Key Initiatives by GoM

GR on delinking the land tenure issues with provision of toilets

GoM issued a special GR for enabling constructions on toilets clarifying that no NOCs will be required from the respective Government Authorities for constructing toilets on the Government lands.

Financial support to households for construction of toilets

GoM is extending support to households by granting additional subsidy of Rs. 8000 per toilet. Also, ULBs are directed to give subsidy upto Rs. 5000 per toilet from the 14th FC funds

Brainstorming workshops and review meetings at State level

GoM not only issued GRs and guidelines to facilitate the process, it also conducted brainstorming workshops timely, that catalysed on-ground implementation of the Mission

Presentations by experts followed by group-work of Chief Officers and other ULB staff

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सप्तपदी स्वच्छतेची

Open Defecation Free City

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INDEX

Foreword…

Government of Maharashtra launched "Swachh Maharashtra Mission Urban" on 15th May, 2015 with a vision to ensure access to safe and clean sanitation and waste management across the State. Under the leadership of Honourable Prime Minister Shri. Narendra Modiji, we are committed to fulfil Mahatma Gandhi's dream of Swachh Bharat by eliminating open defecation in the State.

"Swachh Maharashtra" is essentially a Mission led by local governments and facilitated by the state government. With support and guidance from Urban Development Department, all urban local bodies in Maharashtra are committed to make Maharashtra Open Defecation Free (ODF) by October 2017. Various initiatives, innovative ideas and achievements at city level are the crucial steps towards making the dream of Swachh Maharashtra come true.

I congratulate Urban Development Department and 'Team Swachh Maharashtra' for developing this Handbook on "Making Cities ODF". This handbook will be very useful for city managers in Maharashtra as well as in other Indian States to convert their dreams into reality.

With political will, backed by a dynamic team and massive support from the citizens, Government of Maharashtra is all set to achieve universal access to sanitation and thereby make our cities clean, safe and healthy.

Government of Maharashtra's journey towards becoming ODF State will certainly become a source of inspiration for other States

Mr. Devendra Fadnavis
Chief Minister,
Maharashtra

February 3, 2016

Key Message...

Under the dynamic leadership of Honourable Chief Minister of Maharashtra Shri. Devendra Fadnavis, the Government of Maharashtra is geared up to walk the way towards “Swachh Bharat”.

“Swachhtechi Saptapdi” – Seven steps to cleanliness- were introduced by the Government of Maharashtra as a road-map to Swachh Maharashtra. Local governments are further facilitated and encouraged by the State through building their capacities and engaging in a dialogue with them at various workshops and discussions. Today, results of State level efforts are evident at local level. In fact, some cities have become role models for other cities and States.

Local leadership has played a crucial role in shouldering the responsibility to achieve the targets and have responded phenomenally to Swachh Maharashtra Mission. Nineteen Open Defecation Free Cities had laid the foundation of ‘ODF Maharashtra’ on 2nd October 2015, followed by thirty three more cities to become ODF by the end of January 2016. This has generated tremendous energy at city level. This is evident through a range of innovative activities and convergence of various mission mode projects done at local level for making their cities ODF.

I am happy that the Urban Development Department is publishing this handbook on “Making Cities ODF”. I am sure that this handbook will provide guidance to other cities and States in adopting a systematic approach to meet the goals of Swachh Bharat.

I extend my best wishes to all urban local governments for moving towards “Swachh Maharashtra” and thus making the 'Swacch Bharat' dream and vision of Honourable Prime Minister, Shri. Narendra Modi, come true and get implemented in letter and spirit!

Dr. Ranjit Patil
Minister of State,
Government of Maharashtra

February 3, 2016

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Acknowledgement…

Government of Maharashtra launched "Swachh Maharashtra Mission Urban (SMMU)" , in alignment with the Swachh Bharat Mission (Urban), of Ministry of Urban Development, Government of India.

The SMMU has developed strategic components to ensure coverage of sanitation facilities to all ULBs in the state. This is being done through financial and programmatic support to households and ULBs for community and/or household level sanitation. However, the SMMU has taken a view that "construction of toilets needs to be complemented with mechanisms of promoting usage of toilets, eliminating open defecation practices, managing faecal waste safely and thereby creating "ODF Communities" . Towards this end, we have set quarterly targets for ODF cities . It is heartening to note that we are on track and as of January 31, 2016, over 50 ULBs in the state are declared ODF.

The Swachh Maharashtra Mission strategy envisages "ODF Communities" moving towards "ODF+ and ODF++ Communities" by addressing the entire service chain of sanitation and not focusing only on number of toilets constructed in the cities. The mission is geared up under the dynamic leadership of Honourable Chief Minister of Maharashtra, Mr. Devendra Fadnavis. The Urban Development Department has been continuously updating technical notes on making cities ODF to reinforce the quality of interventions. This Handbook on "Making Cities ODF" gives an useful insight on the planning, implementation and sustainability of ODF Cities as envisaged by the SMMU. Our effort is to make a comprehensive document that is user friendly for city managers in decision making and in taking actions at local level.

This Handbook is the result of team work and synergy of contribution from "Team Swachh Maharashtra" and all ULBs in Maharashtra ably assisted by CEPT University, Ahmedabad. I wish to place on record my deep appreciation of this team effort and hope that implementers and stakeholders in the state and in India will find this book useful in understanding the process of making cities ODF.

Mrs. Manisha Patankar- Mhaiskar , IAS
Secretary, Urban Development Department,
Government of Maharashtra

February 3, 2016

A. INTRODUCTION

Why eliminate open defecation ?

Open defecation refers to the practice whereby people go out in fields, bushes, forests, open bodies of water or other open spaces rather than using the toilet to defecate. The practice is rampant in India and the country is home to the world's largest population of people (urban and rural) who defecate in the open.

While India is home to about 11% of the world's urban population, it has over 47% of the world's population practicing open defecation . India also fares worse than other countries at similar income levels. Despite significant public investment in urban sanitation, over 37 million people in Indian cities resort to open defecation.

The 2011 Census of India provides some startling results. Nearly 12% of urban households resort to Open Defecation and another 8% use public or shared toilet facilities. The situation is far worse in smaller cities (population below 100,000), with Open Defecation rates around 22%. Though significantly less prevalent than in rural India, Open Defecation in urban settings poses more serious challenges. With high population densities and a lack of safe spaces, Open Defecation affords little dignity and poses grave security risks for women. Moreover, recent literature suggests that Open Defecation causes stunting among Indian children, particularly in more dense urban areas

What are “ODF Cities” in Maharashtra ?

A framework developed by Government of Maharashtra for defining “ODF Cities” in Maharashtra

As a long term vision, GoM aims to move towards improved sanitation by encouraging access to own toilets with safe management of faecal waste.

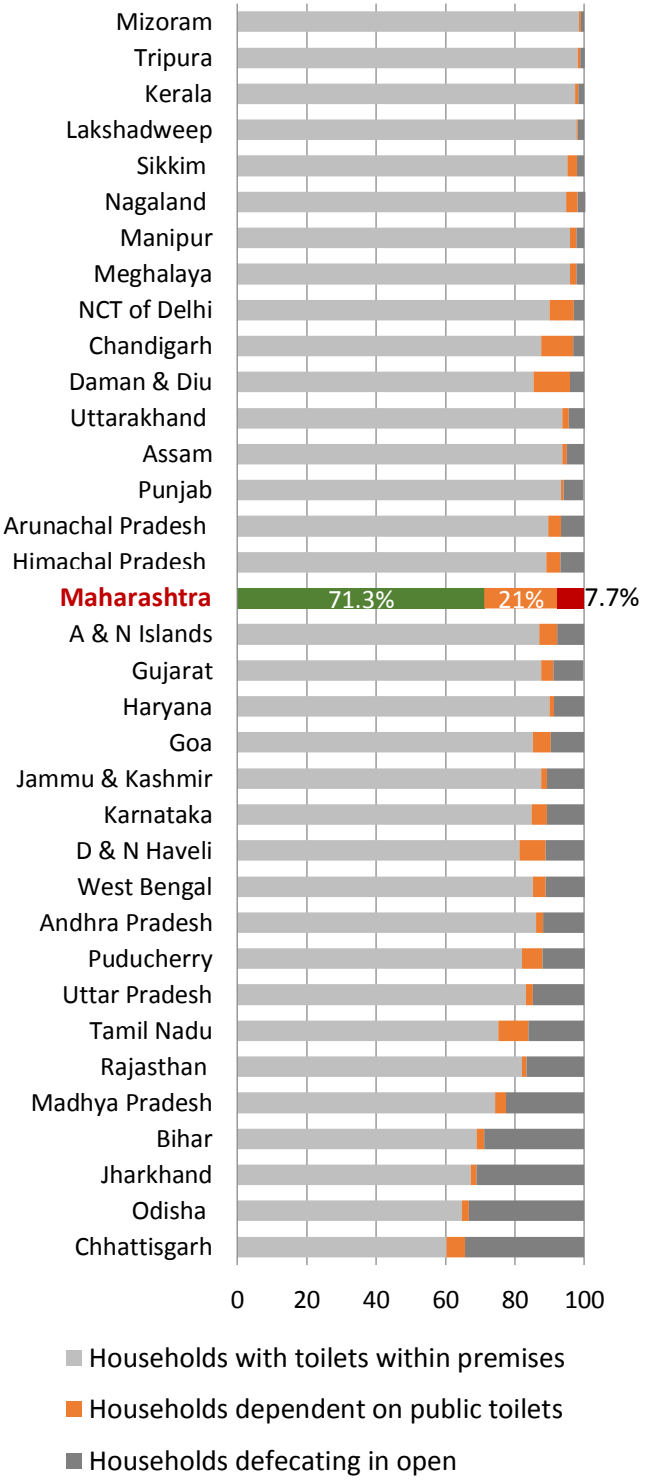
With many new toilets being built under SMMU, cities have to face increased challenges in disposing the faecal waste. For creating awareness about the need of own toilets and safe and regular management of faecal waste SMMU has identified the whole process of ‘granting’ ODF status to cities. In order to encourage ULBs for taking into consideration entire service chain of sanitation, GoM has developed concept of “ODF+ Cities” and “ODF++ Cities”

Framework for “ODF, ODF + and ODF ++ Cities”

	Elimination of OD practices	Access to toilets	Conveyance and treatment of faecal waste
ODF City	• Not a single person found defecating in the open • No traces of faeces are visible in the city at any time of the day.	• All the properties in the city have access to either own toilet or functional community/ public toilet • Floating population in the city has an access to sufficient and functional public toilets	• All toilets are connected to a disposal system
ODF+ City	• Not a single person found defecating in the open • No traces of faeces are visible in the city at any time of the day.	• At least **80%** of residential properties in the city have access to own toilets • Remaining properties and floating population in the city have access to functional community/ public toilets	• All toilets are connected to a disposal system • Regular and safe **collection, conveyance and treatment of all the feacal matter**
ODF++ City	• Not a single person found defecating in the open • No traces of faeces are visible in the city at any time of the day.	• At least **95%** of residential properties in the city have access to own toilets • Remaining properties and floating population in the city have access to functional community/public toilets	• All toilets are connected to safe disposal system • Regular **safe collection, conveyance and treatment of all feacal matter and waste water** including septic tank effluent and grey water

Situation Prior to the Mission

Maharashtra, has a large proportion (21%) of urban households dependant on Community Toilets…!



Due to various efforts made at the State level in the last decade, Maharashtra shows an increase in percentage of urban households having water closets from 44.4% (census 2001) to 67.3% (census 2011).

Unlike other major states, a large proportion of urban households in Maharashtra are dependent on public latrines. However, 7.7 percent of households are still resorting to open defecation.

Treatment of faecal sludge is rarely seen in smaller ULBs wherein, practice of disposing off septage in open dumps, water bodies or vacant lands outside the city limits is more prevalent.

While there are good regulations for design of septic tanks, a majority did not seem to confirm to the standards and regulations. Most of the septic tanks leach out the effluents into drain systems.

Since 2015, this situation has changed and nearly 50 cities are now ODF

Key Challenges addressed

Lack of space and funds for construction of individual toilets:

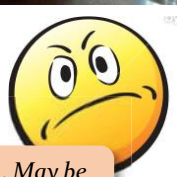
- In urban Maharashtra, principal reasons for households not having on-premise toilets are space constraints and affordability.
- SMMU promotes group toilets – toilets shared by 2 or 3 families
- Many ULBs in the state provide toilet grants form their own budget. Large number of financial institutions prove loans t for toilet construction

Construction and Maintenance of Community Toilets:

- Comparatively low open defecation (OD) rate (7.7%) through provision of community toilets (CTs); however, provision of CTs is no panacea.
- While a few cities have well-functioning CTs, in many others one sees them in a perpetual state of disrepair and people are forced to defecate in open.
- CTs entail large public expenditure as unit costs tend to be high, and they require O & M support throughout their life cycle. CTs may also pose greater health hazards.
- SMMU focuses on making CTs functional.

Lack of awareness and behavioural issues at household level:

- Absence of own toilets is also linked with the traditional habits in some parts of the State, where toilets are preferred to be located outside their houses.
- Lack of awareness amongst the target group regarding need for toilets.
- Perceived issues at household level, with assurance of benefits under the mission, due to which demand for toilets was not visible.
- Major awareness campaign launched at local level



""Toilet??.. May be next year!"

"I like to go out in the open!"

"We want toilets away from our houses"

""What if I go out in the open??"

"Who are you to stop me?!"

Issues linked with permissions to construction of toilets:

- ULBs were following the prescribed procedures for granting building permissions to toilets. This required various documents from the households related to ownership of their house
- The process is now streamlined

Need for clarity and motivation to Urban Local Bodies for implementing the mission:

- From the progress of implementation of mission at city level at initial stages, it was evident that ULBs needed motivation and guidance in implementing the mission effectively.
- Various capacity building programme are being organsied

B. Government of Maharashtra's Approach

Mission led by the Urban Local Bodies, facilitated by the State

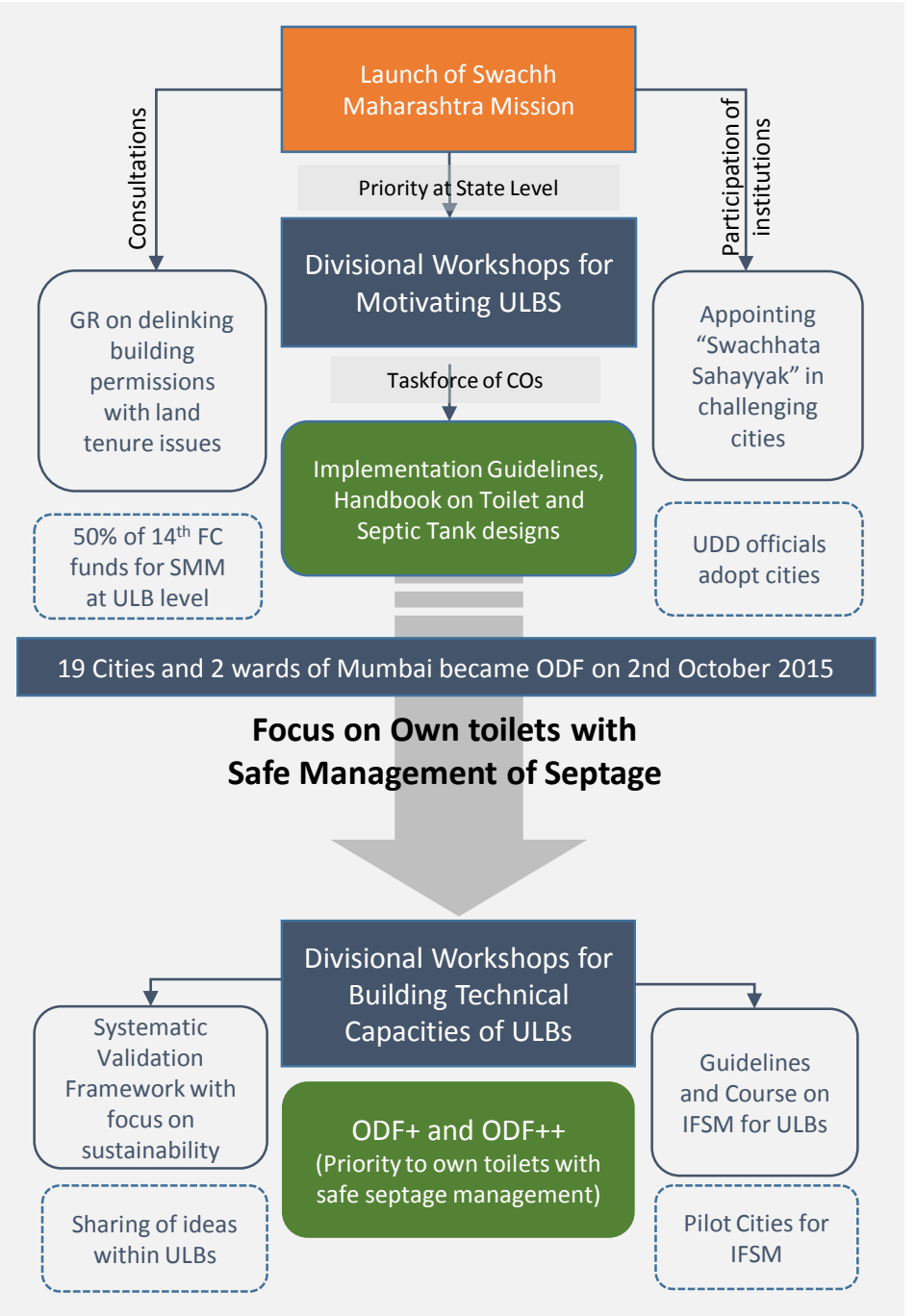
Maharashtra, with 45 percent of its population living in urban areas, is the third most urbanized State in the country. It faces tremendous challenge s to provide adequate and sustainable sanitation for its growing urban population. Launch of Swachh Bharat Mission (Urban) has triggered the efforts being made by the Government of Maharashtra (GoM) in universalising access to sanitation. During 2015-16, the GoM has made several efforts for facilitating implementation of the Swachh Maharashtra Mission at city level through series of motivational consultations with ULBs, issuance of Government Resolutions and guidelines and knowledge sharing workshops . In a short span of time, this has resulted in 50 plus ODF cities in Maharashtra. Under the Mission, GoM intends to move towards improved sanitation instead of encouraging only construction of toilets . For this purpose, GoM has developed the concepts of ODF+ and ODF++ cities for encouraging ULBs for moving towards safe management of faecal waste.

Mr. Devendra Fadnavis, Hon. Chief Minister of Maharashtra in his keynote address during the launch of Swachh Maharashtra Mission in Urban Areas (SMMUA) emphasised on three key areas for making Maharashtra's cities "clean". They were: – 1) Making all cities Open Defecation Free (ODF) with access to improved sanitation , 2) Scientific Management of Municipal Solid Waste, and 3) Safe Management of Septage and Waste Water. GoM is working passionately to achieve the milestones set by the Hon. Chief Minister under the mission. Maharashtra faces many challenges to meet these milestones. GoM has adopted a very systematic approach to sensitize and strengthen the implementers of mission at all levels of the government to address such challenges. The mission is led by the ULBs with enabling mechanism created by the GoM.

Making Sustainable ODF Cities

Objective of Swachh Maharashtra Mission

Encouraging construction and use of own toilets over community toilets and a concern of addressing issues with entire sanitation value chain instead of just toilets, shall enable sustaining the impact of implementation. Sustainability aspect is also well integrated in the "Validation Framework for ODF Cities" developed by the GoM.

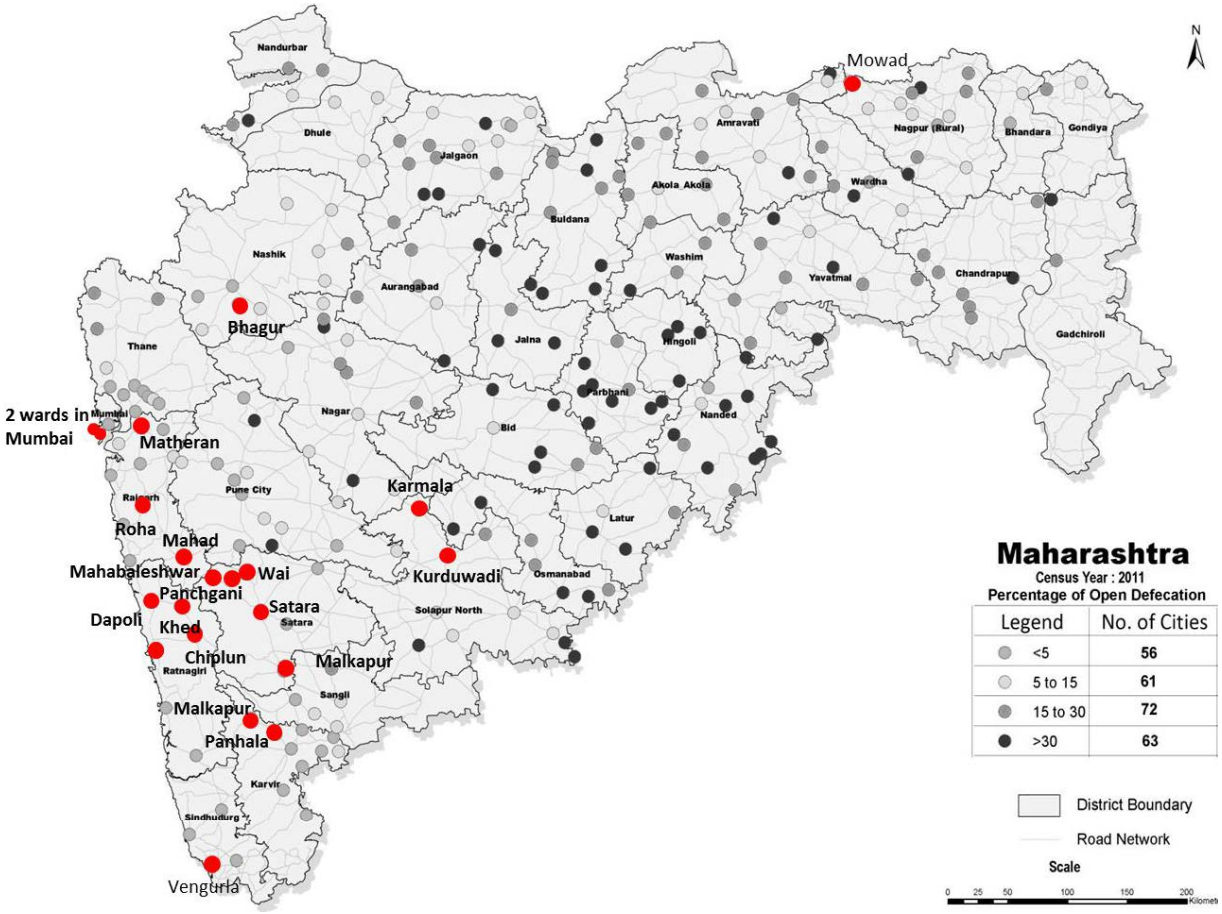


2nd October 2015- The First Milestone

On completion of one year of the mission, 19 cities in the State and two wards in the city of Mumbai self-declared themselves to be ODF. On the 2nd of October 2015, these cities were awarded by the Hon. Chief Minister of Maharashtra for their efforts. On this occasion, GoM also awarded three Swachhata Doots from small cities of Maharashtra, who prioritised constructing their own toilets over the other needs. They have set the examples for all and are formally involved in the movement for motivating others in their as well as other cities

19 cities

laid the foundation of ODF Maharashtra on 2nd October 2015



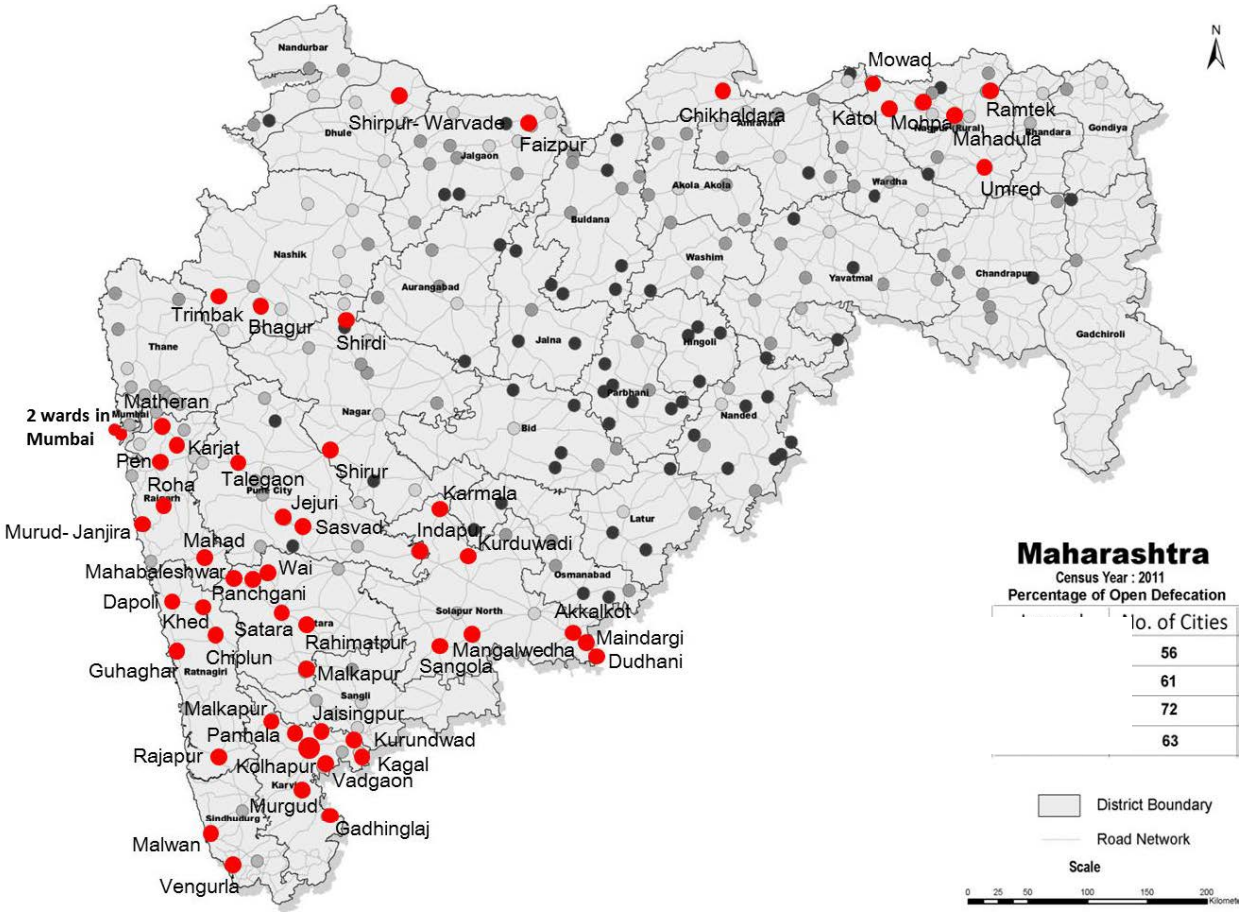
31st January 2016 - The Second Milestone

Total 52 cities in the State and two wards in the city of Mumbai have become ODF as on 31st January 2016. These cities are being awarded by the Hon. Chief Minister of Maharashtra for their efforts on 3rd February 2016.

GoM envisages ODF+ and ODF++ cities in upcoming years for which, support is provided to ULBs by conducting technical workshops and issuing guidelines for septage management in Maharashtra

51 councils and 1 corporation

have become ODF as on 31st January 2016

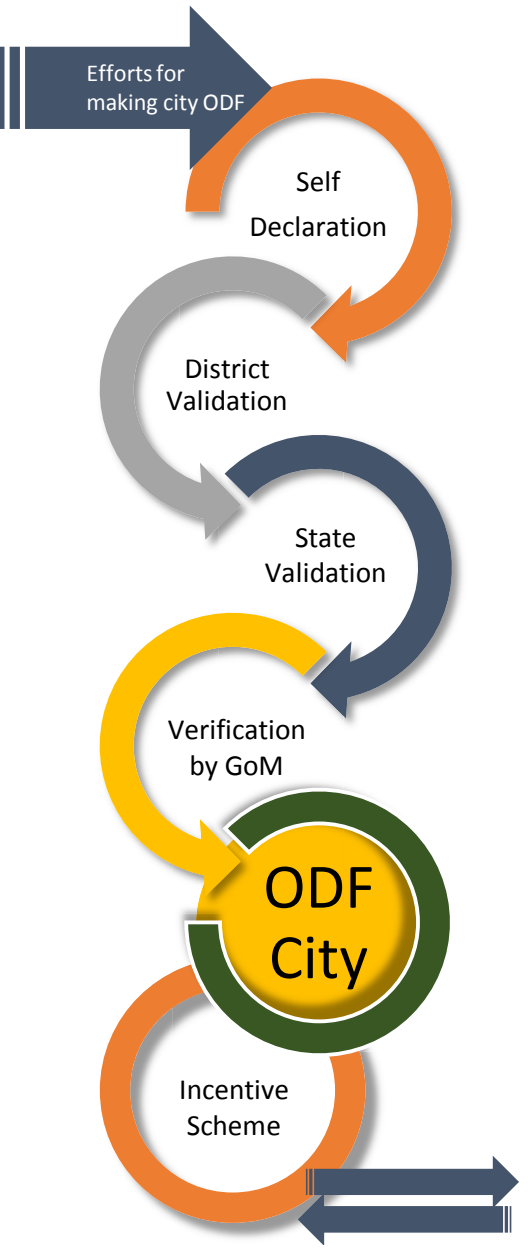


First 19 ODF cities are on the way towards ODF + cities…

How to ensure that the city has become ODF?

GoM has developed a systematic validation framework to ensure authenticity and sustainability of the success achieved by ULBs

Framework for Validation of Self-declared ODF Cities



Rewards to ODF Cities :
30% on round 1 validation by SLC
70% on round 2 validation by SLC

1 Self-declaration by ULBs for achieving the status of ODF/ODF+/ODF++

ULBs to submit the following documents to GoM as a self-declaration

1. Covering letter for self-declaration
2. City level resolution for self declaration as ODF city
3. 2 to 4 pager documentation of efforts made for achieving the target and strategy for sustainability

2 Validation by Collector's Office

1. One day validation as per checklist provided by GoM
2. Collector's office to submit a report for this validation to GoM with collector's signature

3 Validation by State Level Committee (round 1)

1. Six SLCs formed by GoM (for six divisions)
2. SLC comprises of one NGO, one reporter and one official from Divisional Commissioner's office
3. 3-4 days validation as per checklist provided by GoM
4. SLC to submit a report for this validation to GoM within given timeframe

4 Random verification in 10% of the cities by GoM

1. GoM to verify the reports on a random basis through actual city visits, to ensure authenticity

5 Awards to "ODF Cities"

1. Cities that pass all stages of validation will be declared as "ODF Cities" by GoM.
2. The list of such cities will be submitted to the GoI

6 Re-validation by State Level Committee (round 2)

1. SLC will revalidate sustainability of the success, six months after the round 1 validation by SLCs

Financial support by the State to enable construction of toilets…

1. State level additional subsidy of Rs. 8000 per toilet in addition to Rs 4000 from Government of India
2. Directives by GoM for providing ULB level subsidy from 14th FC funds and from ULBs' own funds
3. **Swachh Maharashtra Kosh…**
   Financial support to cities through CSR funds

Adopt districts, cluster of cities or individual cities	Adopt communities/ clusters/ slums within the city	Logistical Support To districts/ cities through provision of -
• Making cities ODF by providing required number of toilets (all types) • Individual / Group toilets (for 100% HHs to make city ODF+/++) • Community and / or Public and /or Institutional toilets • Implementing septage management plans (Installing septage treatment facilities etc.)	**(Corporates can partner directly with cities through "Swachh Shahar Kosh")** • Making city / communities ODF by providing required no. of toilets (all types) • Individual / Group toilets (for 100% HHs to make city ODF+/++) • Community/ Public /Institutional toilets • Implementing septage management plans (Installing septage treatment facilities etc.)	• Providing Skilled Workers- Masons, Plumbers, Electrician etc. • Making available construction material. • Making available proven new technologies for addressing location specific issues. • Operation & Maintenance support for community toilets /public toilets / school toilets. • Installing environment friendly facilities in Public Places.

"Make sustainable ODF cities"

"State Government will provide all the required support in making the dream come true…
But, the beginning has to be made at the city level"

C. City Level Approach ….

Reflection of State's Initiatives and Efforts

(A) 8 Steps for Making Cities ODF

Planning

- Identification of Issues and Gaps through City Level Surveys
- Development of City Specific Strategy
- Formation of City Level SBM Cell
- Development of Implementation Mechanism

Implementation

- Awareness Generation and Advertising of Scheme
- Application Process
- Construction of Toilets
- Elimination of Open Defecation Practices

D. Sustaining Cities to be ODF

E. Way Forward

F. Moving towards ODF+ and ODF++ Cities

A. Making Cities ODF

Planning

A 1. First Conduct the Surveys Identify issues and gaps through city level surveys, do not jump to conclusions

Recognising the need of creating sanitation database at city level, UDD, GoM provided instructions to all the ULBs for conducting household level surveys and generating database on households. This helped in identifying the households in the city who do not have toilets. These households were further probed on reasons for not having a toilet.

Household Level Surveys

- At least **quick surveys** to identify households without toilets and those who defecate in the open should be conducted
- Based on the capacities, **extensive surveys** to understand reasons of open defecation and non-availability of toilets should be conducted, which may be useful in preparing the city level strategy
- **Smart surveys** using the Palm Digital Assistants (Tabs/Mobiles) can be conducted . This enables immediate collation of data at city level and analysis through online dashboards helpful in identifying location specific characters and issues.

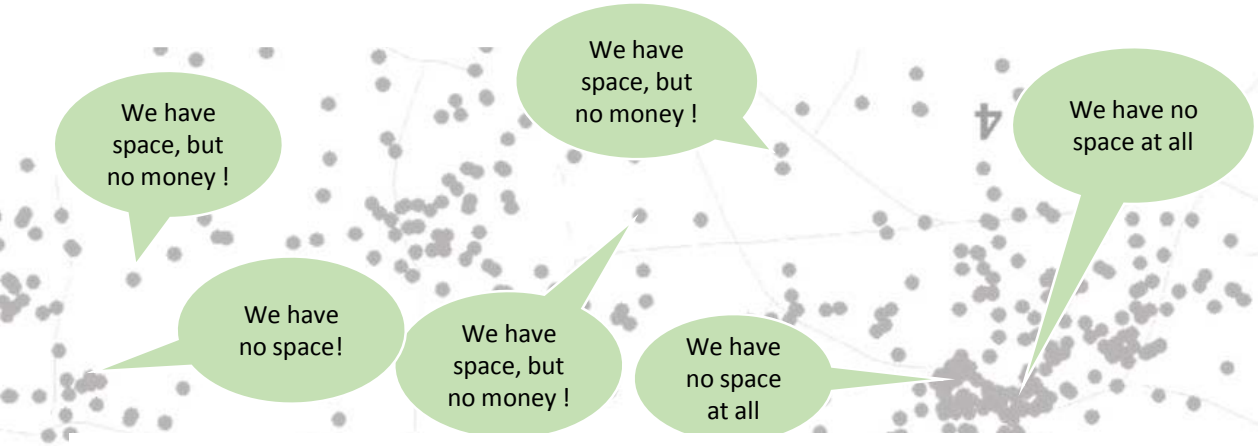
Surveys of Community, Public and Institutional Toilets

To identify gaps in availability of facilities as well as to assess status of existing facilities.

Surveys of Open Defecation Spots

To assess reasons for open defecation are must as the reasons may be situation and location specific and may vary city wise

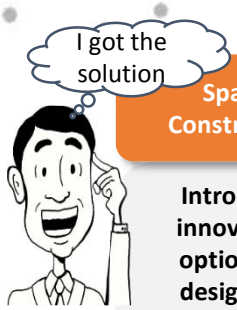
Wai Municipal Council conducted an extensive smart survey on PDAs using an application "SANITAB"- to include questions regarding availability of toilets, reasons for absence of toilets, willingness to construct toilets, issues in doing the same. It also covered questions on availability, access, designs and emptying mechanism of septic tanks in the city



A 2. Develop a City Specific Strategy

Identify appropriate solutions for your city

- Varying geographical, cultural and economical set up of the cities demands for varying solutions suitable to respective cities.
- Surveys should result into identification of location specific issues and reasons for open defecation and absence of toilets and help decision makers in recognising suitable solutions



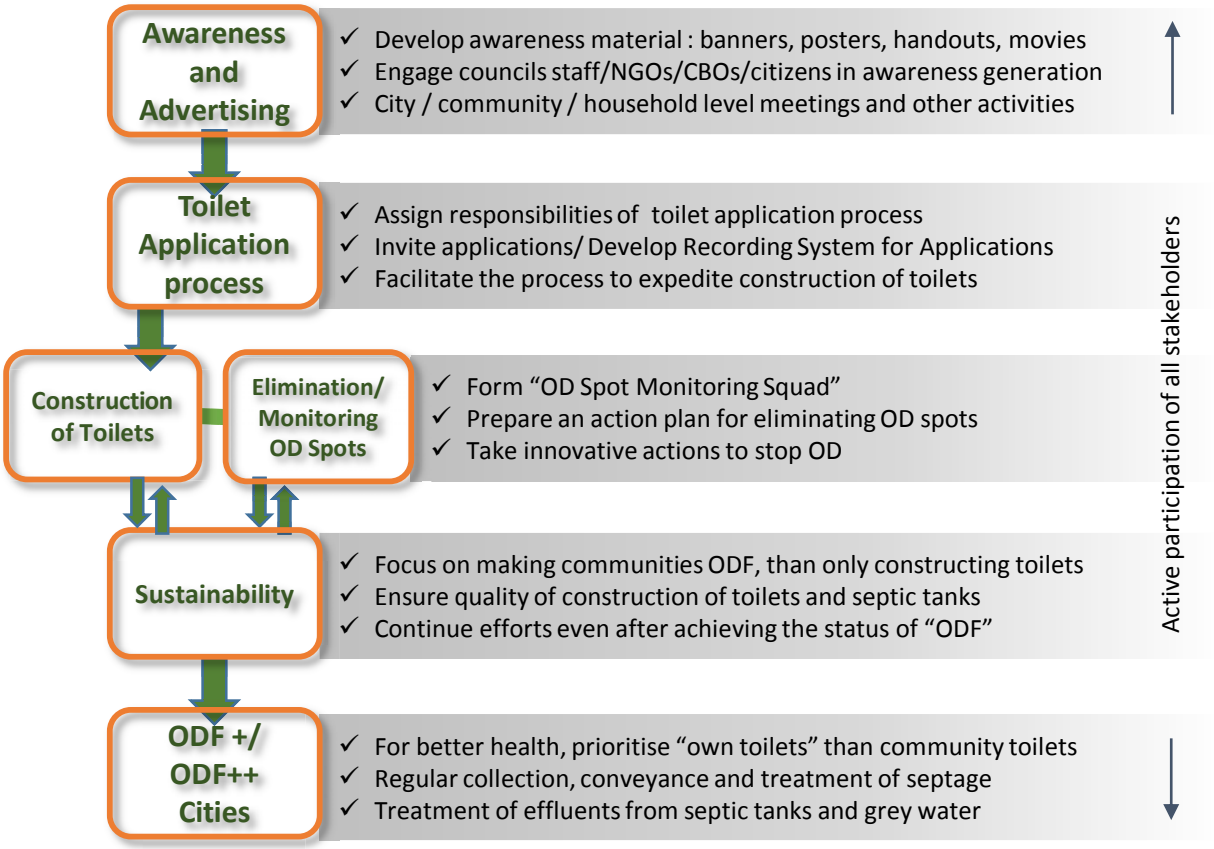
Space Constraints:	Financial Constraints	Land Tenure Issues	Behavioural Issues
Introduce innovative options of designs of toilets and septic tanks ✓	Make available options to fund the toilets ✓	Make the best use of GoM's GR on granting permissions to toilets for all houses.	Engage NGOs/CBOs in awareness generation at household level

A 3. Form a City Level "SBM Cell"

Assign responsibilities and set targets

- A dedicated cell for implementation of the Mission must be established at ULB level.
- The cell should have- the Mayor/ President, M. Commissioner/ Chief Officer, Engineers, Sanitary Inspectors and Accountant.
- If possible, support from NGO, research institutions should be sought
- The SBM cell should act as a think tank, implementer as well as monitor of the activities.
- Each member of the cell should be assigned with specific responsibilities, which is to be monitored by head of the cell.

A 4. Develop an Implementation Mechanism



Making cities ODF is a combination of actions. While restricting households from defecating in the open, it is essential to provide them with access to clean sanitation facilities. GoM has issued implementation guidelines to enable ULBs for taking actions towards achievement of targets.

Implementation

A 5. Generate Awareness & Advertise the Scheme

Foundation of success

ULB Level	City Level	Community Level	Household Level
Understand the Mission ✓ Capacity Building of ULB Staff ✓ Support from other resources in case of dearth of staff	**Create a Buzz** ✓ Announcements in auto/ Rallies ✓ Display banners/ posters ✓ Advertisements on cable channels/ newspaper ✓ Social media platform ✓ Mobile applications ✓ Activities in Schools and other institutions ✓ Toilet and Lenders' Fair	**Encourage Communities** ✓ Active participation and leadership of councillors ✓ Group Discussions/ Ward Meetings ✓ Street plays / mobile games ✓ Meetings with SHGs ✓ Penalise / name and shame ✓ Show influential movies	**Address households' Queries** ✓ Discuss issues with households at the time of distribution of applications ✓ Distribute hand-outs/ pamphlets ✓ One to one assistance by "SBM Cell"

A 5.1 Begin from Home !

Capacity Building of ULB Officials

- Institutional capacities of the corporation/ council should be assessed - strengths and weaknesses
- Training should be given to ULB officials towards objectives of mission and their roles and responsibilities in achieving the same
- Supporting mechanism should be established with the help from external resources – NGOs/ CBOs/ Computer Professionals / Other individuals
- Periodic review meetings should be conducted to assess the progress
- Information/ Knowledge received during various State/ divisional workshops should be transferred to the ULB staff for appropriate actions
- ULB officials need to unite to pledge for achievement of "ODF City"
- Officials should be encouraged to actively participate in various activities by appreciating their efforts and giving them some incentives – (Award best performers for their contribution towards achievement of goals etc.)
- Toilet need to be made mandatory to all corporation / council officials / *safai karmacharis*. They should be encouraged to get one build if it does not exist and the process should be facilitated.

https://www.facebook.com/स्वच्छ-महाराष्ट्र-मिशन-दिग्रस-1478324922492871/

Facebook Page by Digras Municipal Council

A 5.2 Engage with Communities

- Objectives of the Mission - Importance of using toilets for improved health and overall cleanliness and their role in implementing the Mission should be conveyed to citizens through city level campaigns
- Women and children can be the catalysts in conveying messages to society more effectively
- Celebrate “Swachhata Week” at city level, create a platform to discuss objective of the mission and pledge for achieving the targets under the mission with contribution from all.
- Clips explaining “benefits of toilets and drawbacks of open defecation” can be prepared and circulated through social media platforms
- Attractive jingles and songs spreading the messages and information of scheme can be prepared and played
- “Swachata Doots” can be appointed to lead the mission at community level.

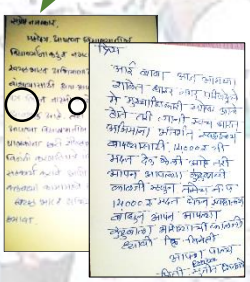
Encourage students to be the catalysts

- Children should be encouraged to think over "sanitation" through essay and drawing competitions, games, street-plays, wall paintings etc.
- Through school activities, students can be encouraged to adopt healthy sanitation practices and convince their friends and neighbours to follow the same

"Balveer Pathak" – a team of ~30 students from 5th to 7th std. monitors OD spots and encourages individuals to get their toilets built. Council has made it's library accessible to these students as a reward – Dudhani Municipal Council

Letters to Parents - Council encouraged students to raise demand for toilets to their parents by writing a letter to them. – Killedharur Municipal Council

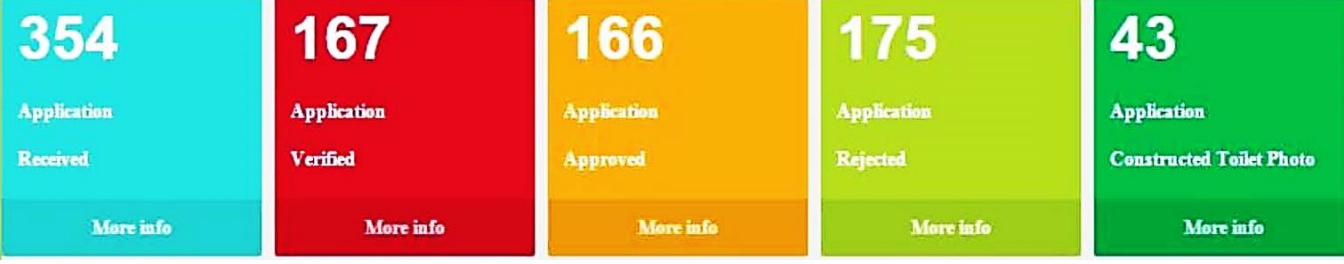
We are taught in the school that we should use our own toilets for better health!.. I want a toilet at home!



A 5.2 Involve leadership at Ward/ Community Level

Conduct group discussions led by the elected representatives

- Queries by beneficiaries should be resolved through ward level meetings
- Activities like street plays/ movie screening / games should be organised to involve citizens in the discussions



A 6. Motivate people for Toilet Application

Let it be demand based… Try and generate the demand!

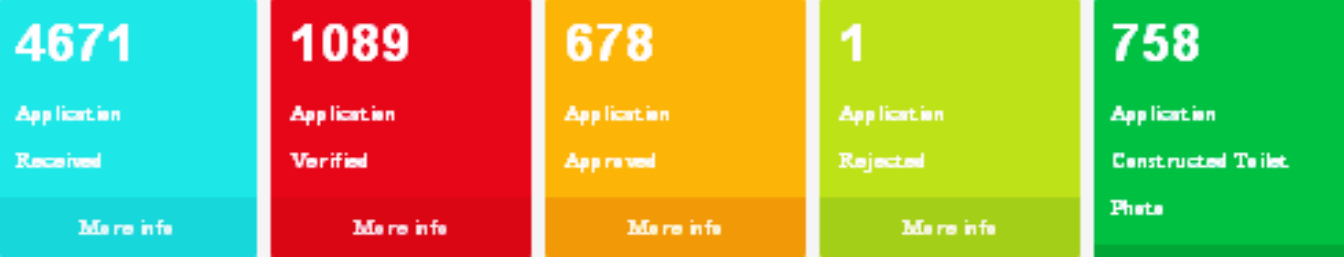
How to ensure that the applications are received?

- To ensure usage of toilets constructed under the mission, demand for toilets needs to be generated than identifying the beneficiaries and imposing toilets on them!
- Meeting with potential beneficiaries identified from the surveys should be conducted to address their queries and perceived fears
- An active participation from councillors to interact and follow up with beneficiaries in respective wards should be sought
- Households should be visited/ approached for assessing the reasons if they are not submitting the applications
- Free bulk SMS can be sent to potential beneficiaries as a reminder to submit applications
- NGOs/CBOs/ Citizens can be involved in making target oriented efforts for inviting applications
- Daily/ weekly targets for number of applications to be received should be set and reviewed by the 'SBM Cell'
- For making households apply for toilets, make a toilet mandatory for receiving any certificate/ *dakhla* from council

Certificates given to beneficiaries on construction of toilets to encourage other potential beneficiaries eg. Kalamnuri, Pulgaon MCls

Meetings with beneficiaries to encourage them and address their queries

- ✓ Wai and Sinnar Municipal Councils have maintained excel based records of applications which helps in following up with the households
- ✓ Khopoli Municipal Council has maintained file for every application with assigned colour codes for different areas
- ✓ Shirpur Warvade is one of the councils to achieve remarkable progress in online processing of applications due to assigned duties of staff and timely review
- ✓ Cities in Solapur district took rigorous and strict actions against open defecation and thereby made households to submit applications for getting their toilets built.



Monitoring System at local level for toilet applications

Upload Applications

- CSCs or computer operators/ centres may be engaged in online uploading of application forms and respective documents
- Applications may be uploaded in night shifts to avail faster speed of internet and availability of computers

Verify and Approve Applications

- A dedicated team should be built to make verification visits with target oriented responsibilities –daily targets should be assigned
- Households may be assisted in resolving space related issues by suggesting options like group toilet/ group septic tanks

Upload Geo-tagged Photos on portal

- Templates for details to be displayed on the toilets- with logos, application number etc. should be prepared (metal stencils, readymade boards etc.)
- Responsibility should be assigned to dedicated person at council/ external help may be taken
- Free mobile applications may be used for geo-tagging the photos

Balapur MCl has outsourced the job of uploading applications on the SBM portal to 10 different centres. This has helped in addressing issues with internet connectivity, power supply and lack of internal capacities which resulted into uploading of more than 3000 applications within a month

A 7. Construction of Toilets

Toilets must be sustainable…

First Decide- "Own Toilet" or Community Toilet ?

Health risks increase with the number of households that share a toilet
Health risks reduce when own (individual or group) toilets are used.

Promote construction and use of "own toilets" than addressing the issue by constructing publically maintained and used community toilets

Facilitate Construction of Own Toilets

- Process of construction of toilets can be expedited by facilitating access to good quality material.
- SMS can be sent to households given "approval" for constructing toilets and reminding them to follow the timeline for construction
- Active role can be played by councillors in close monitoring on status of construction in their respective wards
- To ensure sustainability, it is essential to monitor every toilet being constructed under the Mission and whether is it constructed as per given designs and norms

Multiply your arms – Explore participation of citizens/ NGOs/ CBOs etc.

Dondaicha Warvade Municipal Council **sought support from local NGOs**. Five NGOs are on board to participate in the Mission by adopting 30 HHs each. NGOs are going to generate demand for toilets, provide financial assistance to identified households and facilitate further process till the time toilets are constructed

*Increased risk of adverse health effects associated with community toilets if compared with individual household toilets - **includes diarrhoeal disease, helminth infection and poliomyelitis****

**Source: WHO-UNICEF committee to develop new targets for post-2015 beyond the Millennium Development Goals (MDGs), Research Paper- Public versus Individual Household Latrines- UNICEF-LSHTM*

City Level Toilet Fair

Sinnar and Wai Municipal Councils conducted city level toilet fair to make available various sanitation technologies for households, to make them aware of materials and their costs etc.

Space Constraints?

- Design innovations can be explored to address space constraints
- Options like “Group Toilets” or “Group Septic Tanks” may be adopted to tackle space and fund related issues efficiently.

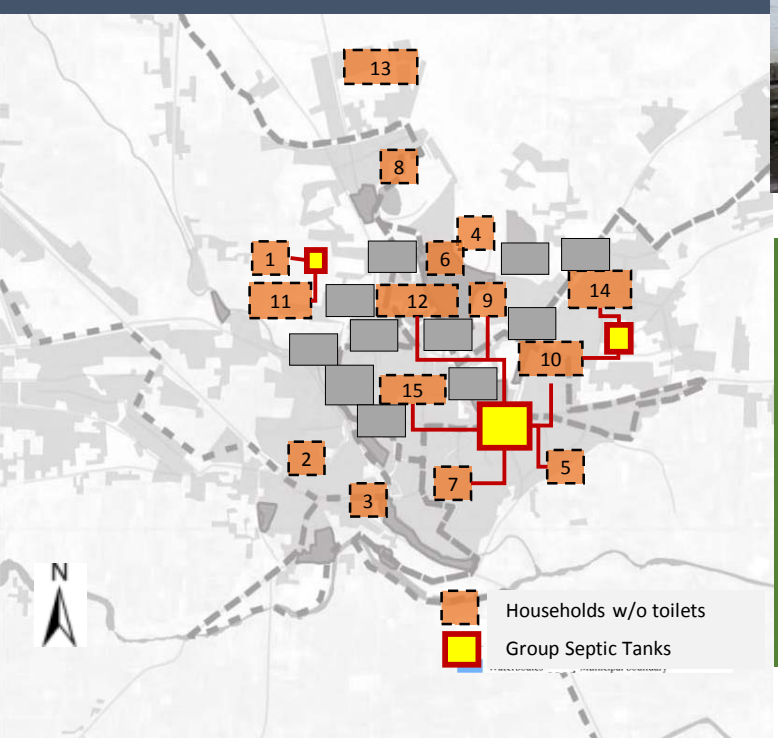
Group Toilet-
A toilet constructed, used and maintained by 2 to 4 households- eg. Mahad, Dahanu, Wai, Sinnar and many other cities

Group toilet is considered as “Improved Sanitation” as against a community toilet which is an “Unimproved Sanitation” facility

Option 1: Group Toilets

Criteria	Type of toilet facility		
	Individual toilets	Group toilets	Community toilets
Space efficiency	◔	◕	●
Cost effectiveness for household	◔	◕	●
Level of cleanliness	●	◕	○
Cost savings for the ULB	●	○	○
Ease of Access	●	●	◔
Safety and User friendly	●	●	◔

Option 2: Group Septic Tank



Group Septic Tank-
A common septic tank constructed for 50 household level toilets in slum of Khopoli by Khopoli Municipal Council. Underground pipeline connecting toilets to septic tank is laid. Septic tank is emptied around once in a month by the council. This module is being replicated in Khopili at 9 more locations

Allow Toilets..

Create enabling mechanism for households by making optimum use of guidelines and GR for delinking tenure issues with construction of toilets

SBM (Urban) Guidelines

4.3.2. Beneficiary households will be targeted under this scheme irrespective of whether they live in authorised / unauthorised colonies or notified / non-notified slums. Under SBM (Urban), tenure issues are to be de-linked with benefits

"Toilet can be constructed for any house and can exist till the time respective house exists"

- Guidelines of the mission and Government Resolution by GoM should be optimally followed for achieving the targets
- Households must not be forced for submission of unnecessary documents
- NoCs not required for building toilets on the Government land
- Provision of toilets should be prioritised on the grounds of public health
- Application process should be facilitated by providing required assistance to households in submission of required documents. Support can be sought from NGOs/ volunteers in this
- However, an assurance letter must be availed from the households for construction and use of toilet once the subsidy is received. Assurance letter should also state the timeline for construction of toilets

Ensure Good Quality Toilets

Good toilet designs make them usable and so, sustainable…

Training to contractors in some cities eg. Sinnar, Wai Municipal Councils

Understanding the importance of good quality of construction of toilets for making them sustainable, GoM has issued -

- A GR for avoiding prefabricated toilets for maintaining good quality of construction
- A handbook on designs and norms for toilets and septic tanks for use at ULB level.
- ULBs being informed about various toilet designs and norms through State level workshops

What Should be done at ULB Level ?

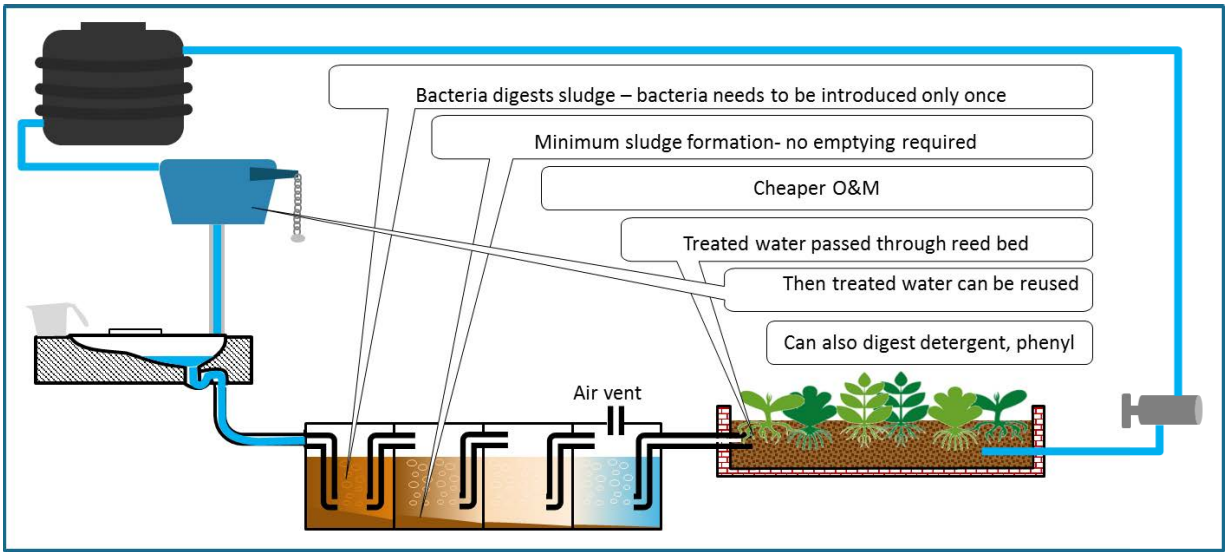
- Construction guidelines/ standard designs and minimum specifications for construction of toilets at household level should be developed and disseminated in the form of hand-outs, posters etc.
- Do's and don'ts' for construction of toilets and septic tanks should be developed and displayed on the notice boards at ULB/ at public spaces.
- Workshops should be conducted to train the local contractors/ masons for appropriate construction of toilets.
- Construction of toilets under the mission should be monitored by the ULB / third party

Dos	Don'ts
✓ सेप्टिक टाकी किमान दोन कप्प्यांची असावी ✓ कप्प्यांमधील भिंत ही टाकीचे एक तृतीयांश व दोन तृतीयांश याप्रमाणे विभाजन करून बांधावी ✓ दोन्ही कप्प्यातील मैला पातळीच्या वर पाईप अथवा चौकोनी छेदाद्वारे जोडावेत. पाईप अथवा चौकोनी छेद हा ७५ मी.मी. पेक्षा मोठा नसावा	X एक कप्प्याची सेप्टिक टाकी बांधू नये X कप्प्यांमधील भिंत चुकीच्या ठीकाणी बांधू नये X दोन कप्पे चुकीच्या पद्धतीने अश्या ठिकाणी जोडण्यात येऊ नयेत जेथे मळी अथवा मैला जमा होतो
✓ नगरपरिषदेच्या मानकांच्यानुसारच टाकीचे बांधकाम करावे	X आवश्यकतेपेक्षा मोठ्या आकाराच्या सेप्टिक टाक्या बांधू नयेत
✓ सेप्टिक टाकी ही नेहमी इमारतीपासून दूर अंतरावर असावी ✓ टाकीच्या सर्व कप्प्यांवर झाकणे असावीत	X टाकीच्या वर शौचालय बंधू नये X सेप्टिक टाकी पूर्णपणे सीलबंद करू नये
✓ विटा, खडी, वाळू, दगड कॉंक्रीट यांचा वापर करूनच टाकीचे बांधकाम करावे	X केवळ खणलेल्या खड्ड्याचा वापर सेप्टिक टाकी म्हणून करण्यात येऊ नये X टँक गळता कामा नये
✓ टाकीचा तळ हा सिमेंट कॉंक्रीटचा असणे आवश्यक आहे तसेच टाकीच्या निर्गमाच्या बाजूकडून आतील बाजूस उतार असणे आवश्यक आहे ✓ टाकीच्या आतील बाजू ह्या सिमेंटने प्लास्टर करून गुळगुळीत केलेल्या असाव्यात	X टाकीच्या निर्गमाच्या बाजूस उतार करण्यात येऊ नये X टाकीच्या आतील पृष्ठभाग खडबडीत असता कामा नये
✓ टाकीत मैला सोडण्याचा मार्ग (inlet) व निर्गम (outlet) हे वेगवेगळ्या पातळीवर असावेत ✓ टाकीत मैला सोडण्याचा मार्ग (inlet) व निर्गम (outlet) हे मळीच्या थरापेक्षा खाली व मैल्यापेक्षा वर असावेत ✓ दोनही मार्गांच्या तोंडाशी 'टी जंक्शन' अथवा बॅफल देण्यात यावेत	X ज्या ठिकाणी मळी अथवा मैला जमा होतो त्या ठिकाणी टाकीत मैला सोडण्याचा मार्ग (inlet) व निर्गम (outlet) देण्यात येऊ नयेत X मैला सोडण्याचा मार्ग (inlet) व निर्गम (outlet) हे एकाच पातळीवर नसावेत
✓ वायुवीजनाच्या पाइपची उंची ही 20 मीटर च्या परिसरातील सर्वात उंच इमारतीच्या उंचीपेक्षा किमान २ मीटरने वर असावा	X वायुवीजनाचा पाइप डासांपासून सुरक्षित ठेवावा X वायुवीजनाच्या पाइपची उंची अतिशय कमी असता कामा नये

Toilet Technologies…

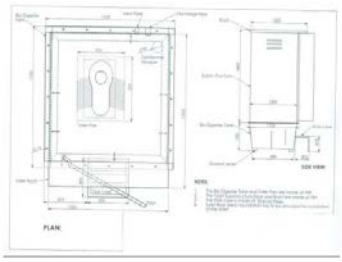
Bio-digester Toilet (Developed by DRDO)

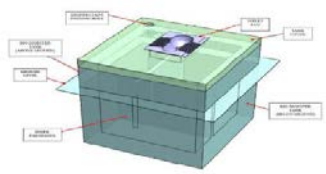
A bio-digester toilet is an anaerobic multi-compartment tank with inoculum (anaerobic bacteria) which digests organic material biologically. This system converts faecal waste into usable water and gases in an eco-friendly manner. It can be connected to the toilet or a series of toilets. The toilet can be a superstructure fixed on the bio-digester or a separate unit. Bio-digester has an inlet, an outlet and a gas pipe. The tank has two components, namely, anaerobic microbial inoculum (seed bacteria) and specially designed fermentation tank. Semi-treated water from bio-digester tank is needed to be further disposed into a soak pit or a reed bed arrangement for its treatment to acceptable levels of discharge.



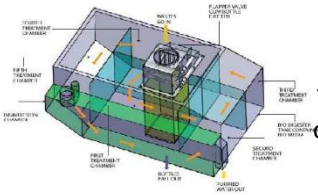
Bio- Toilet

This technology differs from that of the bio-digester toilets developed by DRDO since the process adopted is aerobic - which involves a different multi-strain of bacteria which breaks down the waste matter through oxidization. Bio-toilets consist of a purpose built multi- chambered bio-tank in which the waste is stored as shown in Figure .





The movement of the waste is slowed down as the waste flows from one chamber to another by a special process in the Bio-tank such that the multi-strain bio-media present in the tank can digest the waste and convert it fully into non-toxic neutral water. This water then passes through the last chamber for disinfection. Here water is treated with Chlorine where the majority of the germs are killed.



The resultant water is free from all sorts of E-coli and fecal coliforms. These are available in both flush and non-flush models.

Source: Swachh Bharat Mission guidelines, 2014

Community Toilets

Ensure sustainability with appropriate designs and regular maintenance…

- Community toilets should be opted for only where individual toilets are not possible at all.
- Provision of special seats for physically challenged persons, children and women need to be considered while designing toilet blocks
- Safety of women should be prioritised by ensuring easy access and provision of lights/ electricity inside and near the toilet blocks
- All required facilities like water/ storage tank, electricity, wash basins, dustbin for menstrual waste etc. need to be provided
- Community toilets and surroundings need to be maintained clean and well developed
- Community toilets should be located exactly where they are needed
- Ratio of one toilet seat of a community toilet per six households is advised

Community toilet at Chopda. Clean surroundings, ample of light, air and space inside the toilets, Provision of room for caretaker

Maintenance of Community Toilets…

- Community / Public toilet seats need to be cleaned on a regular basis – at least two (to four) times a day depending on the use of toilets in particular cities
- Complaint redressal system at ULB level needs to be strengthened. Complaints about functioning of community/ public toilets should be redressed on priority (within 24 hrs)
- Community toilet users should be informed about the importance of health and safety and so maintaining the toilets clean and usable on themselves
- Daily monitoring system should be developed and followed for assuring cleaning of toilets. Feedback from citizens should be noted on daily basis.
- If repair and maintenance of these toilets is to be outsourced for better results, ensure that the service contracts with agencies are linked to their performance and conditions regarding frequency of cleaning, daily reporting system, redressal of complaints, timely repairing of facilities etc. are incorporated in the contract.
- Study contracts of other cities that are giving better results
- Even If service of repair and maintenance of toilets is outsourced, regular monitoring of service provision has to be done by the councils.

Community toilet at Lonavla. Well developed surroundings increases use of toilets.

Community toilet at Wai. Provision of wash basins, room for care taker.

Designs Innovations for enabling children to use toilets

Attractive baby toilets at 6 locations, connected to septic tanks of existing community toilets. Children like using them ~ Kurundwad Municipal Council

'Toilet room' for children to address fear in their mind in using a closed small toilet block- eg. Ambernath, Panchgani Municipal Councils

Cleaning on Mission Mode

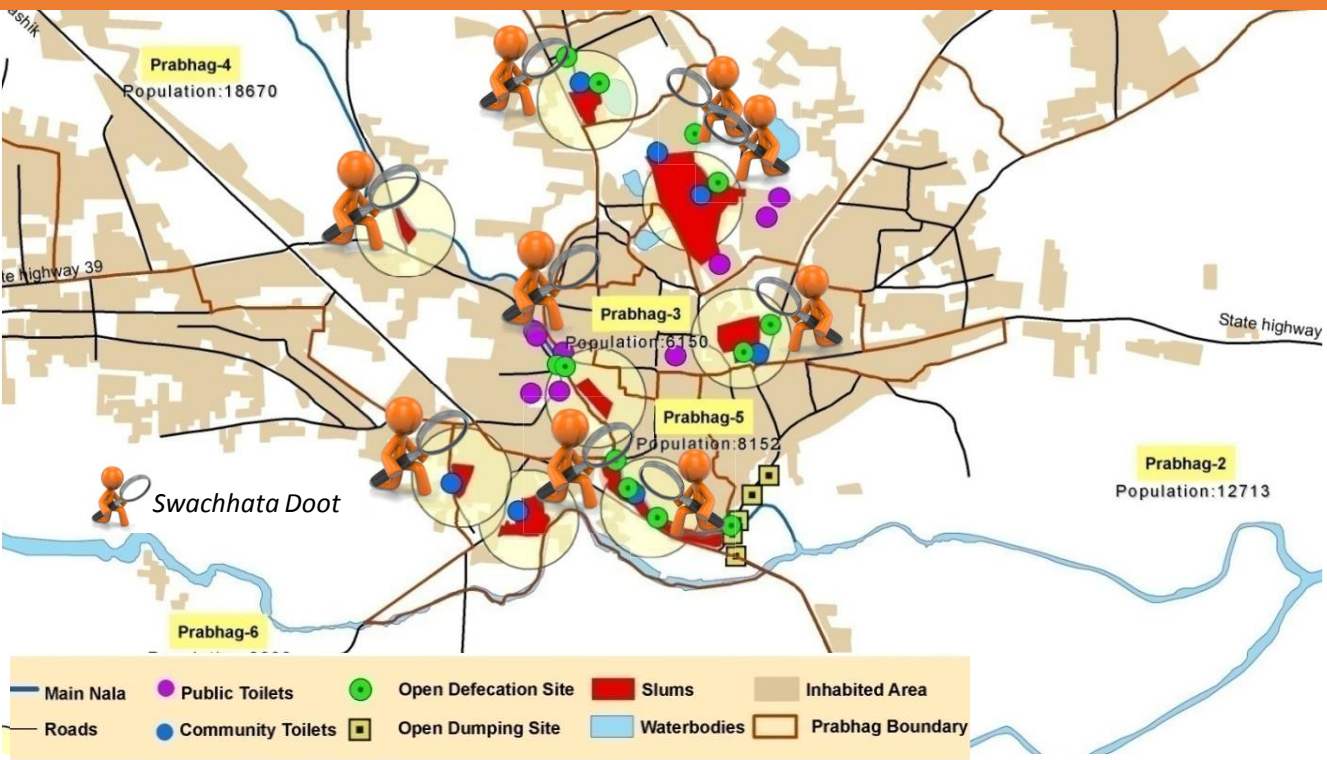
Instructions to be displayed on community toilets

A 8. Elimination of Open Defecation Practices

Open defecation practices can be eliminated only when access to safe sanitation facilities is made available …

- All likely OD spots in the city should be surveyed to assess reasons for open defecation in particular areas.
- Solutions should be identified to address location specific issues and work to implement them eg. provision of toilets, awareness generation to address behavioural issues etc.
- All open spaces in the city need to be maintained clean. Such spaces should be converted into parks, parking lots, play grounds or other recreational spaces.
- Fines/ Penalties should be lavied for defecating in the open based on legal provisions.
- Adopt innovative ideas like displaying photographs of people defecating in open, at public spaces, gifting flowers etc.

Monitoring of OD spots- Map the facilities and problem areas and then monitor the spots



- An in-house "OD Spot Monitoring Pathak", to make monitoring visits to all likely OD spots on a regular basis, in early morning and evening hours should be formed
- *Pathak* should start monitoring the spots and restrict people from defecating in the open only when access to clean and usable toilets is made available.
- NGOs/ CBOs / volunteers / senior citizens / *Swachhata Doots* in cities should be effectively engaged in monitoring open spaces / monitoring the *Pathak*. Incentives may be declared for them
- Best performer's / Swachhata Doot award for the members of *Pathak* should be announced

Solapur District Pattern of eliminating OD

Mission led by Chief Officers under the guidance of a district collector

- **Developed seven stepped action plan for preventing OD**
- **Strict restriction on open defecation automatically resulted into increased number of applications for toilets**
- **Adoption of innovative ideas including "name and shame"- displaying names and photographs on board at ULB**
- **Gift flowers**
- **Procession of person defecating in open**
- **Ward meetings, engaging students, support from Police**
- **Media coverage to create a buzz and maintain pressure on households for not defecating in the open**

All the actions led to zero open defecation and increased demand for toilets

Wai Pattern

Systematic Approach

Moving towards "own toilets" and implementing septage management plan

1 City Sanitation Plan in 2013

Assessment *Planning* *Financial Assessment*

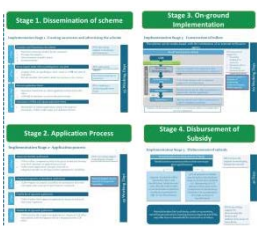
City Sanitation Plan *which focused* ***on universal access to sanitation*** *through* ***outcomes based option rather than technology based option*** *and to develop proposals which are* ***financially feasible for ULB***

2 Development of strategy

3 Household Level Assessment on PDAs

- ✓ Hand outs
- ✓ Rikshaw Announcement and Jingles
- ✓ Movie
- ✓ Posters an Banners
- ✓ Group Discussions
- ✓ Household Level Discussions and Surveys
- ✓ Ward Level Meetings by Elected Representatives
- ✓ SHG meetings

4 Development of Implementation mechanism



5 Awareness Generation Activities

6 Application Process – Generation of demand

7 Toilet construction and elimination of open defecation

8 Septage Management Plan under implementation

Sanitation Financing Options

- ULB level Subsidy, ✓
- Wai Swachhata Kosh, ✓
- "Sanitation Loans" at HH level ✓

Mahad Pattern

Efforts began in 1980s

Passion and leadership of the then President and equal response from council

- **Leadership of the then President (Advocate) in 1980s.**
- **Personal early morning visits to open spaces for preventing OD**
- **Publish photographs of people practicing OD in the newspapers**
- **Penalise or if required, file cases against them**
- **Mobilised private lands for construction of community toilets without any incentives**
- **Introduced group toilets for those who do not prefer CTs**

Early 1980s

ODF Initiative undertaken by President of MMC

- Social awareness and pressure through a strategy of photographing, publishing names and levying fines on those found defecating in open

Late 1980s onwards

Creation of Toilet Infrastructure

- Private landowners willingly surrendered land for CT
- Creating child friendly toilets, ensuring adequate seats and separate entry for women
- Making individual toilets compulsory for getting new building permissions in private premises

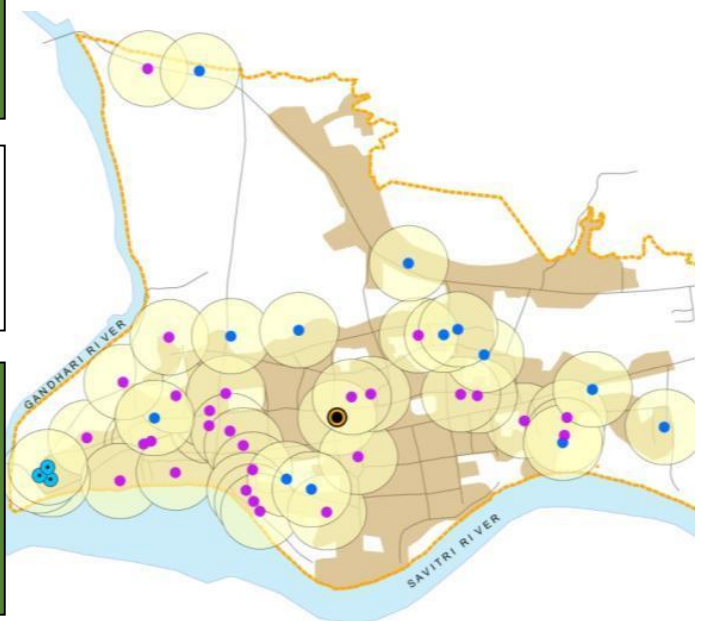
2007

Exhaustive "Toilet Survey"

- **Detailed information** on individual and community toilets – type, location, number, condition, ownership and waste disposal

2008- "Hagindari Mukta Yojana" (Open Defecation Free) Project initiated

- **Zone-wise inventory** of ODF sites and identification of people still practicing OD
- Repair, upgradation, reconstruction of community toilets in the city



2010 onwards

MMC Future Plans geared towards

- Support to construction of individual and CTs
- 'Pay and Use' model for public toilets
- Service contract to private contractors for O&M of community toilet blocks
- Levying sanitation charges under property tax

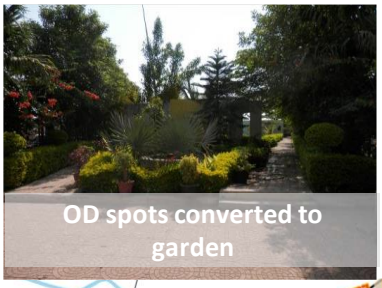
Efforts made by cities in the previous decades …

Cautious efforts showing gradual and permanent impact

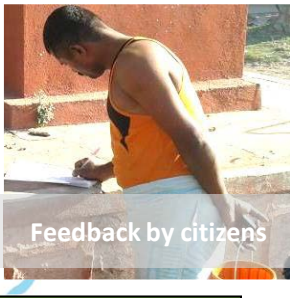
- Steps for preventing open defecation for improved health were taken since 1990s under the leadership of president and councillors
- Optimum use of Government schemes and missions to create sanitation facilities
- Implementation of GRs related to availability and improvement of sanitation facilities
- Prioritised provision and maintenance of community toilets
- Slogans on importance of toilets displayed at open spaces since decades
- Daily feedback by citizens on cleaning of CTs
- OD spots converted to Gardens and playgrounds

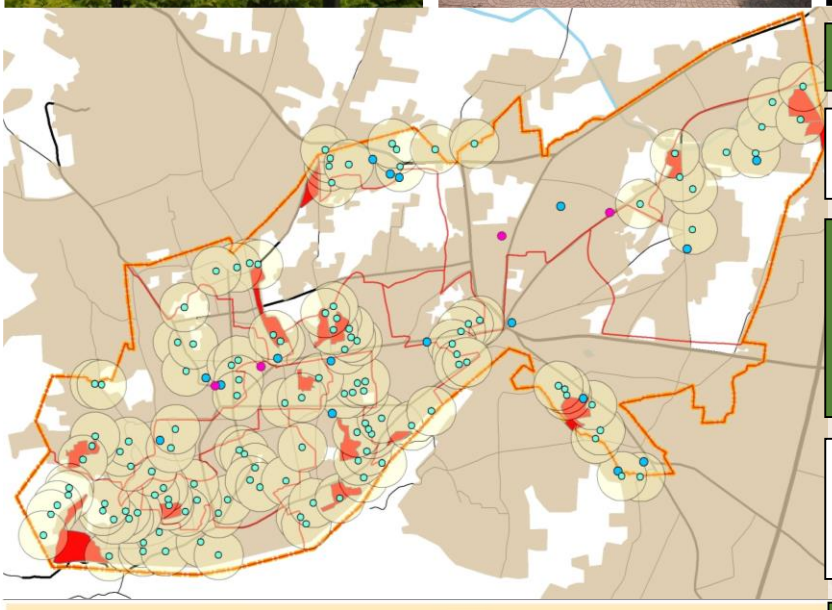
Special considerations for women toilets

Boards displayed since a decade


OD spots converted to garden


Slogans


Feedback by citizens



1990s: 'Ghar Tithe Shauchalaya' / ILCS to stop manual scavenging

Early 2000s: Shift towards sub-contracting
- Sub-contracting the maintenance of CTs
- New toilets constructed by councilors

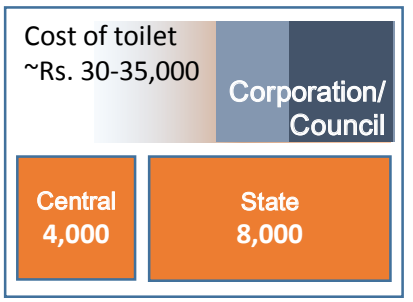
2005 onwards:
- Strategies for ODF - Punitive measures, construction of community toilets, IEC campaigns, social pressure, involvement of politicians, GR making 'Cleanliness Proof' mandatory for government employees
- The game changer- SGBSA awards for 3 years

2009–11: Crusade towards clean and ODF Satara
Political involvement in converting open plots to well maintained gardens, Clearing debris from open plots, Information dissemination via public banners, well monitored sub-contracts for CTs

2011 onwards: New initiatives
- Sanction of MSNA, IHSDP - Infrastructure and housing to all slum dwellers,

Innovative Financing

Articulate demand for toilets by making available options for funding the toilets



ULB level subsidy

- One of the key reasons behind absence of toilets at household level is lack of funds
- The gaps in cost of construction of toilets can be met with by extending ULB level subsidy to households
- GoM has issued a GR for providing additional subsidy upto Rs. 5000 from 14th FC funds, at ULB level

"Shahar Swachata Kosh"

- Potential CSR sources around your city should be approached
- Shahar Swachhata Kosh mechanism will enable local industrialists and other donors to effectively contribute to development of improved and universal sanitation in the city
- Funds in Shahar Swachata Kosh may support ULB in extending additional subsidy to households. It may also support in implementing other activities of mission e.g. Creating septage treatment facility

- ✓ *Sinnar and Wai Municipal Councils have established "Shahar Swachhata Kosh" to enable flow of CSR funds towards the target group*
- ✓ *Expenses from this account will be monitored by the committee of donors, councils, other social organisations and/or individuals from the city*
- ✓ *Regular reporting on expenses will be done to the donors in the form of QPR, to maintain transparency*

Sanitation Loans at Household Level

"Toilet Plans" for Self Help Groups (SHGs)

- Presence of financial institutions in the city and their willingness to introduce "toilet loans" to meet further gap in funding a toilet should be assessed. Microfinance institutions, banks, credit cooperatives, housing finance institutions should be consulted
- Assess willingness and capacities of households to take loans for constructing toilets
- Awareness should be generated amongst households towards prioritising own toilets and adopting an option of 'toilet loans' to meet the gap.
- Households' access to financial institutes should be facilitated by bringing institutions and households on one platform – city level fair etc.
- "Toilet Plan" can be prepared for SHGs in the city formed under Government schemes as well as with other Microfinance Institutions and Banks

Toilet Plans for SHGs underway in cities like Wai and Sinnar

Most of the women from BPL SHGs do not have toilets. They are well aware of the loan culture.

Lenders Fair at City Level:

- ✓ *A city level lenders' fair was conducted in Wai and Sinnar to create a common platform for financial institutions and potential beneficiaries to discuss their mutual requirements and interests.*
- ✓ *Simultaneously, councils are facilitating approval process to enable construction of toilets by taking loans*

SHG Fair in Sinnar for discussing "toilet Loans"

Assessment of financial resources for toilets

Factors	Self help groups (SHGs)	Micro-finance institutions (MFIs)	Credit societies	Commercial banks	Housing finance companies (HFCs)
Income Groups					
Very poor / BPL	🟢	🟡	🟡	🔴	🔴
poor	🟡	🟢	🟡	🟡	🔴
Other low income group	🔴	🟢	🟢	🟡	🟢
Middle income group	🔴	🟡	🟢	🟢	🟢
Housing Type					
Informal housing	🟢	🟡	🔴	🔴	🔴
Formal housing	🟢	🟢	🟢	🟢	🟢

ULB level subsidy linked to households

Multiple subsidy in case of 'group toilets'

- ULBs should explore the idea of linking subsidy to households instead of toilets, so that amount of subsidy per toilet increases along with the number of households ready to share a toilet..
- Group toilet can also address space related issues and is considered as 'improved sanitation'
- In case of issues like lack of space or lack of funds, idea of 'group toilet' may be explored by declaring incentive subsidies linked to households.

Group Toilet

D. Sustaining ODF Cities

Sustainability comes with systematic and cautious efforts made to achieve the success

Permanent Impact through permanent change-

Evidences show that only construction of toilets does not suffice for preventing open defecation. It is essential to eliminate such practices from their roots. One of the biggest hurdles so far has been lack of awareness about need of toilets for improved health. For ensuring sustainability, demand based approach is necessary , instead of a top-down approach. Efforts should be made to bring the permanent change in behaviour which leads to demand and therefore use of toilets.

Children need to be taught to use toilets and adopt healthy habits. This will help ensure sustainability of toilets in the future. 'Sanitation and Health' should be emphasised in the school curriculums

Focus on “Own Toilets”

Provision of community toilets is not a panacea. Non functionality and poor maintenance of community toilets as well as pressure on use of community toilets at peak hours often results into open defecation. Generating demand for own toilets is an ultimate solution to the problem. Hence it is essential to facilitate construction of own toilets as far as possible rather than opting for a convenient option of providing community toilets.

Inconvenience due to queues at peak hours

Women need to wait for morning to use community toilets

Health issues due to multiple use by unknown people

Regular Monitoring of Open Spaces and Community Toilets

Early morning and evening visits to likely OD spots need to be continued by council *pathaks*- initially on daily basis and then on periodic basis as per the need. Members of the pathak need to be encouraged to perform this activity regularly. Besides this, strategy for discouraging open defecation should include ward level monitoring by councillors, timely cleaning and development of open spaces, regular repair maintenance of community and public toilets, involvement of social organisations and individuals etc.

- Responsibility of monitoring OD spots can be shared with citizens for maintaining their areas free of open defecation.
- Monitoring and reporting mechanism should be created within the ULB –Registers / online platforms to note citizens’ feedback and complaints should be maintained. Complaints should be redressed on priority basis

Key Success Factors…

Local Leadership …

Implementation of mission needs an efficient leader to make it a success. It is only the council president or the city manager who knows his city well . It is solely their duty to take the required steps to achieve the SMMU targets through involvement of other stakeholders at appropriate stages. President and the Chief Officers of ULBs are key drivers of the mission at city level.

Knowledge Sharing and Daily Follow up..

Use of Social Media such as WhatsApp Groups are used for review and monitoring of SMMU at local , district and state level. Close monitoring and guidance by divisional commissioners and collectors is proved to be the key factor in achieving city level targets
eg. Solapur District, Nagpur District

Systematic Approach…

Sustainability comes with a systematic approach adopted towards achieving success. Mere provision of toilets is not the objective of the mission. It envisages “ODF Communities” by ensuring usage of toilets and total elimination of open defecation. For achieving these two objectives, it is important to develop a systematic action plan and follow it by engaging all stakeholders

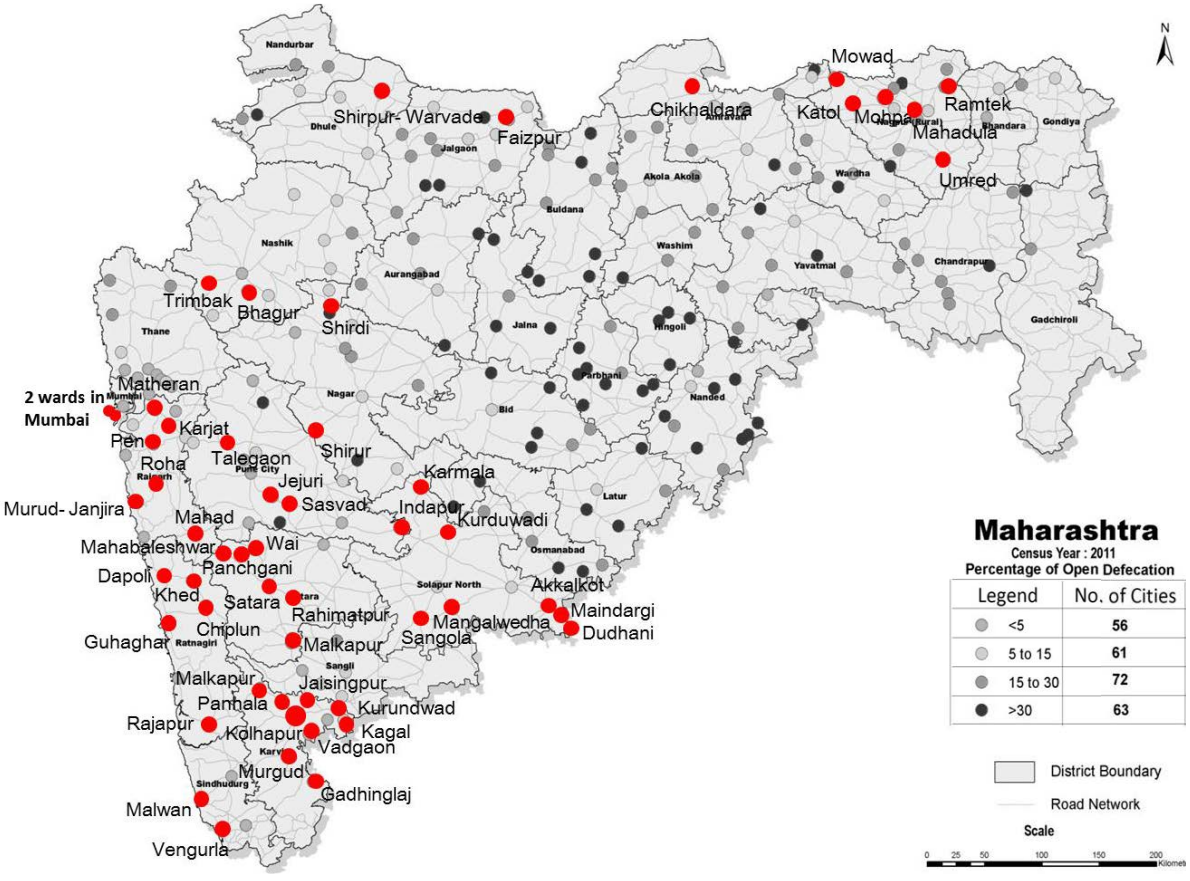
31st January 2016 - The Second Milestone

Total 52 cities in the State and two wards in the city of Mumbai have become ODF as on 31st January 2016. These cities will be awarded by the Hon. Chief Minister of Maharashtra for their efforts on 3rd February 2016.

GoM envisages ODF+ and ODF++ cities in upcoming years for which, support is provided to ULBs by conducting technical workshops and issuing guidelines for septage management in Maharashtra

51 councils and 1 corporation

have become ODF as on 31st January 2016



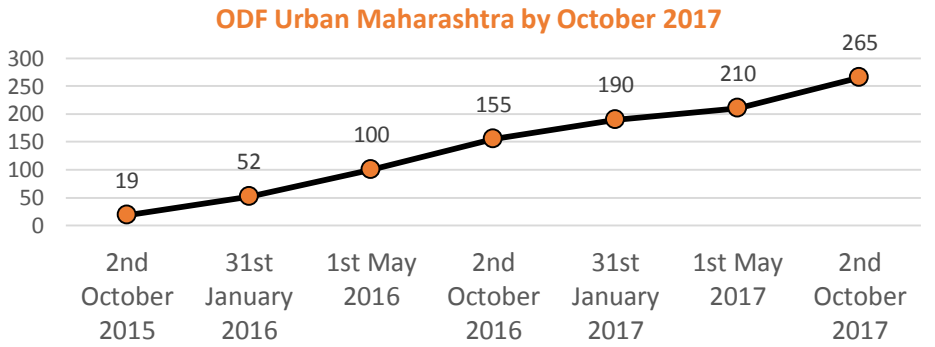
First 19 ODF cities are on the way towards ODF + cities...

E. Way Forward…

GoM is aiming for 3rd Milestone of

100 ODF Cities

by 1st May 2016



Government of Maharashtra has encouraged ULBs to set their targets to become ODF. ULBs have very passionately made commitments to make entire urban Maharashtra ODF by October 2017

19 ODF Cities moving towards ODF + and ODF ++ Cities

1st Step – workshop on "Implementing Septage Management Plan"
ULBs committed to making their cities ODF+ and ODF++

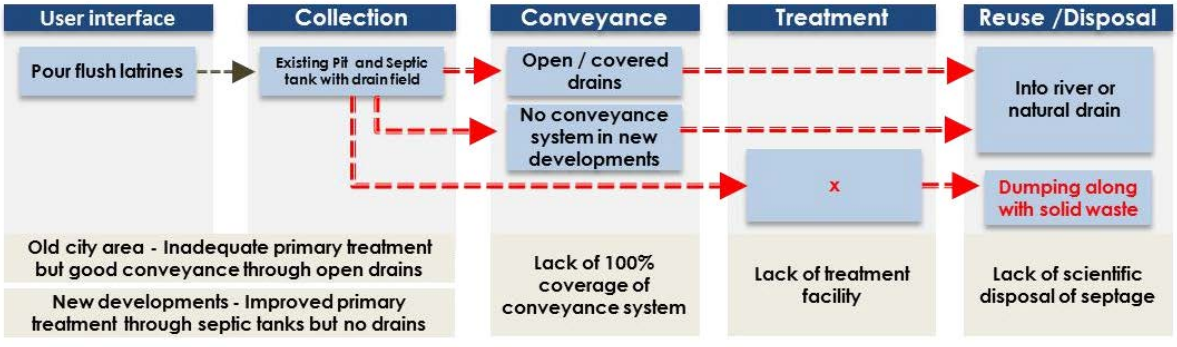
F. Moving Towards ODF + and ODF++ Cities

What are ODF + and ODF ++ Cities ?

1. Increased coverage of "own toilets"
2. Safe collection, conveyance and treatment of septage
3. Safe collection, conveyance and treatment of other waste water including effluent from septic tanks and grey water from kitchen and bathroom

Current status of septage management

in Small – Medium towns of Maharashtra



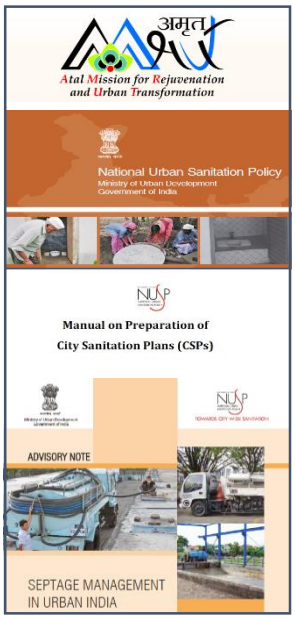
Emerging recognition of septage management at GoI level

- One of the major thrust areas of **AMRUT** is Septage Management

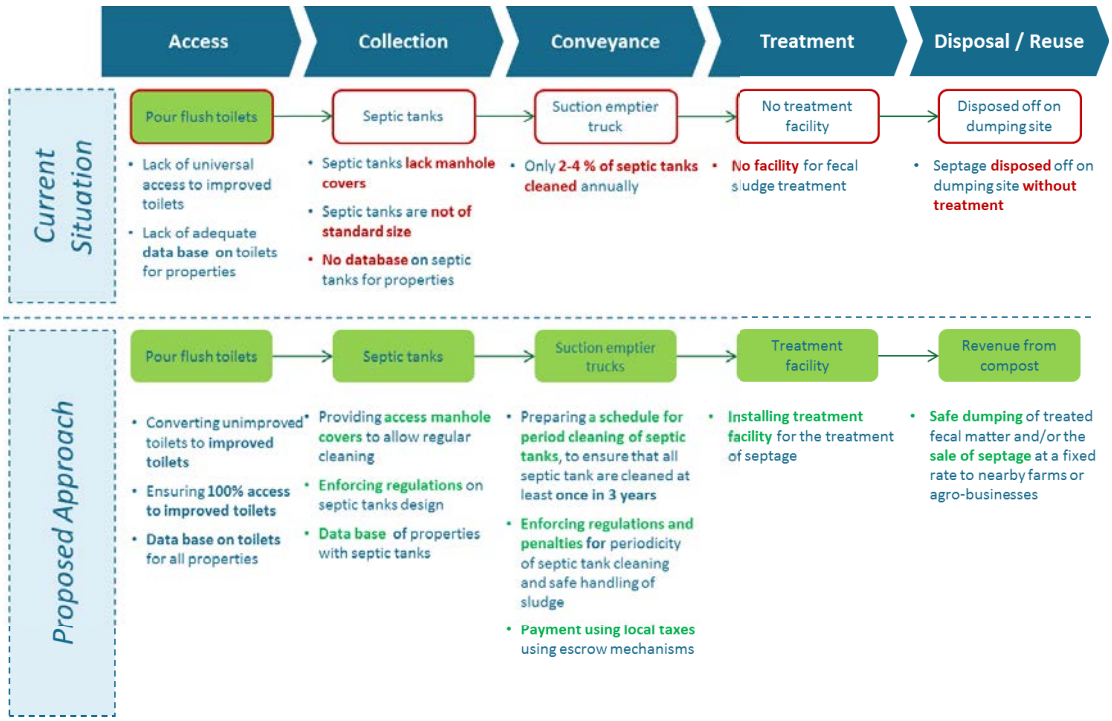
- **NUSP** has accorded high importance to plan and implement actions for the organized and safe management of fecal matter from on-site installations.
  - It highlights the importance of safe and hygienic facilities with proper disposal.
  - Recommends developing a Septage Management Plan (SMP) as a part of **city sanitation plans** (CSP)

- Septage Management **Advisory of Government of India** provides references to **CPHEEO guidelines, BIS standards**, and other resources for preparing SMP / FSM plan.

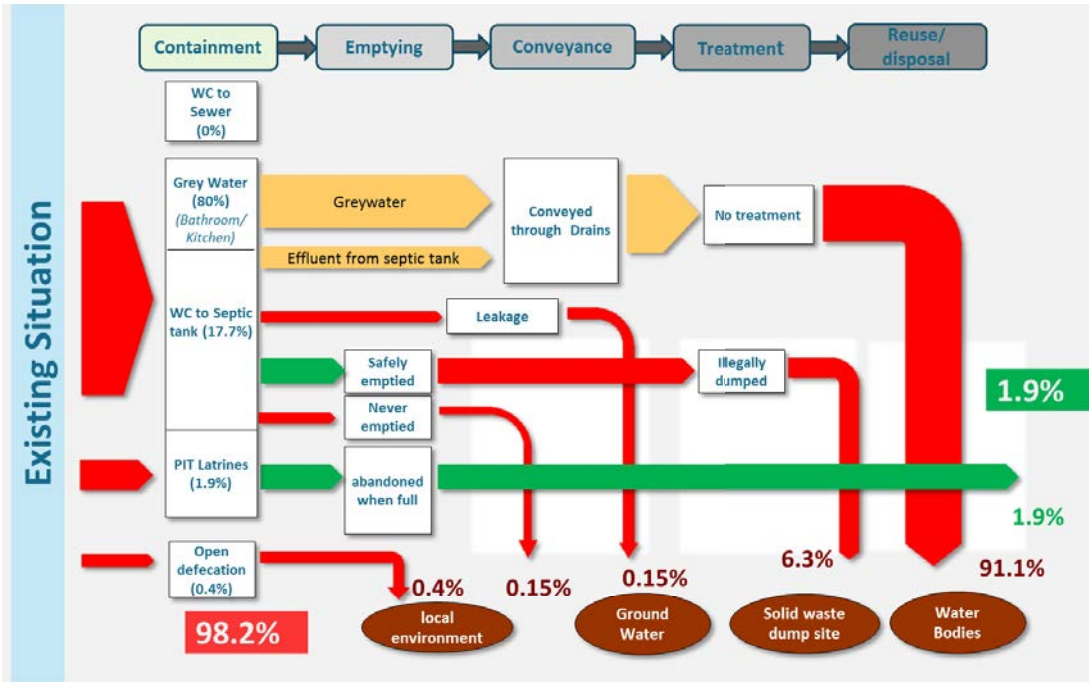
- **Niti Aayog's Report on SBM**, October 2015 – 14th FC funds to be utilised for Sanitation including Septage Management



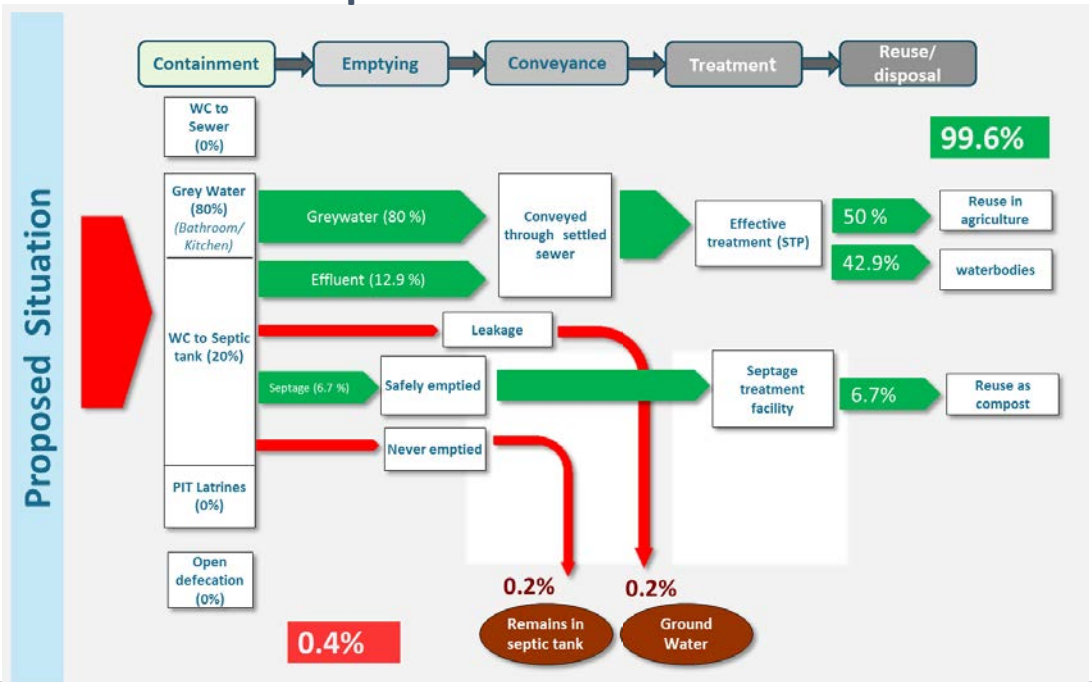
End-to-end IFSM solution – From red to green



Waste Flow- Current Situation in Small Towns



Waste Flow- Proposed Situation in Small Towns

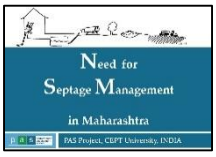


For more details, please refer to 'Guidelines for Septage Management in Maharashtra', published by GoM

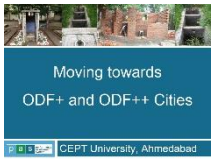
For more information, log on to :

www.swachh.maharashtra.gov.in
www.pas.org.in

How to make cities ODF
Stepwise approach at ULB level



Need of Septage Management
Reference to advisory and basics of septage management



Moving towards ODF+ and ODF++ Cities
Validation, Sustainability and Overview of ODF+ and ODF++ Cities

Journey towards becoming ODF city
Documentation of efforts made by Satara and Mahad Municipal Councils.

Urban Development Department
Government of Maharashtra

"India can not become a superpower with open defecation being witnessed in states"

This handbook is prepared in consultation with ***Urban Development Department, Government of Maharashtra****, with support from* ***CEPT University, Ahmedabad*** *and* ***All India Institute of Local Self Governments (AIILSG), Mumbai*** *under the* ***Performance Assessment System (PAS) Project****.*

Urban Development Department
Government of Maharashtra

सत्यमेव जयते

Government of Maharashtra

स्वच्छ भारत
एक कदम स्वच्छता की ओर

सप्तपदी स्वच्छतेची

हगणदारीमुक्त शहर

pas performance assessment system

Guidelines for Septage Management in Maharashtra

February, 2016

Swachh Maharashtra Mission (Urban)

Urban Development Department, Government of Maharashtra

Disclaimer

This report is compiled from various government reports and guidelines. It draws from the Ministry of Urban Development, Government of India's Advisory Note on Septage Management in Urban India-2013, manuals of Central Public Health Engineering and Environmental Organization, and Operative guidelines for septage management for urban and rural local bodies in Tamil Nadu.

The report is to be used solely as a reference guide by various stakeholders. Urban local bodies are advised to seek guidance and technical approval from appropriate authorities before implementation. The Urban Development Department, Government of Maharashtra and CEPT University are not responsible for the content or the consequences of any action taken on the basis of the information provided in this report.

Guidelines for Septage Management in Maharashtra

Table of Contents

Guidelines for Septage Management in Maharashtra

1 Septage Management and its importance

1.1 Introduction:

"Septage" is the liquid and solid material that is pumped from a septic tank, cesspool, or other treatment facility after it has accumulated over a period of time. A septic tank will usually retain 60 to 70% of the solids, oil, and grease that enter it. The scum accumulates on top and the sludge settles at the bottom, comprising 20 to 50% of the total septic tank volume when pumped. Septage has an offensive odor and appearance and contains significant levels of grease, grit, hair, and debris. It is a host for many disease-causing organisms.

Septage management Plan covers the entire service chain starting from design of septic tank, collection, conveyance, safe treatment and reuse or safe disposal of septage.

Proper treatment and management of faecal sludge is integral to safe sanitation practices. According to the Census 2011 around 30 million urban households, are not connected to any sewer system. Even if the cities create more underground sewerage infrastructure, the septic tank often remains an integral component of the sewerage scheme. A rapid assessment of septage management in Asia carried out by USAID in 2010 revealed that in India about 148 million people in urban areas depend on septic tanks. This was recognized by the National Urban Sanitation Policy (NUSP), 2008, which emphasizes the need for proper collection, treatment and disposal of sludge from on-site installations. In this context, more attention needs to be paid to proper construction of toilets and septic tanks, their maintenance and safe collection, conveyance and disposal of faecal sludge from these systems.

In addition to this, most urban local bodies (ULBs) in India do not effectively monitor the regular cleaning and maintenance of septic tanks. Some ULBs provide septic tank cleaning as a municipal service. This is generally treated as a

complaint redressal activity. So when the septic tank/pit overflows a complaint is registered with the ULB. However, many ULBs do not have adequate number of emptying trucks and are unable to provide prompt service. In many cities private players have filled this gap by providing these services. However, their fees are quite high and their services are not regulated. Disposal of collected septage/faecal sludge is not regulated, and sludge is dumped in open drains or in water bodies, or near garbage dumps. Such practices pose considerable health and environmental risks.

1.2 Current septage management practices and its need in Maharashtra

Septage management has been neglected in cities in Maharashtra, as in most Indian cities. The sector has not received any attention because of poor understanding of septage, lack of proper technical guidance, inadequate resources and skills, shortage of manpower and lack of finance.

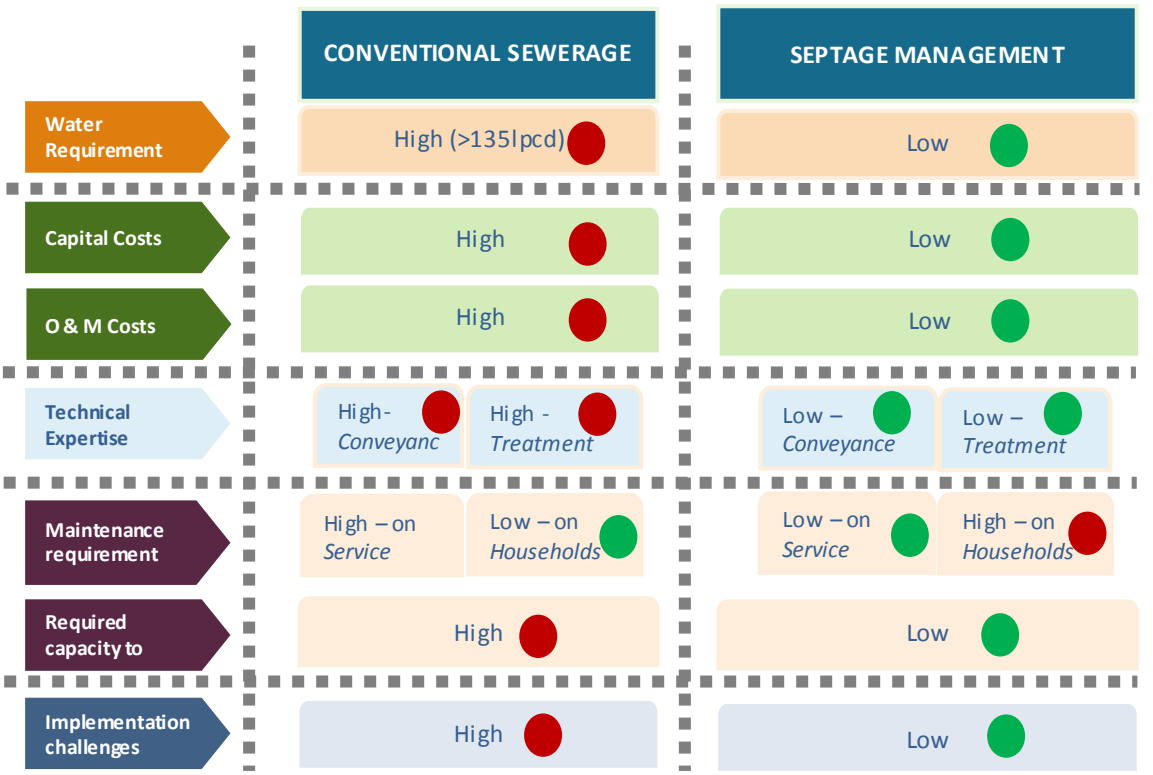
In Maharashtra, only 32 cities have at least a partial conventional underground sewerage system. Hence, the reliance on on-site sanitation systems is very high in state of Maharashtra However, most cities in the state depend on on-site technologies such as single pit, and twin-pit or septic tank based toilets. As per Census 2011, In Maharashtra, around 70% of households have individual toilets of which 53 % are connected to sewer network, 40 % to septic tanks and around 7% to pits and other systems. The toilets that are connected to septic tanks/ pits often discharge the effluent into road side open drains. As per CPHEEO norms septic tanks need to be cleaned periodically at an interval of 2-3 years (see for example Annexure 1. However surveys conducted in a few cities Maharashtra suggest that septic tanks/pits are emptied only once in 8 to 10 years and only when they overflow.

As per the Prohibition of Employment as Manual Scavengers (and their rehabilitation) Act, 2013, manual cleaning/emptying of pit toilets and septic tanks is prohibited. All ULBs are required to adopt mechanical processes for cleaning of pits/septic tank. Most ULBs in Maharashtra provide mechanised cleaning. However, since the tanks are emptied only once in 8 to 10 years, the sludge that is solidified at the bottom of the pit/septic tank is hard to remove

with the small powered emptier that is typically used. As a result, the pits/tanks are not emptied properly.

On the whole, sludge treatment the situation in Maharashtra is quite grim. Currently there is a lack of adequate infrastructure for adequate faecal sludge treatment in most Municipal councils. Even in cities that have sewerage network and functional sewage treatment plants (STPs), only 6 ULBs treat the septage/faecal sludge at the STPs.

The benefits of septage management over the conventional sewerage systems are as follows:



Recognizing the growing importance of safe faecal sludge management practices, there is an emerging need for framing an operative guideline for Septage management for ULBs

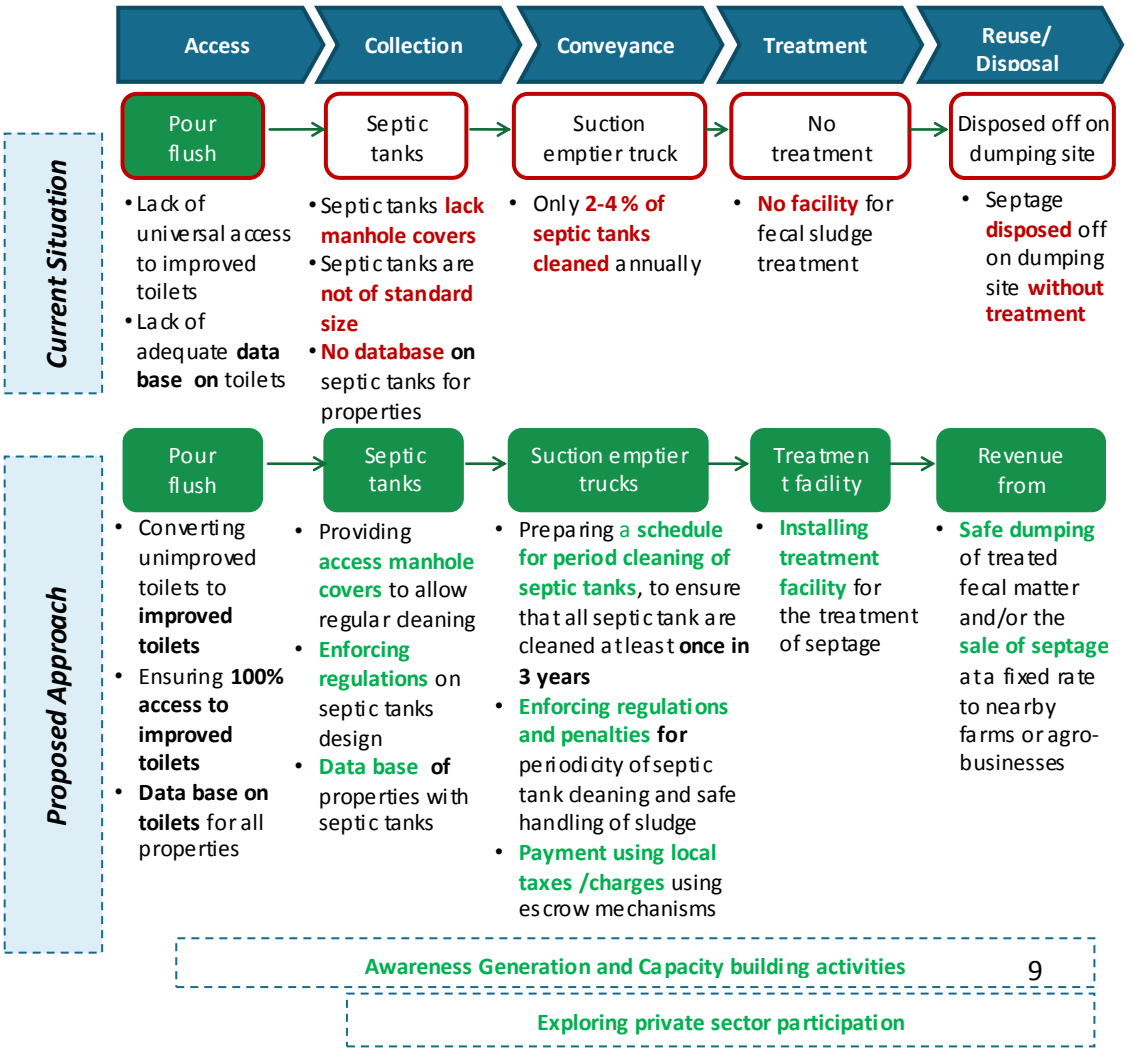
2 Objectives

The objective of this guideline is to facilitate all ULBs in Maharashtra to prepare an integrated faecal sludge management plan and implement a full septage management service in their cities. This would cover aspects across the service chain of on-site sanitation including safe collection, conveyance, treatment and disposal/reuse of the treated faecal sludge for all type of residential and non-residential properties (except industrial properties). These guidelines for seek to provide urban local bodies with knowledge and procedures of preparing a septage management plan. These guidelines also discuss other aspects related to regulation, monitoring and awareness generation that are needed in sustainable implementation of septage management in their cities. The septage management plan would help ULBs improve overall sanitation in their towns.

3 Guideline for ULBs for effective implementation of Septage Management Plan

Septage management Plan covers the entire service chain starting from design of septic tank, collection, conveyance, safe treatment and reuse or safe disposal of septage. The objective of these guidelines is to help city achieve improved sanitation situation in the city through implementation of septage management plan

The following figure depicts the existing situation assessment of on-site sanitation status across service chain in majority urban local bodies of Maharashtra and proposed framework for action to achieve improved sanitation through Septage management.



3.1 Step by step approach: Operationalize of septage management plan

The following is the step by step guide for effective implementation of septage management plan:

A. Preparation of plan for Septage management

1. Existing situation assessment across sanitation service chain
    - Steps for assessment of existing toilets and septic tanks and creation of database
    - Steps for Scheduled septic tank empting services
    - Steps for Planning of septage treatment facility
2. Explore private sector participation for septage management activities
3. Awareness generation and capacity building activities
4. Record-keeping , reporting (MIS), monitoring and feedback systems

B. Financial Resource Mobilization Plan

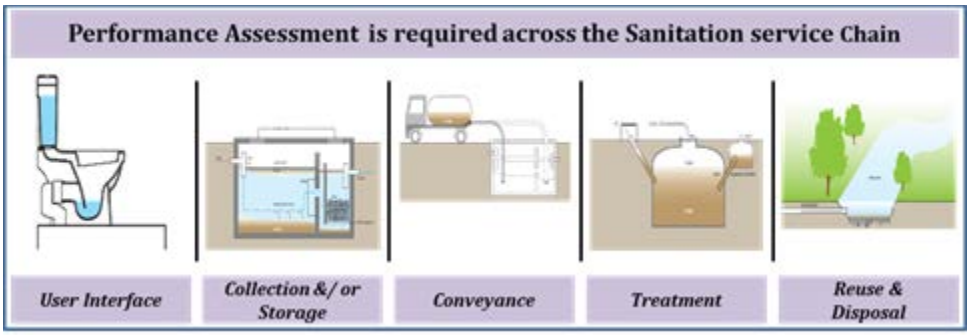
- Sources of revenues for septage management
- Mobilize financial resources to implement septage management plan

A. Preparation of plan for Septage management

1. Existing situation assessment across sanitation service chain

Assessing service performance across the service chain through a city level assessment is the first step in planning process. It is an important exercise, which provides an initial sense of the state of septage facility in the city, help in understanding the context and identifying gaps in key services.

The sanitation service chain considers the following 5 stages:



Detailed assessment of services will need to be done across each link in the chain through appropriate field assessments:

a) Access & Collection:

- **Access** describes the type of toilet and captures if the HH uses individual, shared or community facility. The choice of User Interface will depend on the availability of water. At city level it also measures the availability of public toilets. For sullage disposal, it captures access to bathroom facilities and drainage outlets.
- **Collection** and Storage/Treatment describes the ways of collecting, storing, and sometimes treating the excreta, grey water generated at the User Interface. The toilet may be connected to sewerage system; onsite systems like septic tank with soak pits, pits or may be functioning as Ecosan / composting toilets. Similarly for grey water disposal, the HHs may be connected to sewerage system or drains of any kind (Open/covered).

Steps for assessment of existing toilets and septic tanks and creation of database

a. City level assessment of coverage of toilet and on-site sanitation facility using the existing database (like property tax module, Census 2011 etc.) or based on recent survey carried out under SBM.
b. If the ULB do not have database, then ULB shall create database of toilets and septic tanks based on questionnare given in ***Annexure 2.*** All

ULB shall link the key result related to toilet availability, type of toilet and its connection with waste water outlet with property tax database on e-governance platform.

c. ULB shall keep updated database related to toilet availability and on-site sanitation through property tax assessment survey carried out at every four years of interval

d. Evaluate existing septic tank designs and other storage/treatment systems and modify (in case of variation) based on design mentioned in ***Annexure 1***.

e. Notices should be issued to all property owners whose septic tanks do not meet the standard septic tank design.

f. Identify insanitary toilets[1] and convert them to sanitary latrines for safe collection and disposal of waste as per norms set out in ***Annexure 1.***

g. All existing septic tanks should have access covers for each chamber, so that they can be easily opened during emptying process. Where such covers are not available, it should be made compulsory for all property owners to provide proper covers.

h. The new septic tanks need to be designed and constructed as per the norms suggested in National Building Code, 2005 and CPHEEO Manual, 2013 which takes reference of design norms from IS: 2470 on Code of practice for installation of septic tanks - Part 1: Design and Construction and Part 2: Secondary treatment and disposal of septic tank effluent 1985 (Reaffirmed 1996). The design norms CPHEEO Manual, 2013 is compiled in ***Annexure 1.***

b) Conveyance

Conveyance describes the transport of products across the service chain. ULB should plan for scheduled septic tank emptying services for effective implementation of septage management plan. Prior to plan for the same,

[1] Insanitary toilet / latrines in households are those where night soil is removed by human, serviced by animals or/and night soil is disposed into open drain or pit into which the excreta is discharged or flushed out, before the excreta fully decomposes. As mentioned in Swachh Bharat mission guidelines, single pit toilets will also be considered as an insanitary toilet/latrine.

ULB shall first assess its role and capacity for implementation of septage management plan. ULB should assess various aspects of septic tank empting like how many septic tanks required to be emptied annually as per CPHEEO norm versus how many are emptied in a year, how many vaccum emptying trucks/ capacity of trucks are required if number of septic tank emptied as per CPHEEO norm versus how many trucks are available/working with capacities of emptier trucks, assessing the cost per emptying visit, method of maintaining the register for septic tank emptying services database etc.

If private player is involved in septic tank emptying business in the city, then, ULB shall also review the role of private septic tank emptier and assess their capacity in lines with the number of septic tank empting annually, charges/fees for empting services, location of disposal, registration/licensing with ULB or not etc.

Steps for Scheduled septic tank empting services

a. ULBs should initiate pre-determined scheduled septic tank empting services and develop a route plan for the same.
b. Mobilize or procure adequate number of suction emptier trucks to maintain a three year rotating cycle. Number and type of vehicles to be purchased based on the sizes of septic tanks or septage generation rate[2] for the city, distance from the location of septic tanks to the septage treatment facility, cleaning frequency of septic tanks and available road width for the suction truck operations.
c. ULBs should either provide the emptying services themselves or enter into appropriate management contracts with private agencies. In case of private sector contract, ULBs should certify and license private septage transporters to de-sludge and transport waste to the

[2] Septage generation rates vary widely from place to place depending on practices of septic tank use, number of users, water used for flushing, and the frequency of cleaning the septage. Adopting the (U.S. EPA, 1984) estimate of septage generation of 230 litres/year and an average household size of four, the septage generation/ household would be 920 litres/year. So for a three year cycle the septage generation rate would be 2760 litres or 2.76 cum. Alternatively, assuming an average septic tank volume of 3 m3 and emptying of septage when one-third of the septic tank is filled with settled solids, the volume of septage emptied would be 1 m3.

designated treatment facility. The license/septage transporter permit is detailed out in ***Annexure 3.1*.**

d. All septage transporters need to maintain a collection and transport receipt such as the one detailed out in ***Annexure 3.2***. This needs to be filled duly by the private / ULB service provider and submitted to ULB office.

Measures to be taken during Desludging of septic tanks

a. While desludging the following norms should be followed:
    - The septic tanks should not be fully emptied; small amount of sludge of around 1 to 2 inches should be left in the septic tank to facilitate decomposing of incoming faecal waste.
    - No fire or flame should be used near the septic tanks as there may be inflammable gases inside septic tanks
    - Proper safety gears should be used by the operator while desludging / emptying the septic tanks
b. Septage transportation vehicle operators (whether from ULB or private sector) should be well trained and equipped with protective safety gears, uniforms, tools and proper vacuum trucks, to ensure safe handling of sewage/septage. The rules under the Prohibition of Employment as Manual Scavengers and their Rehabilitation Act, 2013 provide for a comprehensive list of safety gear that should be used while providing these services. The operating procedure for cleaning of septic tanks is detailed out in ***Annexure 3.3.***

c) Treatment and disposal

Treatment: ULB must not dispose the septage collected from septic tank without any treatment and ULB must comply with CPCB and MPCB norms before disposal of septage. ULB should assess the load of septage and assess the requirement of capacity for treatment plant. ULB should first try and assess the possibility of setting up septage treatment facility at the solid waste treatment/disposal site and at the STPs within the city or in nearby city.

Reuse/disposal refers to the methods in which products are ultimately returned to the environment, as either useful resources or reduced-risk materials. The

treated septage can be used as a soil enricher or as filling material at construction sites. ULB should carry out primary assessment for availability of market and demand for reuse.

Steps for Planning of septage treatment facility

a. Septage collected from the septic tanks or pits should not be disposed without any treatment.

b. ULB should first assess the possibility of septage treatment at existing STP in the city or STP of nearby city through appropriate agreements with STP operators and receiving ULBs. A list of cities that have STPs in Maharashtra is given in ***Annexure 4.***

c. If STP is not available in the city or nearby that can receive the sludge, then ULB should plan for new septage treatment facility. Various treatment options are given in ***Annexure 5.*** Such a new septage treatment facility should be designed to cater to expected volumes of septage generated in urban local body and if faecal waste is expected from nearby urban local bodies.

d. Input quality of the collected septage should be tested at the treatment facility for checking presence of any metal or traces of industrial waste.

e. The faecal sludge treatment plant should be operational during working hours only and a responsible person should be appointed in the facility to ensure that no commercial or industrial waste is unloaded in these facilities.

f. Septage should be reused / safely disposed only after it meets the parameters mentioned in **Annexure 6**. Various possible reuse options are outlined in ***Annexure 6.***

Measures to be taken while planning for Septage treatment facility

Identification of septage treatment site [3] is crucial for effective implementation of septage management plan. Following parameters to be taken into consideration before finalization of treatment sites:

[3] Referred to: Faecal Sludge Management: Systems Approach for Implementation and Operation, Linda Strande, Mariska Ronteltap, Damir Brdjanovic, IWA 2014

Distance of treatment site: Distance from emptying to delivering and accessibility of the treatment site are major issues. The transport of relatively small fecal sludge volumes (5-10m^3 per truck) on congested roads over long distances in large urban areas is financially unfeasible. A site that is too far away implies fewer trips per day, less revenue and more fuel costs to private operators.

Reliability of electricity: It is also important to assess the availability and reliability of electricity if treatment technology has mechanical operated parts; as in case of fluctuations it will increase treatment time and will affect optimal utilization of treatment capacity.

Neighborhood: A treatment site may generate nuisance, especially bad odors. For this reason it should be located at an appropriate distance from the residential areas.

Land availability: Projects are often delayed because of non-availability or high price of land. ULB should identify the land bank for treatment facility. ULB should also explore the possibility of developing septage treatment facility at solid waste dumping or treatment site.

Geological Parameters: Assessment of existing geological conditions on site like groundwater table, type of soil, prone to flooding is always recommended as it may directly affect selection of technology option.

Indicative Decision making framework for Evaluation of Septage treatment site

Sr. No.	Particulars	Unit	Treatment location 1	Treatment location 2	Treatment location 3	Treatment location 4
Identification of treatment sites						
1	Distance of existing septage disposal site	km				
2	Distance of SWM treatment or disposal facility	Km				
3	Type of SWM treatment facility					
4	Average distance and duration of emptying trip	Km & mins.				
5	Electricity availability					
6	Neighborhood (Residential/ institutional/commercial/ irrigation/farming areas)					
Land availability						
7	Government or private land					
8	Available/ Non-available for developing site					
Geological parameters						
9	Water table	**mt**				
10	Type of soil					
11	Prone to flooding	**Yes/No**				

2. Explore private sector participation for septage management activities

For effective operationalize of scheduled septic tank emptying service and treatment facilities, ULB may also explore the option for private sector participation. Following points to be taken into consideration by ULB:

a. Explore private sector participation for various activities like procurement, operations and maintenance of the suction emptier trucks, construction and operations of septage treatment facility and possible re-users of treated septage within the city as well as in nearby cities.
b. Develop performance based contracts such that payment is linked to the performance of private sector for providing the services.

3. Awareness generation and capacity building activities

Awareness generation activities need to be taken up for successful implementation of faecal sludge management plan and community acceptance and adherence to regulations and service plan set up by the ULBs. Associated training and capacity building of municipal staff as well as private sector contractors also needs to be taken up.

a. **Awareness generation for residents**: Members of Resident Welfare Associations, community organizers, self-help groups and the general public should be made sensitized periodically regarding the need for a sound faecal sludge management system including a 3-year cycle. The health hazards associated with improper collection and treatment of waste, and the ill-effects of sewage discharge into fresh water/storm water drains should be explained to the residents. Sample material for awareness generation is in ***Annexure 7.*** Awareness generation activities should be carried out at the beginning of introducing a scheduled service in all wards and then repeated periodically over the three year cycle.
b. **Capacity building for municipal staff**: Municipal Commissioners/ Chief Officers, Engineers, Sanitary Inspectors, Health Officers, and Sanitary Workers should be well trained in safe septage management and its best practices. This involves regular training sessions on safe collection, treatment and disposal. Information regarding standard septic tank

design, the need for periodic inspection and desludging of septage, design of a treatment facility, tender details for engaging licensed transporters, etc. should be disseminated widely to achieve a safe faecal sludge management system. Training should also be provided on safety standards.

c. **Capacity building for septage transporters / private vendors**: Local Bodies should ensure all safety norms are clearly explained to the septage transporters. Private Operators and Transporters should be well trained in safe collection and transportation of sewage including vehicle design, process of desludging, safety gears and safe disposal at the nearest treatment facility.

4. Record-keeping, reporting (MIS), monitoring and feedback systems

a. **Recordkeeping and manifest forms** should be an integral part of a comprehensive septage management program. Recordkeeping requirements should be codified into the law governing the program. A sample manifest form is detailed out in ***Annexure 3.2***

b. The completed document or documents with signatures of the household/property, suction truck operator and treatment plant operator should be submitted to the local government for their records. Payment to the suction truck operator should only be made if there are signatures of all the stakeholders. A possible monitoring framework for septic tank emptying services is detailed out in ***Annexure 8***

c. An **MIS system** such as the one discussed in access and collection will need to be developed and maintained.

d. Where possible, **GIS** should be used to be plan the route of suction emptier trucks and tracking these for regular record keeping.

e. **Consumer grievance redressal system** for faecal sludge management should also be set up as a part of urban local body record keeping systems and helpline numbers to be shared with residents as a part of monitoring and record keeping systems for faecal sludge management.

B. Financial resource mobilization

1. Sources of revenues for septage management

a. **Sanitation tax/ charge** should be levied on all the properties for sustaining the septage management activities. The tax/ charge can be added either as surcharge on property tax or a new sanitation tax/ charge can be levied under the Maharashtra Municipal Councils, Nagar Panchayats and Industrial Townships Act, 1965, Chapter IX: Municipal taxation, Section 108.

b. If ULB explore the possibility of Private sector involvement in septage management, then an **escrow account** can be set up where revenues from the sanitation tax/ charge are transferred. The contractual amount for FSM services to the private party can be paid from this escrow account to avoid delays.

c. **Periodic revisions for the taxes/ charges** to be effected based on revisions in costs involved

d. To the extent possible, revenues should be generated from **sale of treated septage** for agriculture or other purposes.

2. Mobilize financial resources to implement septage management plan

a. ULB may utilize the funds from 14th FC to implement the various components related to septage management plan. Creation of database for toilets and septic tanks, procurement of suction emptier trucks and construction of septage treatment facilities are the permissible components to utilize the 14th FC funds. The funds would also be provided as preparatory activity like preparing detailed project report and prefeasibility report for septage management.

b. **IEC & Capacity building funds:** IEC funds under SBM shall be utilized for various awareness generation activities undertaken for implementing septage management plan includes capacity building activities for ULB staff, septage transporters, treatment plant operators and residents of city.

c. Convergence with existing schemes/activity: If any ULB is going to undertake the water audit survey under MSNA or survey under SBM or property tax assessment etc, then ULB should integrate the sanitation survey with the respective activity.

Annexures

1. Conventional septic tank design as per CPHEEO, 2013[4]

1.1 Conventional septic tank

A septic tank is a combined sedimentation and digestion tank where the sewage is held for one to two days. During this period, the suspended solids settle down to the bottom. This is accompanied by anaerobic digestion of settled solids (sludge) and liquid, resulting in reasonable reduction in the volume of sludge, reduction in biodegradable organic matter and release of gases like carbon dioxide, methane and hydrogen sulphide. The effluent although clarified to a large extent, will still contain appreciable amount of dissolved and suspended putrescible organic solids and pathogens.

Therefore, the septic tank effluent disposal merits careful consideration. Due to unsatisfactory quality of the effluent and also the difficulty in providing a proper effluent disposal system, septic tanks are recommended only for individual homes and small communities and institutions, whose contributory population does not exceed 300. For larger communities, septic tanks may be adopted with appropriate effluent treatment and disposal facilities. However, in both cases the sewage from the septic tank should be discharged into a lined channel constructed along with storm water drain as an interim measure till a proper sewerage system is laid. The outfall from such drains should be connected to a decentralised or centralised sewage collection system.

1.2 Design

Several experiments and performance evaluation studies have established that only about 30% of the settled solids are anaerobically digested in a septic tank. In case of frequent desludging, which is necessary for satisfactory effluent quality, still lower digestion rates have been reported. All these studies have proved that when the septic tank is not desludged for a longer period i.e., more

[4] Source: Central Public Health and Environmental Engineering Organization (CPHEEO) and Japan International Cooperation Agency. (2013). Manual on Sewerage and Sewage Treatment Systems, Part A – Engineering, Chapter 9 – Onsite Sanitation, Page no: 9-15 to 9-21.

than the design period, substantial portion of solids escape with the effluent. Therefore, for the septic tank to be an efficient suspended solids remover, it should be of sufficient capacity with proper inlet and outlet arrangements. It should be designed in such a way that the sludge can settle at the bottom and scum accumulates at the surface, while enough space is left in between, for the sewage to flow through without dislocating either the scum or the settled sludge. Normally, sufficient capacity is provided to the extent that the accumulated sludge and scum occupy only half or maximum two-thirds the tank capacity, at the end of the design storage period. Experience has shown that in order to provide sufficiently quiescent conditions for effective sedimentation of the suspended solids, the minimum liquid retention time should be 24 hours. Therefore, considering the volume required for sludge and scum accumulation, the septic tank may be designed for 1 to 2 days of sewage retention.

The septic tanks are normally rectangular in shape and can either be a single tank or a double tank. In case of double tank, the effluent solids concentration is considerably lower and the first compartment is usually twice the size of the second. The liquid depth is 1-2 m and the length to breadth ratio is 2-3 to 1. Recommended sizes of septic tanks for individual households (up to 20 users) and for housing colonies (up to 300 users) are given below in table below

Table 1: Recommended size of septic tank up to 300 users ***(Source CPHEEO, 1993)***

No. of Users	Length(M)	Breadth(M)	Liquid Depth (Cleaning interval of)	
			2 Years	3 Years
Recommended size of septic tank up to 20 users				
5	1.50	0.75	1.00	1.05
10	2.00	0.90	1.00	1.40
15	2.00	0.90	1.30	2.00
20	2.30	1.10	1.30	1.80
Recommended size of septic tank for housing colony upto 300 users				
50	5.00	2.00	1.00	1.2
100	7.50	2.65	1.00	1.2
150	10.00	3.00	1.00	1.2

No. of Users	Length(M)	Breadth(M)	Liquid Depth (Cleaning interval of)	
			2 Years	3 Years
200	12.00	3.30	1.00	1.24
300	15.00	4.00	1.00	1.24

Note 1: The capacities are recommended on the assumption that discharge from only WC will be treated in the septic tank
Note 2: A provision of 300 mm should be made for free broad.
Note 3: For population over 100, the tank may be divided into independent parallel chambers of maintenance and cleaning.
Note 4: The sizes of septic tank are based on certain assumption on peak discharges, as estimated in IS: 2470 (part 1) and while choosing the size of septic tank exact calculations shall be made

1.3 Construction details

The inlet and outlet should not be located at such levels where the sludge or scum is formed as otherwise; the force of water entering or leaving the tank will unduly disturb the sludge or scum. Further, to avoid short-circuiting, the inlet and outlet should be located as far away as possible from each other and at different levels. Baffles are generally provided at both inlet and outlet and should dip 25 cm to 30 cm into and project 15 cm above the liquid. The baffles should be placed at a distance of one-fifth of the tank length from the mouth of the straight inlet pipe. The invert of the outlet pipe should be placed at a level 5 to 7 cm below the invert level of inlet pipe. Baffled inlet will distribute the flow more evenly along the width of the tank and similarly a baffled outlet pipe will serve better than a tee-pipe.

For larger capacities, a two-compartment tank constructed with the partition wall at a distance of about two-thirds the length from the inlet gives a better performance than a single compartment tank. The two compartments should be interconnected above the sludge storage level by means of pipes or square openings of diameter or side length respectively of not less than 75 mm. Every septic tank should be provided with ventilation pipes, the top being covered with a suitable mosquito proof wire mesh. The height of the pipe should extend at least 2 m above the top of the highest building within a radius of 20 m. Septic tanks may either be constructed in brick work, stone masonry or concrete cast

in situ or pre-cast materials. Pre-cast household tank made of materials such as asbestos cement / HDPE could also be used, provided they are watertight and possess adequate strength in handling and installing and bear the static earth and superimposed loads. All septic tanks shall be provided with watertight covers of adequate strength. Access manholes/covers (minimum two numbers one on opposite ends in the longer direction) of adequate size shall also be provided for purposes of inspection and desludging of tanks. The floor of the tank should be of cement concrete and sloped towards the sludge outlet. Both the floor and side wall shall be plastered with cement mortar to render the surfaces smooth and to make them water tight. A typical two compartment septic tank is shown in figure below

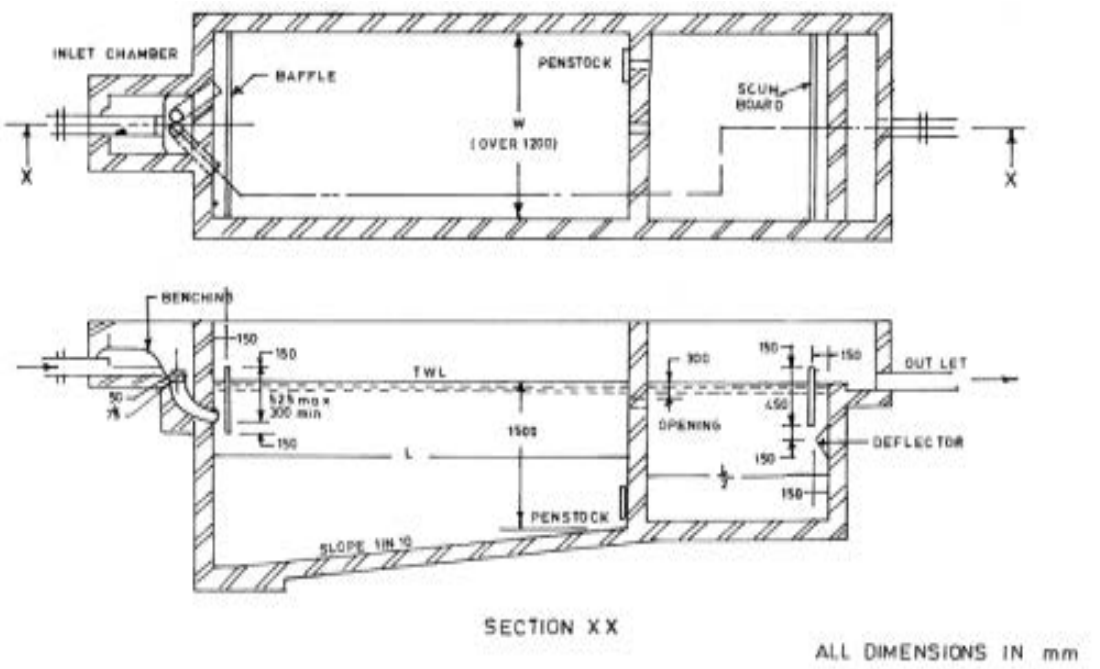


Figure 1: Typical sketch of 2 compartment septic tank for population over 50 (Source: CPHEEO, 1993)

Annexure 2. Questionnaire for septage management database creation[5]

Q No	Question		Options
1	Form id		
2	Locality type	1	Slum
		2	Non-Slum
3	What is the name of the locality?		Locality Name _____
4	Ward no:	1	Number ____
5	Property number as per Council property tax records:	1	Number ____
6	Status of property during the survey	1	Open
		2	Locked
		3	Vacant
7	Type of Property	1	Residential
		2	Institutional
		3	Commercial
		4	Mixed
8	Mark the house typology (only if 7 = Residential)	1	Bungalow
		2	Apartment
		3	Row House
		4	Wada
		5	Chawl
		6	Hut
		7	Others, specify _____
9	Select the type of Institution (only if 7 = Institutional)	1	Hospital
		2	Dispensary
		3	School/College
		4	Religious Institutions
		5	Government Office
		6	Others, specify _____
10	Select the type of commercial	1	Industry

[5] Source: Questionnaire developed by CEPT University / AIILSG

Q No	Question		Options
	(only if 7 = Commercial)	2	Shop
		3	Hotel / Lodge
		4	Others, specify _____
11	Name of Apartment/Building:		
12	Number of Blocks		Number
13	Name of the respondent/ building secretary:	1	First name _____ Middle name _____ Last name _____
14	Contact no. of building secretary:	1	Number ____
15	How many flats are there in this apartment?	1	Number ___
		2	Don't know
16	How many toilets are there in this property?	1	Number ____
		2	Don't Know
17	Number of flats that are occupied	1	
18	How many households are there on this property?		Number ___
19	Name of the respondent/Head of the Household	1	First name _____ Middle name _____ Last name _____
20	Pl provide a mobile Contact no. of head of the household	1	Number ____
21	What is the tenure status of this property?	1	Owner occupied
		2	Tenant occupied
22	Pl provide the name of the owner of this property:	1	Name _____
	-	2	Don't Know
23	Pl provide a mobile contact no. of owner	1	Number ____
		2	Don't Know
24	How many persons are there in this household? (for Commercial, approx numbers of toilet users)		children (less than 6 year):___, Other Male: ___ Other female: ___
25	Do you have your own toilet on your premises?	1	Yes
		2	No
26	What is your own toilet	1	Sewer Network

Q No	Question		Options
	connected to for disposal?	2	Septic tank with soak pit
		3	Septic tank connected to open/closed drain
		4	Single Pit
		5	Double pit
		6	Directly to open/closed drains
		7	Others, specify _____
27	No. of septic tanks in the property	1	1
		2	2
		3	3
		4	Don't Know
28	Type of septic tank: 1. Individual 2. Shared	1	Individual
		2	Shared
29	This property shares septic tank with: _____		
30	What is the shape of your septic tank	1	Rectangular
		2	Circular
		3	Don't Know
31	Provide dimensions:	1	Don't know
	("L" relevant only if rectangular)	2	Length (ft.) _____
	-	3	Breadth/Diameter (ft.) _____
	-	4	Depth (ft.) _____
32	Septic tank outfall is connected to	1	Soak pit
		2	Open drain
		3	Covered drain
		4	Open land
		5	Others, specify
		6	Don't Know
33	When was the septic tank emptied the last time?	1	Last 6 months
		2	From 6 to 12 months
		3	12-24 months
		4	24-36 months
		5	More than 36 months
		6	Never emptied

Q No	Question		Options
		7	Don't know/Remember
34	Why was the septic tank emptied?	1	Blocked toilet
		2	Overflow from access hole/manhole
		3	Smell
		4	Others, specify
		5	Don't know/remember
35	Were there any problems during emptying of septic tanks?	1	Access or distance for suction truck to house
		2	Break floor tiles to access septic tank
		3	Break concrete manhole to access septic tank
		4	Difficult to locate the septic tank
		5	Smell during emptying
		6	Made a mess
		7	No problem found
		8	Others, specify
		9	Don't know
36	Is the septic tank accessible from road for cleaning by using a suction emptier truck?	1	Yes
		2	No
37	Is there proper access with manholes/covers for any of the chamber of septic tank which can be easily opened	1	Yes
		2	No
B	GPS Location ID		
C	Photographs		

Annexure 3. Scheduled septic tank emptying services

3.1 Septage transporter permit (License)[6]

Septage Transporter Permit for _____ Municipality

In accordance with all the terms and conditions of the current _____ Municipality's Rates, Rules and Regulations, the special permit conditions accompanying this permit, and all applicable rules, laws or regulations of Government of Maharashtra, permission is hereby granted to:

NAME OF PERMITTEE:

_____

ADDRESS:_____

_____

For the disposal of septage from domestic septic tank or commercial holding tank at the_____ treatment facility.

This Permit is based on information provided in the Septage Transporter Permit application which constitutes the Septage Management Hauled Permit.

This Permit is effective for the period set forth below, may be suspended or revoked for Permit Condition Non Compliance and is not transferable. The original permit shall be kept on file in the Permittee's office. A copy of this Permit shall be carried in every registered vehicle used by the permittee.

EFFECTIVE DATE:

EXPIRATION DATE:

____ CHECK IF RENEWED PERMIT

Permit is liable to be cancelled in case of violations of any Acts, Rules and Regulations relating to the operation of Septage System or in cases of safety protocols not being adhered to or in case of non-permitted disposal.

[6] Source: Operative guidelines for septage management for urban and rural local bodies in Tamil Nadu.(2014)

3.2 Collection and transport records form / manifest forms[7]

Sample Form to be filled by Operator / Transporter of Septage

i. Identification of Waste:

a) Volume _____
b) b) Type: ____ Septic Tank ____ Others
c) c) Source: ____ Residential ____ Commercial ____ Restaurant ____ Portable Toilet ____Others

ii. Details of Waste Generator

a) Name:
b) Phone Number:
c) Address:
d) Pin:
e) Property tax no.:
f) Any kind of deficiencies, missing pipes or fittings, improper manholes or access covers, any other cracks or damage observed: _____

The undersigned being duly authorized does hereby certify to the accuracy of the source and type of wastewater collected and transported.

Date: _____ Signature: _____

iii. Details of Transporter / Operator

a) Company Name:
b) Permit:
c) Vehicle License:
d) Pump out date:

The above described wastewater was picked up and hauled by me to the disposal facility name below and was discharged. I certify that the foregoing is true and correct:

e) Signature of authorized agent and title: _____

iv. Acceptance by _____Municipality's authorized STP

The above transporter delivered the described wastewater to this disposal facility and it was accepted.

Disposal date: _____ Amount Collected from Transporter (if any):_____

Signature of authorized signatory and title: _____

[7] Adapted from operative guidelines for septage management for urban and rural local bodies in Tamil Nadu.(2014)

3.3 Operating procedure for cleaning of septic tanks[8]

3.3.1 Daily Preparation for the ULB / private emptying and transport service

- Receive work orders for the day
- Check the functioning of vacuum emptier and equipment
- Check personal protective equipment – All employees should be responsible for maintaining their own personal protective equipment (such as gloves, boots, hat, face mask, Davy's lamp) in good condition
- Check disinfecting and spill control equipment – Operators should be trained on identifying spills and proper methods of disinfecting. Sprinkle lime over spilled area, wait 15 minutes, then wash with water
- Check Hoses – inspect hoses for cracks and wear– discard or repair worn and broken hoses. Connecting the Hose in the correct manner using the clamp style fitting ensures a tight and leak proof connection. Use of twine and plastic for making connections causes leaks and require cleanup.

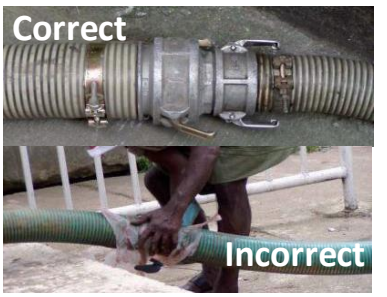


Figure 2: Connecting Hoses

3.3.2 Operating the vacuum emptier

Operators should become familiar with the proper operation of the equipment in use for each operation. This includes the physical operation of the truck, and all valves, piping, power take-offs and ancillary equipment for the vacuum emptier (including the tank, valves, hoses, and fittings). The following steps can be followed for operating the vacuum emptier:

- Reach the first site and meet the building owner.

[8] Source: Guidelines for 'Open defecation Free Towns' under Mahatma Gandhi Swachhata Mission, Government of Gujarat.(2015)

- Before pumping, check the tank to look for obvious damage to the structure and to verify proper piping is in place.
- Check the water level to get clues as to tank condition: high levels (above outlet level) indicate a clogged outlet; low levels (below outlet level) indicate a leaking tank (or tank not in use).
- Check for back flow into tank during pumping and when pumping is complete. Flow back may indicate a problem with plumbing in the house or clogged disposal.
- Open the access covers, inspect the interior and exterior of the tank. If more than one, locate and remove lids from all compartments.
- Each compartment will require pumping after ventilating. Probe the tank with the last length of hose. This will provide an indication on the volume of sludge to pump.
- Start the pump or vacuum equipment. The operator will make sure there is suction and that the pump is operating.
- Volume in the tank should start decreasing rapidly. Use hose to break up sludge and scum to the extent possible.

After pumping is complete, check the tank for remaining sludge. If there are accumulated solids remaining, initiate the pump-back procedure, which is to send the pumped faecal sludge under pressure back into the tank and direct this flow toward the sludge mass. This will break up the mass, making it possible to pump out. When pump-back is complete, pump out the tank again (suction). When pumping is complete, wash the hoses and replace the tank lids. Leave back small amount of sludge of around 1 to 2 inches in the tank so that it microorganisms can act upon the new incoming faecal waste. Clean up any spills and disinfect with lime or bleach solution. Chemicals such as lime can also be added into the suction trucks to neutralize the septage, to render the septage more treatable and to reduce odours.

Annexure 4. ULB Wise Capacity of STPs, present flow and utilization[9]

Sr. No	Class of ULB	Name of the ULB	Capacity* (MLD)	Technology	Present flow (MLD)	% Utilization	Data source year
1	M. Corp	Aurangabad	216	SBR-ASP	100	46	2014-
2	M. Corp	Bhiwandi	17	UASB	17	100	2014-
3	M. Corp	Greater	ND	Aerated Lagoon	ND	ND	2014-
4	M. Corp	Kalyan Dombivli	153	SBR, Soil based technology (IIT)	153	100	2014-15
5	M. Corp	Kolhapur	120	SBR	68	57	2014-
6	M. Corp	Mira	30	MBBR	30	100	2013-
7	M. Corp	Nagpur	200	UASB	150	75	2014-
8	M. Corp	Nanded	174	Extended Aerator with	25	14	2013-14
9	M. Corp	Nashik	271	UASB	239	88	2014-
10	M. Corp	Navi	848	C-TECH	420	50	2014-
11	M. Corp	Pimpri	564	ASP, SBR	432	77	2014-
12	M. Corp	Pune	1134	ASP, SBR, Biotech with extended	1134	100	2014-15
13	M. Corp	Sangli	22	Oxidation pond	22	100	2013-
14	M. Corp	Thane	304	SBR	180	59	2014-
15	Class A	Ambernath	56	UASB	49	87	2013-
16	Class A	Ichalkaranji	40	UASB	30	75	2013-
17	Class A	Panvel	28	C-TECH	8	29	2014-
18	Class B	Karad	8	Aerobic, anaerobic,	8	100	2014-15
18	Class B	Lonavala	8	Aeration tank, clari- floculator,	8	100	2014-15
19	Class B	Pandharpur	31	UASB	8	26	2013-

[9] Source: www.pas.org.in

20	Class C	Mahabalesh	3	Multimedia Bio	2	67	2013-
21	Class C	Pachgani	2	UASB	2	100	2014-
22	Class C	Shirur	6	Aeration type	6	100	2013-
23	NP	Shirdi	26	Sludge bed	12	46	2013-

Note: * - Capacity = Installed capacity of primary treatment plant + Installed capacity of secondary treatment plant

Annexure 5. Faecal sludge / septage treatment options

Septage is the settled solid matter in semi-solid condition usually a mixture of solids and water settled at the bottom of septic tank. It has an offensive odour, appearance and is high in organics and pathogenic microorganisms, whereas septic tank effluent is the liquid part which flows out from septic tank (since solids are trapped in septic tank). Septage has a much higher concentration of pollutants than the septic tank effluent. Biological Oxygen Demand (BOD) and Total Suspended Solids (TSS) are two common measurements of the strength of septage. As per U.S. EPA, 1984 septage in tropical countries may have BOD concentrations between 440 to 78,600 mg/l and TSS values in range of 310 to 93,378 mg/l, where septic tank effluent has values averaging around 200 mg/l BOD and 300 mg/l TSS. As septic tanks fill with septage, the effluent begins to resemble faecal sludge with higher pollution values. Therefore, regular desludging provides dramatic improvements in effluent quality. Detailed septage characterization (BOD, TSS &other microbial characteristics) as well as its dewatering characteristics (specific resistance etc.) should be done prior to the design of any faecal sludge management facility. Treatment of septage / faecal sludge can be of two types, treatment at sewage treatment plants and at independent septage treatment plants. The details of these two types of treatment are given in the section below:

5.1 Treatment of septage/faecal sludge at sewage treatment plants:

Co-treatment of septage along with domestic sewage at a sewage treatment plant (STP), if available, is the most desirable option. Though septage is more concentrated in its strength than domestic sewage, its constituents are similar to municipal wastewater. But care should be taken that the STP should have adequate capacity to accept the septage without hampering the functioning of the sewage treatment plant. The municipality should monitor the incoming wastewater load to the STP and accept the septage, if the design norms are not violated with the increased load (on account of the septage). *Annexure 4* provides a list of ULBs with their capacity of the STPs and the present flow received at STPs. The treatment plants that are under-utilized can serve as treatment plants for septage from nearby ULBs and if the STPs are working close

to the design capacity, additional loads due to disposal of septage will necessitate expansion or up-gradation of the STP capacity.

The septage could be added at various locations for treating it along with STP wastewater:

1. **Septage addition at the nearest sewer manhole**: Septage could be added to a sewer upstream of the STP, and substantial dilution of septage occurs prior to it reaching the STP, depending on the volume of sewage flowing in the sewer
2. **Septage addition at the STP:** Septage could be added to sewage immediately upstream of the screening and grit removal processes
3. **Septage addition to sludge digesters/sludge drying beds:** Septage could be processed with the sludge processing units of STP.

If septage / faecal sludge are to be co-treated with sewage, it will be necessary to construct a septage /faecal sludge receiving chamber. Chemicals such as lime or chlorine can also be added to the faecal sludge in the storage tank to neutralize it, to render it more treatable, or to reduce odors.

Treatment of septage/faecal sludge at independent septage treatment plants

When an STP does not exist for a city, or the distance or the capacity of the available plant becomes a limiting factor, it is not a feasible option to transport and treat the septage at the sewage treatment facilities. Hence, a treatment plant especially meant for septage treatment becomes the option to consider. Independent septage treatment plants are designed specifically for septage treatment and usually have separate unit processes to handle both the liquid and solid portions of septage. These include:

- Lime stabilization – odor control, conditioning and stabilization of the sludge.
- Dewatering – sludge drying beds or mechanical dewatering.
- Anaerobic / aerobic wastewater treatment – liquid from the sludge drying beds and mechanical dewatering systems.

- Co-composting with organic solid waste

The choice of mechanical dewatering or sludge drying beds would be dependent on the land availability, with mechanical dewatering systems being preferred where land is scarce and sludge drying beds being adopted where land availability is not a constraint. The benefit of using these treatment plants is that they could provide a regional solution to septage management. Many septage

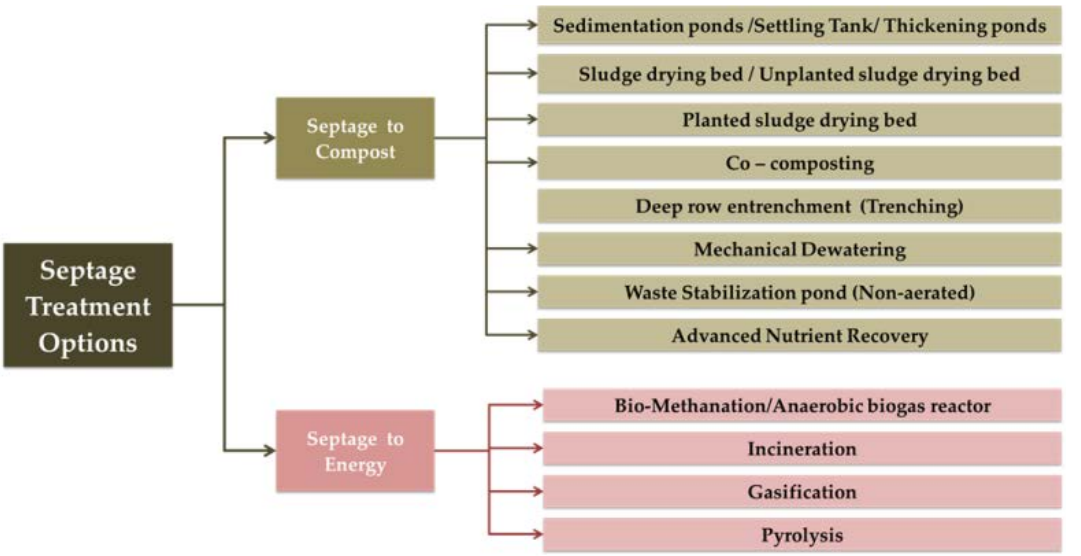


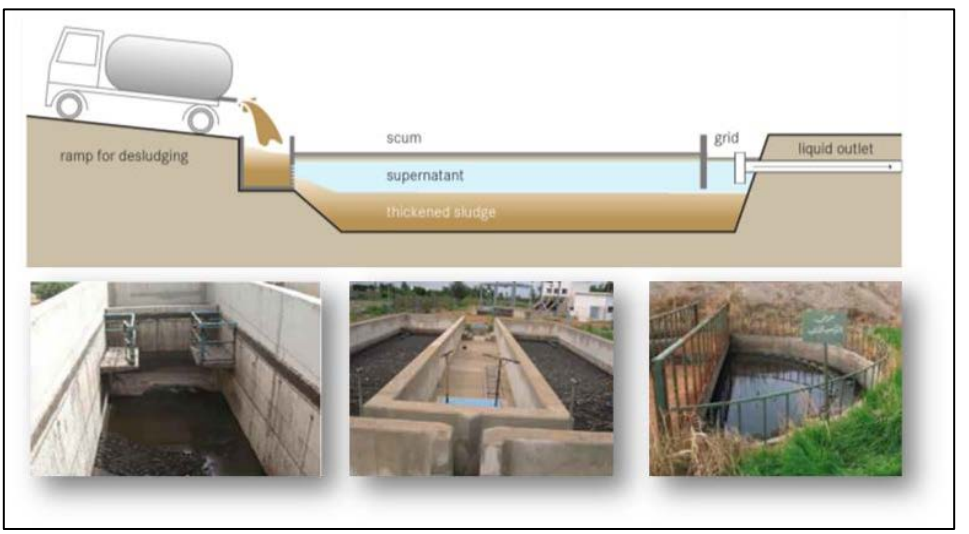
Figure 3: Septage treatment

treatment plants use lime to provide both conditioning and stabilization before the septage is dewatered, and this dewatered sludge can be used as organic fertilizer after drying and composting. Additionally, lime stabilization also helps to reduce/ minimize odour. The common practice is to add lime to raise the pH to 12 and hold it for a period of 30 minutes. The filtrate from the dewatering units needs to be further treated through treatment process such as waste stabilization ponds, anaerobic baffled reactor, constructed wetland or aerobic treatment systems before discharging into the environment.

However, the choice of an appropriate septage management system is dependent on land availability, local site conditions, level of treatment required,

hauling distance, technical requirements, costing , requirement of expertise for construction and operation, availability of skilled labour, legal and regulatory requirements. The management option selected should be in conformity with local, state, and central regulations. From review of various options for the Septage treatment, it was observed that treatment options could broadly be divided into two types. One form of technology is to convert faecal sludge/septage to compost and another is to convert septage to energy. These technologies can be grouped as shown in the figure. Details of these technologies is detailed out in section below

1. **Sedimentation ponds /Settling Tank/ Thickening ponds**
   Sedimentation or Thickening Ponds are simple settling ponds that allow the sludge to thicken and dewater. The effluent is removed and treated, while the thickened sludge can be treated in a subsequent technology. Settling tanks provide a liquid retention time of a few hours (enough to ensure quiescent settling of settle able solids).

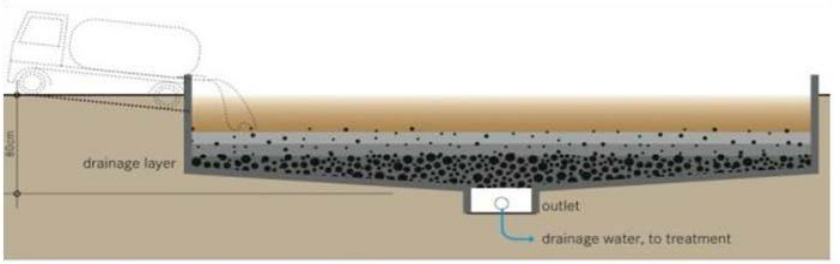


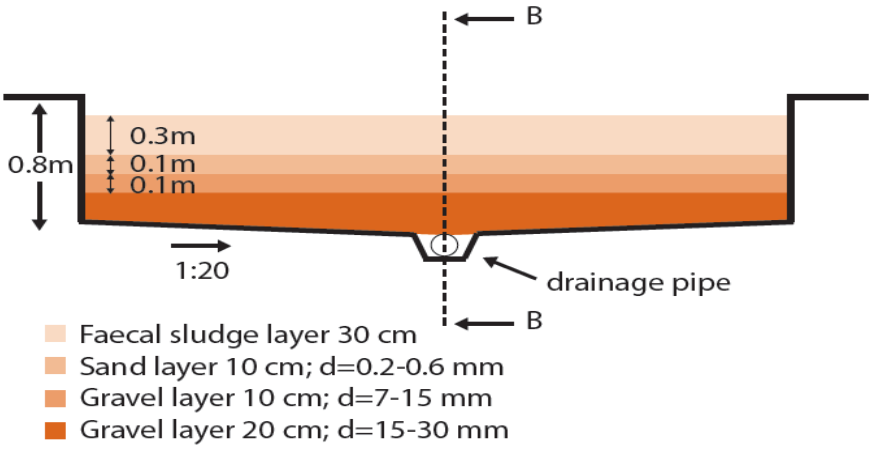
Here input is faecal sludge and output is dried Septage and effluent, which can be used in agriculture, arboriculture and pastures. This treatment option can be coupled with sludge drying bed or co-composting for treatment of thickened sludge. This technology is affected by seasonal changes and can be efficiently used in hot and temperate climate. The discharging area must be maintained

and kept clean. The thickened sludge must be removed mechanically when the sludge has thickened sufficiently. Septage and effluent may require further treatment.

2. Sludge drying bed / Unplanted sludge drying bed

An unplanted sludge drying Bed is a simple, permeable bed that, when loaded with sludge, collects percolated leachate and allows the sludge to dry by evaporation. Approximately 50% to 80% of the sludge volume drains off as liquid. The bottom of the drying bed is lined with perforated pipes that drain away the leachate. On top of the pipes are layers of sand and





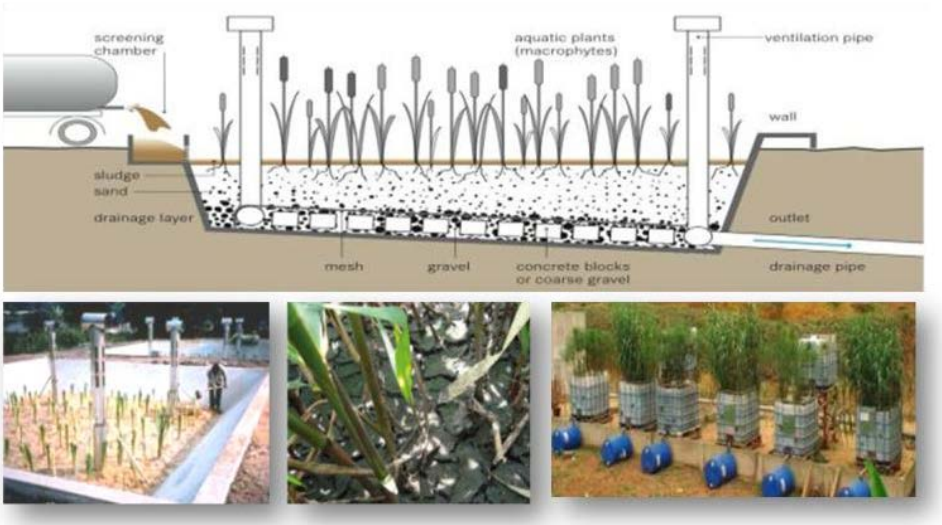
gravel that support the sludge and allow the liquid to infiltrate and collect in the pipe.

In this technique input is faecal sludge and output is treated sludge and effluent, which can be use in agriculture, arboriculture and pastures. Sludge drying bed can be coupled with co-composting for further treatment. This technology is affected by seasonal changes and can be used in hot and temperate climate. Excessive rain may prevent the sludge from proper settling and thickening or this can be avoided by providing transparent sheds over the sludge drying bed.

Over most of the year, the septage drying time is expected to be about seven days; however, an average of 10 days is considered to accommodate longer drying periods during the rainy season. Dried sludge must be removed every 10 to 15 days. Sand must be replaced when the layer gets thin. Treated Septage and leachate may require further treatment based on output quality.

3. Planted sludge drying bed

Planted sludge drying bed is similar to an unplanted drying bed with the benefit of increased transpiration. The key feature is that the filters do not need to be desludged after each feeding /drying cycle. Fresh sludge can be applied directly onto the previous layer; it is the plants and their root



systems that maintain the porosity of the filter. The roots of the plants create pathways through the thickening sludge to allow water to escape more easily.

In this technique input is faecal sludge and output is treated sludge and effluent, which can be use in agriculture, arboriculture, pastures and as cattle fodder. Planted sludge drying bed can be coupled with co-composting for further treatment. It is affected by seasonal changes.

The drains must be maintained and the effluent must be properly collected and disposed off. The plants should be periodically thinned and/or harvested. Treated Septage and Leachate may require further treatment based on output quality

4. Co-composting

Co-Composting is the controlled aerobic degradation of organics using more than one feedstock. Faecal sludge has a high moisture and nitrogen content while biodegradable solid waste is high in organic carbon and has good bulking properties. There are two types of Co-Composting designs: open and in-vessel. A Co-Composting facility is only appropriate when there is an available source of well-sorted biodegradable solid waste. Mixed solid waste with plastics and garbage must first be sorted.

In this technique input is faecal sludge and biodegradable organic solid waste and output is compost which can be use in agriculture, arboriculture and pastures. It is affected by seasonal changes and depending on the climate (rainfall, temperature and wind) the Co-Composting facility can be built to accommodate the conditions. At places where there is heavy rainfall covered facilities are especially recommended.

Careful monitor of the quality of the input materials & track of the inflows, outflows, turning schedules, and maturing times is required to ensure a high quality product. Turning must be done periodically.

5. Deep row Entrenchment (Trenching)

It consists of digging deep trenches, filling them with sludge and covering them with soil. Trees are then planted on top, which benefit from the organic matter and nutrients that are slowly released from the FS. Availability of land is a major constraint & distance to groundwater bodies. This technology is feasible in areas, where the water supply is not directly obtained from the groundwater and groundwater table is low.

6. Mechanical Dewatering

Mechanical dewatering is normally associated with large wastewater treatment plants and is used to separate sludge (residual sludge from wastewater treatment plants or faecal sludge from on-site sanitation) into a liquid and a solid parts. These techniques are usually sophisticated and costly for smaller systems to be implemented on community level. The process does not treat the sludge, it only separates solid from liquid parts.

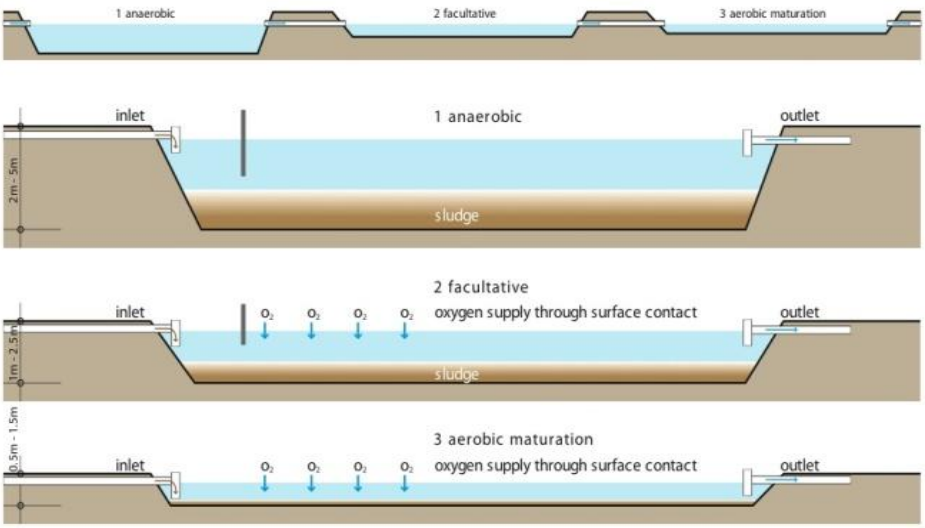
Both solid and liquid parts still contain pathogens and pollutants and further treatment is necessary. Mechanical parts need periodical inspection and replacement.

In this technique input is faecal sludge and output is black water, organic solid waste, compost/biosolids which can be use in agriculture, arboriculture and pastures. It requires to be coupled with co-composting or incineration treatment technique. This technology is not affected by seasonal changes as it is entirely depends on mechanical process. This technology requires less space.

7. Waste Stabilization Pond (Non - aerated)

WSP comprises pre-treatment units (tanks or ponds) for solid-liquid separation followed by a series of one or more anaerobic ponds and one facultative pond.

A number of problems may arise where waste stabilisation ponds are used to treat municipal wastewater and co-treat FS. In many instances, the problems are linked to the fact that the wastewater ponds were not originally designed and equipped to treat any additional FS load. In this technique input is faecal sludge and output is sludge & effluent, which can be use in agriculture, arboriculture, pastures, ground water recharge in deep aquifer and in desert areas. It requires to be coupled with co-composting or sludge drying bed. It can be implemented at neighbourhood level or city level. This technique is affected by seasonal changes.



As per sanitation experts and review of various technical documents, it was analysed that waste stabilization pond is good option for treatment of wastewater but not a good option for treatment of Septage.

8. Advanced nutrient recovery

Wastewater, municipal sludge or the ash after dried sludge, which is incinerated or disposed of, can be a very rich source for nutrients, in particular phosphorus and nitrogen. There is a wide range of promising technologies emerging which can convert septage to phosphorus and nitrogen. Some of these techniques are still not fully developed. These technologies are expensive and require engineering knowledge to guarantee a sustainable and long-term operation of the facility.

In this technique black water, faecal sludge and grey water is converted to fertilizer and treated waste which can be use in agriculture, arboriculture, pastures, ground water recharge in deep aquifer and desert areas. This technology is highly expensive.

The following table details out advantage, disadvantages and prevalence of this composting technologies.

Table 2: Advantages, Disadvantages & Prevalence of Septage to Compost technologies

Sr. No.	Description	Advantages	Disadvantages	Prevalence in India/Abroad
1	**Sedimentation ponds /Settling Tank/ thickening ponds**	• Can be built with local available materials • Low capital and operating cost • No energy requirement • After sedimentation, sludge is used for agriculture / tree plantation.	• A major minus is the smell, especially if fresh undigested Septage is coming from public toilets. • Large land requirement • Post treatment required for both solid and liquid effluent through SDB or Co-composting	Accra/Ghana & Bangkok, Alcorta (Argentina)
2	**Sludge drying bed / Unplanted sludge drying bed**	• No energy requirement • Can be built with local available materials • Moderate capital cost and low operating cost	• Requires large area • Only applicable during dry seasons or needs a roof during rainy season	Punjab (100 villages) World Bank Project; Accra, Ghana, USA , Dakar, Senegal, Malaysia
3	**Planted sludge drying bed**	• Can handle high loading • Moderate capital cost; Moderate operating cost • No energy requirement	• Requires large land area • Long storage time • Requires expert design and operation • Leachate requires	Europe, USA, Thailand, Dakar senegal, Africa

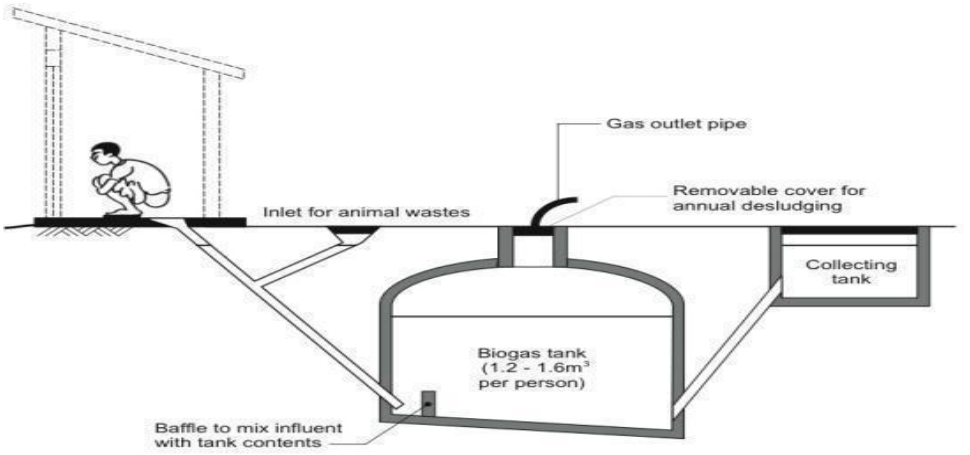
Sr. No.	Description	Advantages	Disadvantages	Prevalence in India/Abroad
		• Widely used by DEWATS for sewage treatment; could as well be used to treat Septage after diluting by mixing with sewage.	secondary treatment • Large de-sludging cycle hence larger area required • More capital and O&M cost as compared to unplanted SDB	
4	**Co - Composting**	• Best combination of cheap bio-technology and agriculture • Good choice for most Indian hot weather cities. • Low capital & operating cost • Easy to set up and maintain and can be built with local materials • No energy requirement	• Requires large land area • Requires segregated organic waste • Long storage times • Operational issues in terms of constant mixing required	Massachusetts, U.S.A; Kalpabriksha Compost Plant in Kathmandu, Bangladesh. Till recently in Dhrangadhra (Gujarat) and Barshi (Maharashtra)
5	**Deep row entrenchment (Trenching)**	• No expensive infrastructure or energy required • Odours are eliminated. • Risk of exposure to pathogens is reduced	• Large land requirement • Not feasible where GW is high	China, south-East Asia, Africa
6	**Mechanical Dewatering**	• Reduces volume of sludge • Process can be fully automated • Requires less space	• Constant power supply required • Need expert design • Both dewatered sludge and effluent requires post treatment	Vizag: built and operated by Pune based Thermax company, Malaysia
7	**Waste**	• No energy	• Not a good option	

Sr. No.	Description	Advantages	Disadvantages	Prevalence in India/Abroad
	stabilization pond (Non - aerated)	requirement • Low O&M cost	for treatment of Septage alone • Requires wastewater for process to work • Requires large area • Requires expertise for design and operation	
8	**Advanced nutrient recovery**	• Recovery of nutrients • Effluent requires no further treatment • Production of fertiliser	• Highly expensive technology • Requires expert knowledge • Some processes are still in development stage • Not proven technology • Sludge requires further treatment	

Septage to energy

1. **Bio-Methanation/Anaerobic biogas reactor**

   In this treatment technology there is microbes driven anaerobic decomposition of organic components in faecal sludge to biogas. Faecal sludge & organic solid waste is converted to treated sludge, effluent and Biogas. Pretreatment of sludge is required but not compulsory. To start the reactor, active sludge (e.g. from a septic tank) should be used as a seed. The tank is essentially self-mixing, but it should be manually stirred once a week to prevent uneven reactions. However once stable state reached, stirring not essential. Gas equipment should be cleaned carefully and regularly so that corrosion and leaks are prevented. Grit and sand that has settled to the bottom should be removed once every year. Bio-Methanation/ Anaerobic biogas reactor option is popularised by Sulabh organization in India.



Advantages:

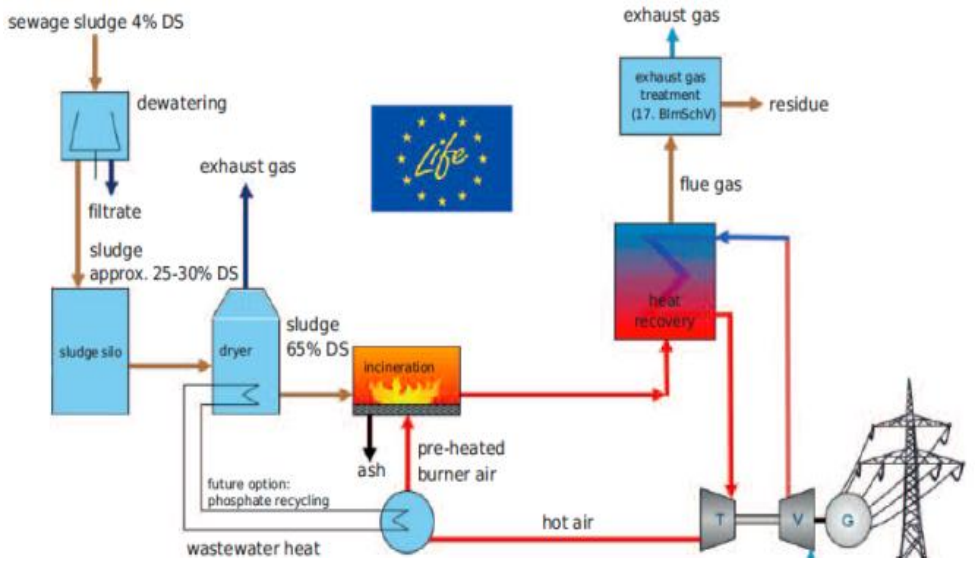
- Established and mature technology.
- Best suitable for wastes with high moisture content.
- Technology could be optimized for any scale.
- Considerable reduction in the emission of greenhouse gases like methane is possible.

Disadvantages:

- There are concerns with odour and pathogen dissemination from the digestate.
- Issues are there in controlling microbial activity if the digester is beyond a certain size.
- Affected by temperature less efficient in colder climates

2. Incineration

In Incineration treatment option there is oxidation of organics in the sludge under the conditions of complete aeration or oxygenation and requires high temperature. Incinerators are a useful technology to combust household waste, medical waste, slaughter waste, etc. instead of discharging it in a landfill. Furthermore, heat and energy may be recovered and it helps to avoid open burning of municipal waste which creates much more harmful emissions and endanger human health and environment. In this treatment sludge is converted to heat. Drying of sludge is required prior for treatment in incinerators. This technology requires trained operators. There is risk of malfunction if not properly maintained and operated.



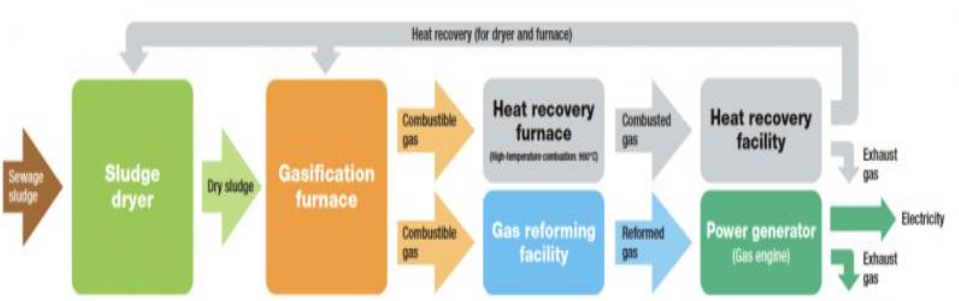
Advantages: Incineration is relatively a simple technology for treating all kinds of wastes.

Disadvantages:

- Liberates considerable amounts of emission
- Sludge incineration costs are not attractive to be used in India
- Sludge incineration is not proven in India

3. Gasification

In Gasification treatment technology there is thermal transformation of organic mass under limited supply of air/oxygen to Syngas. In this technology sludge is converted to syngas & biochar. Drying of sludge is required prior for treatment in incinerators. This technology also requires trained operators and there is risk of malfunction if not properly maintained and operated.



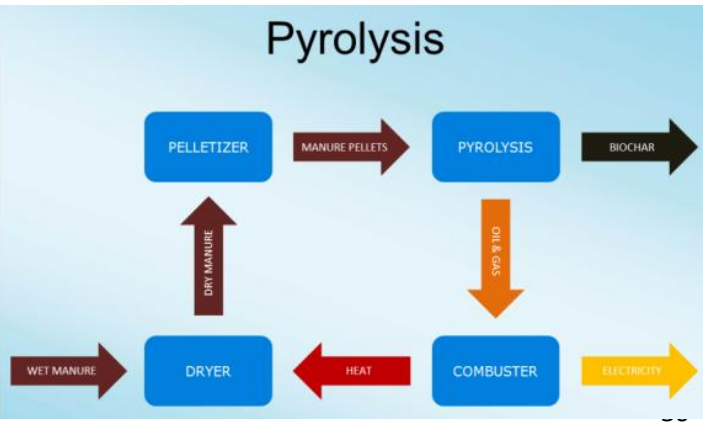
Advantages: Technology best suitable for dry feed stocks. The produced gas can be converted into any type of fuel by FT synthesis.

Disadvantages:

- Gasification of faecal sludge is a relatively new concept in India.
- Process is very energy intensive, as wet feedstock cannot be used directly in a gasifier.
- The process is economically less viable.

4. Pyrolysis

In pyrolysis treatment technology there is thermal conversion of carbonaceous materials in sludge to



produce complex oil in the absence of air/oxygen. In this technology sludge is converted to Bio-oil, Pyrolytic Gas and Bio-char. Here also drying of sludge is required prior for treatment in incinerators. This technology requires trained operators and there is risk of malfunction if not properly maintained and operated.

Advantages: Energy recovery efficiency is high.

Disadvantages:

- Pyrolysis has been attempted only for the treatment of plastic and related feed stocks so far.
- This process is also energy intensive like gasification, as more energy is needed to dry of feedstock.
- High capital and operational costs make the process economically less viable.

Annexure 6. Safe reuse/disposal of treated septage[10]

For dewatered septage/sludge can be used as fertilizer in agriculture application, it should satisfy the following criteria of Class A Bio-solids of US EPA: A faecal coliform density of less than 1000 MPN/g total dry solids, Salmonella sp. density of less than 3 MPN per 4 g of total dry solids. WHO (2006) suggests Helminth egg concentration of < 1/g total solids and E coli of 1000/g total solids in treated septage for use in agriculture

MSW Rules (2000) recommended the quality for compost as referred to Table below.

Table 3: Compost Quality as per MSW Rules, 2000

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

In the absence of any standards, it is recommended that these be adopted until such time standards are notified by the Central Pollution Control Board.

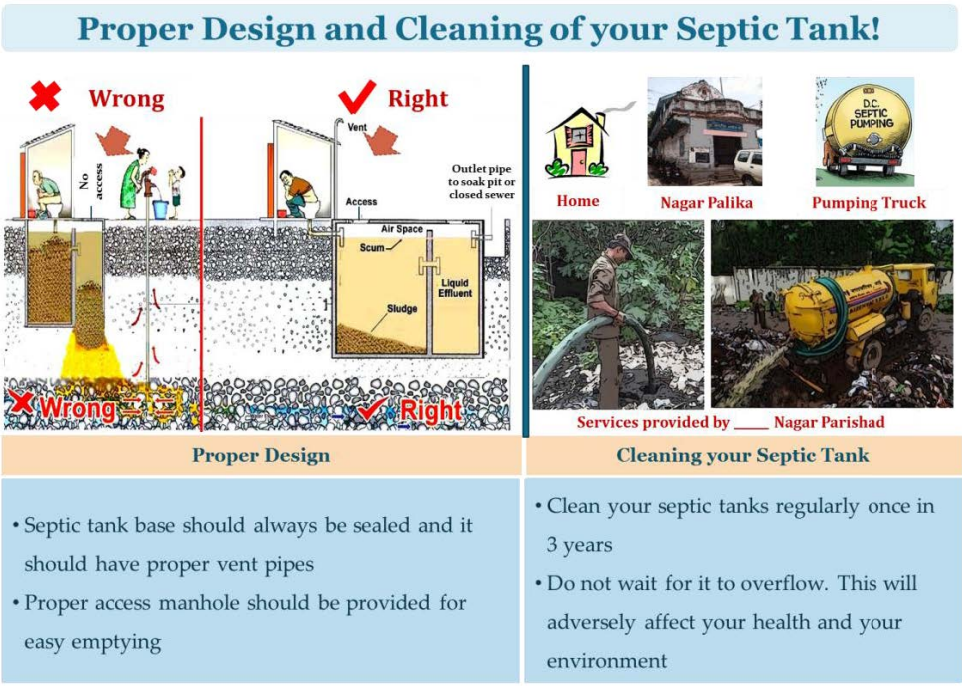
Properly treated sludge can be reused to redaim parched land by application as soil conditioner, and/or as a fertilizer. Deteriorated land areas, which cannot support the plant vegetation due to lack of nutrients, soil organic matter, low pH and low water holding capacity, can be reclaimed and improved by the application of treated septage. Septage sludge, as a result of lime stabilization has pH buffering capacity that is beneficial for the reclamation of acidic soils. Treated septage contains nutrients in considerable amounts, which supports the growth of a number of plants.

[10] Source: Advisory note: Septage Management in Urban India, Ministry of Urban Development, Government of India. (2013) and Guidelines for 'Open defecation Free Towns' under Mahatma Gandhi Swachhata Mission, Government of Gujarat.(2015)

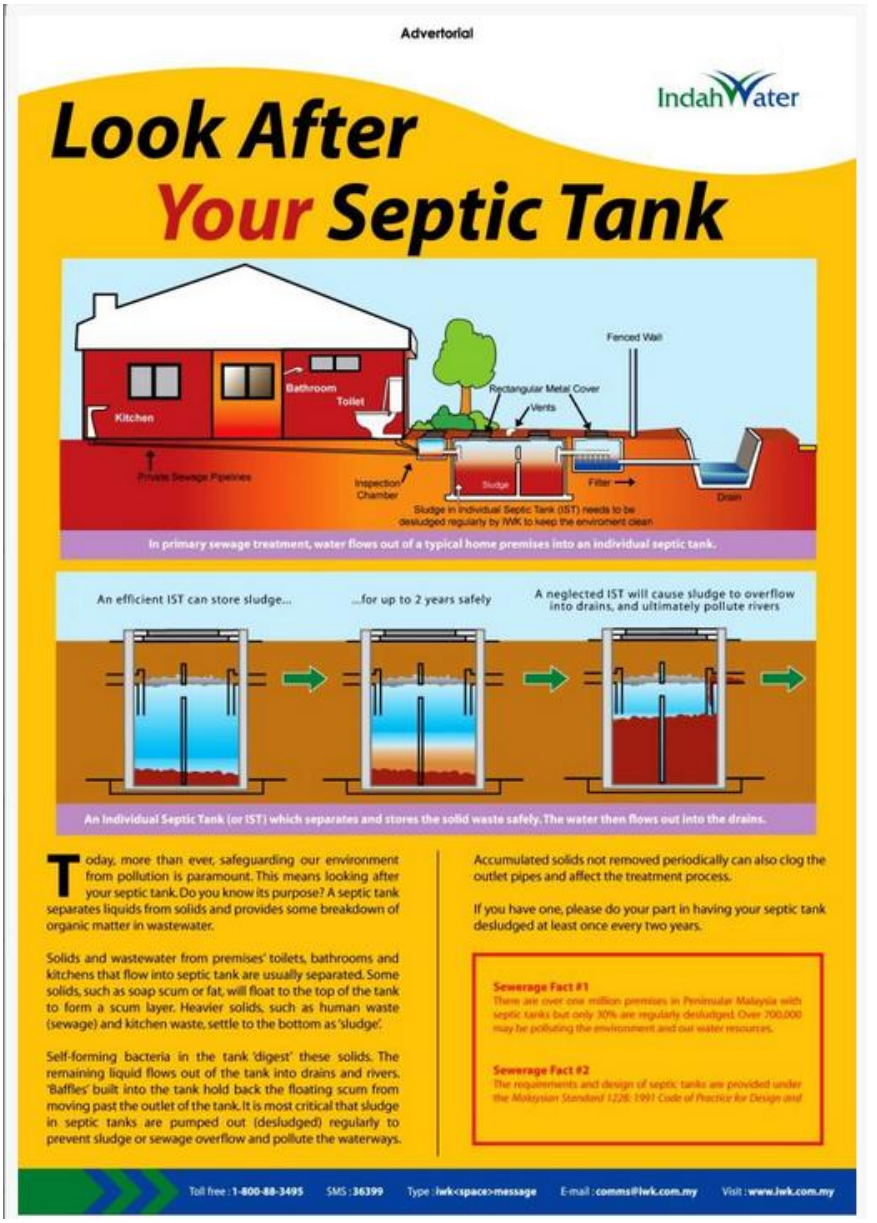
Drip irrigation is the preferred irrigation method for settled septage effluent when irrigation is feasible. Crops which could be safely grown are corn, fodder, cotton, trees including fruit trees, eucalyptus and poplar.

Aquaculture can be practiced for settled septage effluent when freshwater is available to achieve dilution to ensure dissolved oxygen is above 4 mg / l. Fish species of tilapia and carp are preferred since they tolerate low dissolved oxygen. Both drip irrigation and aquaculture need land and are feasible at city outskirts.

Annexure 7. Sample IEC materials

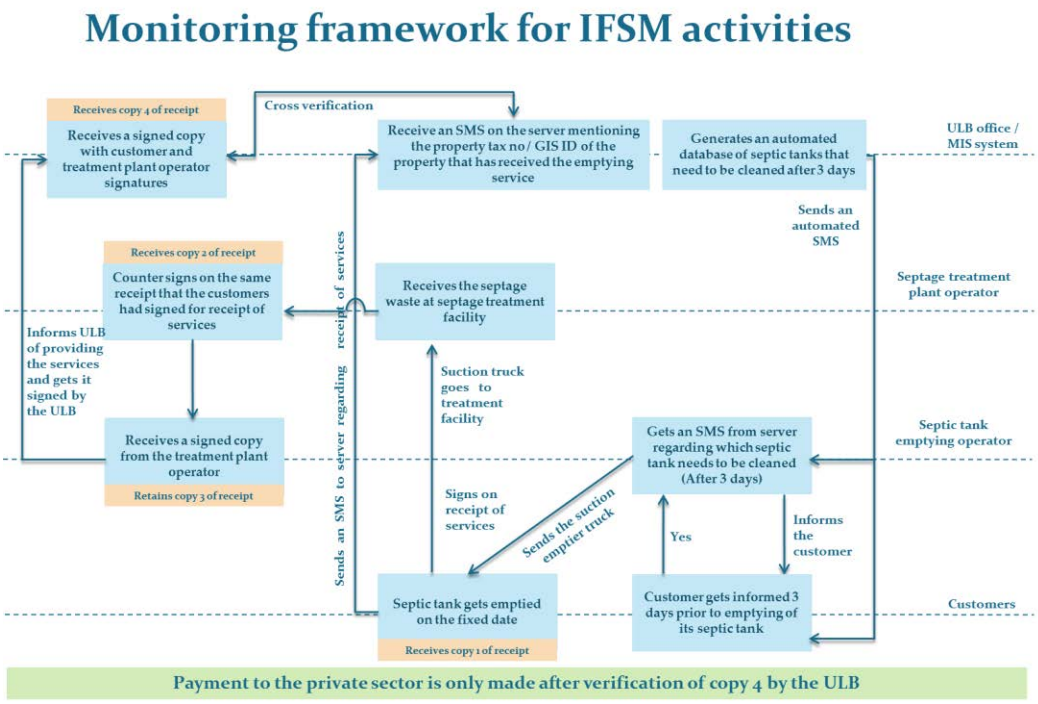


Source: IEC material used for awareness generation activities in Wai and Sinnar by CEPT University / AIILSG



Source: Indah Water, Malaysia, as shown in advisory note: Septage Management in Urban India, Ministry of Urban Development, Government of India. (2013)

Annexure 8. Monitoring framework for IFSM activities[11]



[11] Source: Monitoring framework to be used for monitoring septage management activities in Wai and Sinnar by CEPT University / AIILSG / Urban Local Body

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These Guidelines are prepared with support of CEPT University under Performance Assessment System (PAS) Project in consultation with Government of Maharashtra.

pas performance assessment system

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Handbook of Technologies

Solid Waste Management

First Edition - 2016

Swachh Maharashtra Abhiyan

Urban Development Department

Government of Maharashtra

HANDBOOK OF TECHNOLOGIES

SOLID WASTE MANAGEMENT

FIRST EDITION - 2016

Foreword

"A Clean India" would be the best tribute India could pay to Mahatma Gandhi on his 150th birth anniversary in 2019," said our Prime Minister Shri Narendra Modi as he launched the Swachh Bharat Mission on 2 October,2014 throughout the length & breadth of the country. The Swachh Bharat Mission is a bold & visionary response to one of India's key urban challenges aiming at scientific processing & disposal of Municipal Solid Waste.
Maharashtra is one of the most urbanized states in the country. Urban Maharashtra is facing an ever increasing challenge to provide for the infrastructural needs of the growing urban population. Solid Waste Management in a scientific way is the key for maintaining the quality of life thereby moving towards healthier & greener surroundings.

It was felt that Urban Local Bodies face challenges in zeroing down on methods for treatment & disposal of municipal solid waste. Therefore the Urban Development Department, with the support & collaboration of Asian Development Bank (ADB), has come out with this "Handbook of Technology for Solid Waste Management". This handbook focuses on the treatment of Municipal Solid Waste and stresses upon the importance of waste segregation at source into dry and wet waste. I am confident that this Handbook, will definitely assist the ULBs in selecting the appropriate technology option based on population for treatment of Municipal Solid Waste and thereby accomplish the objective of " **Swachh Maharashtra**" by October,2019.

I am thankful to ADB & its team for their support in bringing out this Handbook of technology.I am also thankful to Government of India for their sustained support & guidance to the state.

Mumbai
3rd February, 2016

Mr Devendra Fadnavis,
Chief Minister,
Maharashtra

Acknowledgement

The Urban Development Department is implementing the Swachh Maharashtra Abhiyan under the aegis of the Swachh Bharat Mission with the vision to make Maharashtra "Clean by October 2019", under the dynamic leadership and able guidance of Hon. Chief Minister Shri Devendra Fadnavis. Processing Municipal Solid Waste through modern & scientific technologies is one of the key Mission objectives.

As we worked towards achieving the Mission objectives we had a series of workshops and it was felt that our Urban Local Bodies (ULBs) faced challenges in selecting an appropriate technology for scientific processing of Municipal Solid Waste. The Hon. Chief Minister also expressed a keen desire and need for bringing out such a Handbook of Technology for Solid Waste Management, which would guide and support the ULBs in selecting an appropriate technology based on the population size.

The Department accordingly in collaboration and support of the Asian Development Bank (ADB), thereafter worked towards publishing this Handbook. This Handbook is an attempt by the Urban Development Department to provide an understanding of Waste Processing technologies with emphasis on segregation of waste at source. This Handbook provides an insight on selecting suitable technology based on population size of the ULBs.

I am grateful to the ADB & their team for assisting & supporting the Department in bringing forth this Handbook.

The Handbook would not have been completed in time but for the valuable inputs received from the Ministry of Urban Development, Government of India. I am thankful to the Ministry of Urban Development for their constant support & guidance in this initiative.

I am sure this Handbook will definitely assist the ULBs towards selecting an appropriate technology for Scientific treatment of Municipal Solid Waste and thereby move ahead towards achieving **'Swachh Maharashtra'** by October 2019.

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Secretary, Urban Development Department
Government of Maharashtra.
3rd February, 2016

Table of Content

List of Tables

List of Figures

1 1.0 Introduction

Urban India is facing an increasing challenge to provide for the incremental infrastructural needs of the growing urban population. According to the 2011 census, the population of India was 1.21 billion, of this 31% lives in cities. It is further projected that by 2050 half of India's population will live in cities.

Solid Waste Management is one of the most essential services for maintaining the quality of life of the people in the urban areas and for ensuring better standard of health, sanitation and the environment. With this increasing population, the management of Municipal Solid Waste (MSW) in the country has emerged as a severe problem not only because of the environmental and aesthetic concerns but also because of the sheer quantities generated every day.

According to Central Pollution Control Board 144,165 TPD (Tons per day) of Municipal Solid Waste was generated in India during 2013-14. Of the total waste generated, approximately 115,742 TPD (80%) of MSW was collected and only 32,871 TPD (22.8%) was treated.

Maharashtra is one of the urbanized states in the country. The state is having total 258 Nos. of Local Bodies. The population of Maharashtra as per 2011 census is about 11.24 crores, out of which 45.22% people live in urban areas. The total figure of population living in urban areas is 5.1 crore and the urban population in the last 10 years has increased by 45.22%.

With rising urbanization and change in lifestyle and food habits, the amount of municipal solid waste has been increasing rapidly and its composition is also changing. With rapid migration of rural masses to urban areas, particularly in metro cities, MSW is being produced at an ever - increasing rate. The increasing population directly influences the municipal solid waste generated in the surrounding areas. Again industrialization affects level of urbanization and increases population levels there by increasing the overall waste generated.

1.1 Types and Source of MSW

Municipal solid waste (MSW), also called Urban Solid Waste, and is a waste type that includes predominantly household waste (domestic waste) with sometimes the addition of commercial wastes, construction and demolition debris, sanitation residue, and waste from streets collected by a municipality within a given area. They are in either solid or semisolid form and exclude industrial hazardous wastes and bio-medical waste. MSW can be broadly categorized into four broad categories such as:

- **Biodegradable waste**: food and kitchen waste, green waste (vegetables, flowers, leaves, fruits), paper (can also be recycled).
- **Recyclable material**: paper, glass, bottles, cans, metals, certain plastics, etc.
- **Inert waste**: construction and demolition waste, dirt, rocks, street sweeping, drain silt, debris.
- **Domestic hazardous waste** (also called "household hazardous waste") & toxic waste: medication, e-waste, paints, chemicals, light bulbs, fluorescent tubes, spray cans, fertilizer and pesticide containers, batteries, shoe polish.

Table 1-1: Sources of waste, waste generators & solid waste contents

Source	Typical waste generators	Solid waste contents
Residential	Single and multifamily dwellings	Food wastes, paper, cardboard, plastics, textiles, leather, yard wastes, wood, glass, metals, ashes, special wastes (e.g., bulky items, consumer electronics, batteries, oil, tires), and household hazardous wastes.
Commercial	Stores, hotels, restaurants, markets, office buildings,	Paper, cardboard, plastics, wood, food wastes, glass, metals, special wastes, hazardous wastes
Institutional	Schools, hospitals, government centres	Paper, cardboard, plastics, wood, food wastes, glass, metals, special wastes, hazardous wastes.
Construction and demolition	New construction sites, road repair, renovation sites, demolition of buildings	Wood, steel, concrete, dirt, etc.
Municipal services	Street cleaning, landscaping, parks, beaches, other recreational areas, water and wastewater treatment plants.	Street sweepings; drain silt; landscape and tree trimmings; general wastes from parks, beaches, and other recreational areas; sludge.

1.2 Regulatory Framework

Municipal Solid Waste (Management & Handling) Rule, 2000 and draft revised MSW Rules 2013

The Ministry of Environment and Forest has notified the Municipal Solid Waste (Management & Handling) Rule, 2000 under the Environment (Protection) Act, 1986 to manage the Municipal Solid Waste (MSW) generated in the country. According to this rule there is specific provision for collection, segregation, storage, transportation, treatment and disposal of MSW & it applies to all Municipal Authorities.

The MSW Management and Handling Rules 2000 are under revision by MoEF and the draft revised Rules in 2013 will reflect new systems, technology developments and concepts for an integrated MSWM. In particular the Rules cover the following aspects:

- list of authorities involved in MSWM and their corresponding duties;
- mandatory MSWM Policy/Strategy to be prepared by the State or the Union Territory;
- mandatory MSWM Plans to be prepared by the municipal authority;
- specific requirements for the management of MSW including segregation into wet and dry waste, as well as restriction on material to be disposed in landfills; only nonreactive inert and pre-treated waste may be disposed;
- levy of service fees by the municipal authority to make this service sustainable;
- requirements for landfill sites including site selection and mandatory lining system;
- requirement of environmental clearances for setting up MSW treatment and disposal facilities including landfills;
- standards for composting;

- standards of treated leachate;
- emission standards for incineration facilities;
- mandatory annual reporting by the municipal authority on MSW operations;

The Rule designates the Urban Local Bodies as sole responsible to manage solid waste in their area and dictates that "within the territorial area of the municipality, be responsible for the implementation of the provisions of these rules, and for any infrastructure development for collection, storage, segregation, transportation, treatment and disposal of municipal solid wastes".

Further, **Government of Maharashtra made important law provisions to handle waste generation.**

Maharashtra Non-Biodegradable Garbage (Control) Act 2006

The State government has legislated special enactment entitled Maharashtra Non-biodegradable Garbage (control) Act 2006 to regulate the non-biodegradable municipal solid waste generated in the urban areas. As per Maharashtra Municipal Solid Waste Rules 2006, notified under this Act; no person, by himself or through another shall knowingly or otherwise throw/ cause to throw any non-biodegradable garbage, Construction debris or any biodegradable garbage in any drain, ventilation shaft, pipe & fittings, sewage lines, natural or manmade lake, wetlands; which is likely to interrupt the drainage & sewage system, interfere with the free flow or affect the treatment & disposal of drain & sewage contents, be dangerous or cause a nuisance or be prejudicial to public health and damage the lake, river water & wetland. Also no person shall knowingly or otherwise, place or permit to place any biodegradable or non-biodegradable garbage in any public place or open to public view.

The Act also states that, it shall be the duty of the owners and occupiers of every land and building to store and segregate the waste generated by them into a minimum of two receptacles one for biodegradable waste and one for non-biodegradable waste.

1.1.1 Maharashtra Plastic Carry Bags (Manufacture and Usage) Rules 2006

To minimize the environment and health impact of plastic waste State government issued Maharashtra plastic Carry Bags (Manufacture and Usage) Rules 2006 under Maharashtra Non-biodegradable Garbage Control Act 2006. To control plastic waste generation, manufacturing (and stocking, distributing or selling) plastic carry bags made of virgin or recycled plastic of thickness less than 50 micron and of the size 8 x 12 inches are banned in the State.

Direction of Hon'ble National Green Tribunal (NGT)

Hon'ble NGT in OA No 199 of 2014 (Almitra H. Patel Vs Union of India) on 5th February, 2015 directed that "The Central Pollution Control Board shall submit its independent comment in relation to formulation of a national policy with regard to collection and disposal of a municipal solid waste as a National policy to be adopted. Accordingly, CPCB has developed a National Policy providing indicative strategy and broad framework which states may refer to derive the needs in-terms of tools and tackles, equipment and suggested technological options.

1.3 Swachh Bharat Mission

The "Swachh Bharat Mission-Urban" (SBM-U) is a major initiative of Government of India. Launched on the birth Anniversary of Mahatma Gandhi on 2nd October 2014, the mission seeks to attain his

vision of a 'Clean India' by his 150th birthday in 2019. Expected to cost over Rs. 62,000 crore, it is a national campaign covering 4041 statutory towns.

The SBM-U is a bold and visionary response to one of India's key urban challenges. The specific objectives of the Mission, describe a comprehensive set of actions that can deliver, at one end, the goals of social transformation, such as eliminating open defecation and manual scavenging, and, at the other, the goals of scientific solid waste management and sanitation, through the fundamental instruments of social change: change in behaviour and attitudes, and greater awareness about the adverse health effects of poor sanitation and waste management.

Modern and scientific Solid Waste Management (SWM) is one of the key component of the SBM-U and it was felt that urban bodies face challenges in zeroing down methods of collection and transportation, treatment technology selection and disposal methods. This shortcoming also retards project progress as implementers take time to gather information from various sources to understand the sector as there is no nutshell document that provides comprehensive information about the sector.

The Central Government incentive for SWM under SBM will be in the form of a maximum 20% grant or Viability Gap Funding (VGF) for each project. The State Government will contribute a minimum of 25% funds for SWM projects to match 75% Central share. This is minimum assured government contribution available to all ULBs considering an estimated project cost based on unit cost of Rs. 1,200 per capita. However, the state governments can also add or generate funds for ULB's as additional incentives over and above minimum 25% share required to make the projects viable.

As a first step, under the Swachh Bharat Mission ULB's are to prepare Detailed Project Report (DPR) for solid waste management of their city and get it approved from the State High Power Committee. DPRs should be aligned with Government of India's goals outlined in the National Urban Sanitation Policy (NUSP) 2008, SWM rules, advisories, CPHEEO manuals (including cost-recovery mechanisms), O&M practices and Service-level Benchmark advisories released by MOUD from time to time.

In addition to the above, other initiative and support provided by Government of India is as under:

1. In case of compost, market development assistance in the form of subsidy to the tune of Rs. 1,500 per metric ton is available on sale of compost.
2. In case of waste to energy plants, Central Electricity Regulatory Commission (CERC) has notified generic tariff for sale of electricity at the rate of Rs. 7.04 per unit for mixed MSW based waste to energy plant and Rs. 7.90 per unit for RDF based plant.
3. Ministry of Power has made is mandatory for all state Discoms to purchase 100% power generated from MSW based power plant.

1.4 Rationale for Handbook for Waste Treatment Technology

In 2000, the MSW Rules were notified by the Ministry of Environment , Forests and Climate Change (MoEFCC) making it mandatory for ULBs to improve their waste management systems in a timeframe ending 31st December, 2003. Non-compliance with MSWM Rules is still a relevant cause for concern even after 15 years of notification of the MSW Rules, 2000.

Urban Local Bodies (ULBs) continue to face challenges not only in the selection of appropriate or advanced collection & transportation systems, treatment & processing technology and disposal methods, but also in the sustainable financial management of municipal solid waste management.

To manage the current challenges of urban waste management, an integrated approach to waste management involving planning, financing, construction and operation of facilities for the segregation, collection, transportation, recycling, treatment and final disposal of the waste could be considered the challenge has many elements where source segregation needs to be encouraged, efficient collection of waste, scientific treatment of waste and final disposal of waste.

Source segregation into dry and wet waste is important for further treatment of waste. It allows for cleaner streets and roads, effective waste treatment promoting recycling and reuse and better disposal of waste.

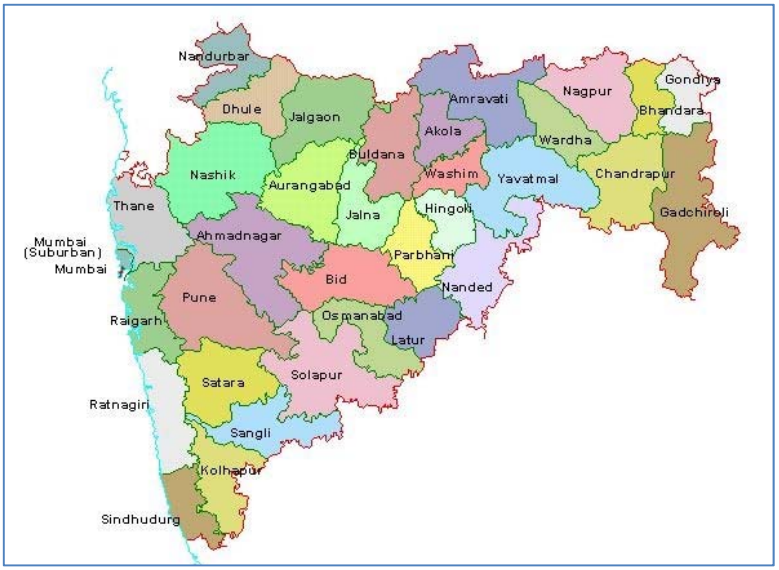
This handbook focuses on the treatment of municipal solid waste (MSW) and stresses upon the importance of waste segregation at source and has been prepared based on the Municipal Solid Waste (Management & Municipal Handling) Rules, 2000, and the manual on Municipal Solid Waste Management by the Central Public Health & Environmental Engineering Organization (CPHEEO).

These rules stipulate that all urban local bodies are responsible for proper collection, storage, transportation, processing and disposal of the municipal wastes. Only the residual inert after due processing of waste are to be disposed into a sanitary landfill in accordance with these rules. The rules advocate the use of composting, vermi composting, anaerobic digestion or biomethanation for treatment of biodegradable waste. Incineration with or without energy recovery including pelletization and other thermal processes can also be used for processing techniques of municipal wastes.

2.0 Status of SWM in Maharashtra

Maharashtra is second largest state in India in terms of population and third largest state in terms of area. Maharashtra is also the second most urbanised state in India.

Maharashtra has 35 districts, divided into six revenue divisions for administrative purposes including Konkan, Pune, Nashik, Aurangabad, Amravati and Nagpur. Local self-governance institutions in rural areas include 33 Zilla Parishads, 355 Panchayat Samitis and 27,993 Gram Panchayats. Urban areas in the state consists of 258 Urban Local Bodies 239 Municipal Corporations/ Councils, 7 Nagar Panchayats and 6 Cantonment Boards. Mumbai known as financial capital of India is capital of the state and houses almost all the financial institutions.



Maharashtra is the second largest state in India both in terms of geographical area and population, spread over 3.08 lakh sq. km having a population 11.24 crore as per Census 2011. Maharashtra is a highly urbanized state with 45.2 per cent of Maharashtra's population living in urban areas while the national urban population average is 31 percentage. Maharashtra is one of the highly industrialised states. It is pioneer in Small Scale Industries and continues to attract industrial investments from both, domestic as well as foreign institutions. It is a major IT growth centre.

2.1 Generation of Municipal Solid Waste

As per Central Pollution Control Board (CPCB) report (2014-15) on state wise municipal solid waste generation data, Maharashtra generates 22,570 Tons per day (TPD) including Mumbai out of which about 5,927 TPD (26%) of waste is treated as per the requirement of MSW Rules 2000. Per capita MSW generation in various towns of the state ranges from 100 to 600 gram per person per day.

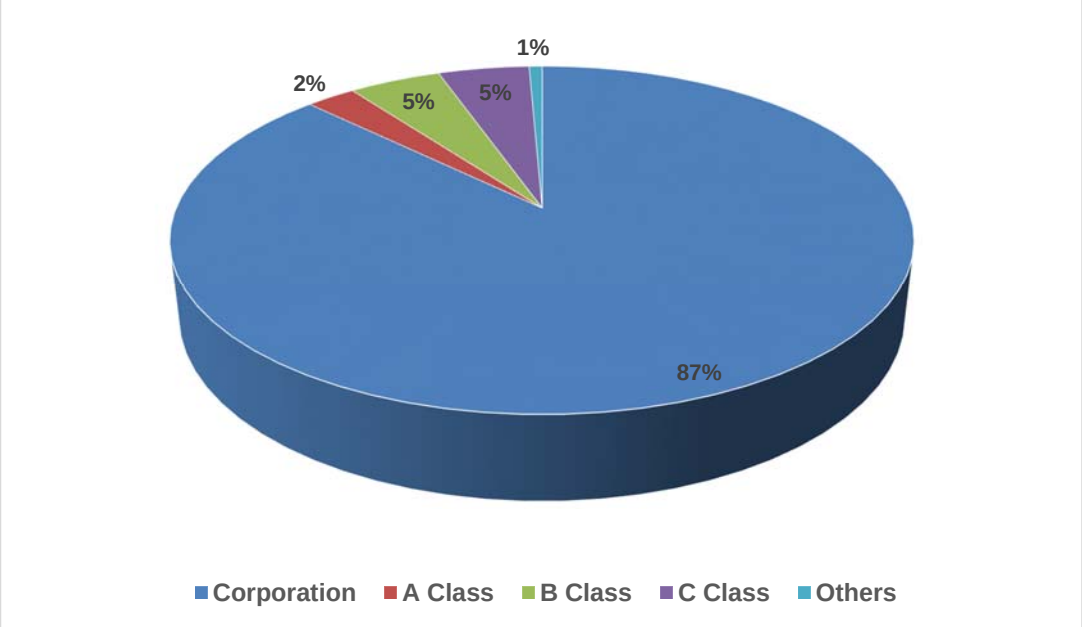
Out of the total waste generation in the state, the Corporation generates 87.26 %, A Class Council generates 2.57 %, B and C Class Council generates 4.77 % and 4.72 % respectively and others is 0.68%. The Table 2.1 below shows the region wise breakup of solid waste generations in the State of Maharashtra**.**

Table 2-1: Municipal Solid Waste Generation (MT/day) in the State of Maharashtra

Region	Corporation	"A" Class	"B" Class	"C" Class	NP/Cant./ other
Amravati	320	25	169.55	114.5	--
Aurangabad	935	79	209	371.6	31
Kalyan	1,170	98	53	--	---
Kolhapur	355	120	86	72.8	10
Mumbai	9,746	-	-	-	--
Nagpur	800	70	97.5	63.17	--
Nashik	1,010	47	158.63	199	33.5
Navi Mumbai	650	-	-	11	--
Pune	3,100	81	161.5	96.5	78
Raigad	-	31	25	59.2	--
Thane	1,490	--	23	3	--
Chandrapur	120	28	94	75.1	
TOTAL	**19,696**	**579**	**1077.18**	**1065.87**	**152.5**

Source: MPCB Annual Report on SWM (2014-15)

Figure 2-1: Maharashtra Percentage of MSW Generation



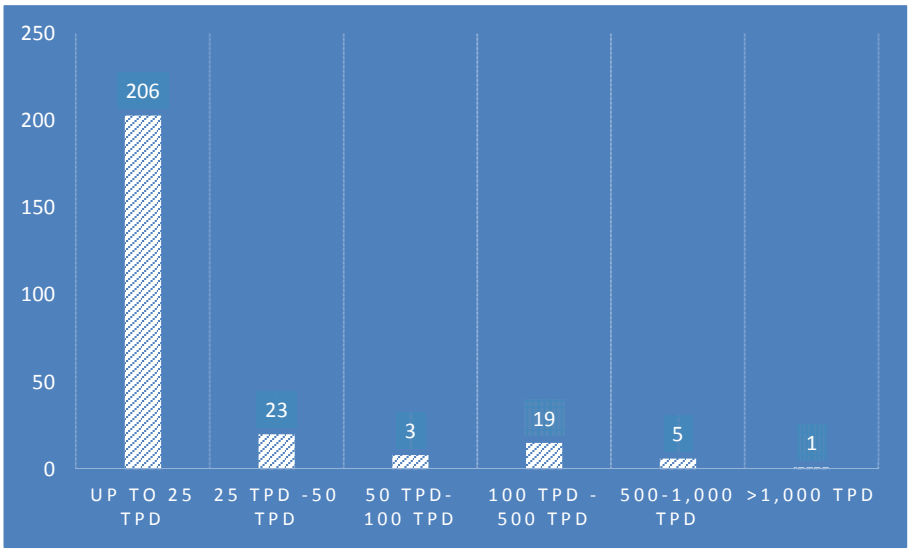
Based on the average solid waste generation in each ULBs in Maharashtra, distribution of the ULBs related to the quantity of waste it generates is shown in Table 2.2.

Table 2-2: Average Municipal Solid Waste Generation (MT/day) in the ULB's in the State of Maharashtra

SN	Waste Generation	ULBs	
		Nos.	**%**
1	Up to 25 TPD	206	80.2%
2	25 TPD - 50 TPD	23	8.9%
3	50 TPD - 100 TPD	3	1.2%
4	100 TPD - 500 TPD	19	7.4%
5	500 TPD - 1,000 TPD	5	1.9%
6	>1,000 TPD	1	0.4%
Total (excluding Mumbai)		257	

Source: MPCB annual report 2014-15

Figure 2-2: Average Waste Generation in ULBs



Several ULBs in the State have taken a number of initiatives for processing of municipal solid waste. These initiatives primarily involve composting, vermi-composting, and waste to energy (biomethanation). Although, there are about 69 composting plants, 35 Biomethanation plants, 3 RDF plants and 2 Waste to Energy plant, the total quantum of waste processed through these methods is considerably less (approximately 26% of generation) as per annual report of Maharashtra Pollution Control Board 2014-15.

2.2 Characterization of Municipal Solid Waste

Materials in MSW can be broadly categorized into three groups - compostable, recyclables and inert. Compostable or organic fraction comprises of food waste, vegetable market wastes and yard waste. Recyclables are comprised of paper, plastic, metal and glass. The fraction of MSW which can neither be composted nor recycled into secondary raw materials is called inert which comprises of street

sweeping, C&D waste, ash and silt which enter the collection system due to littering on streets and at public places.

In general a major fraction of urban MSW in India is organic matter (51%). Recyclables are 18% of the MSW and the rest 31% is inert waste. The average calorific value of urban MSW between 600 to 1200 Kcal/kg) and the average moisture content is 47%.

3.0 Waste Segregation, Collection & Transportation

It is essential to segregate wastes into different fractions, commonly referred to as primary segregation. Segregation of municipal solid waste needs to be linked to primary collection of waste from the door step and given high priority by the ULBs. Unless primary collection of segregated waste is not planned by the ULBs the source segregation by waste generators will be meaningless.

At a minimum level, waste should be segregated by waste generators into two fractions: wet (green container) and dry (blue container). This system is referred to as the 2-bin system. The wet fraction should preferably be treated at the ULB level by applying appropriate treatment technology and as many fractions as possible from the dry waste such as paper and plastic should be sent for recycling. The inert material and rejects should be sent to regional or cluster landfill facility. Figure 3-1 shows the flow chart of waste management system.

3.1 Source segregation and Storage

Source segregation is the setting aside of inorganic and organic waste at their point of generation by the generator. Separating waste at source ensures that organic and inorganic waste is less contaminated and can be collected and transported for further treatment. Segregation of waste also optimizes waste processing and treatment technologies.

Source segregation will not only provide an efficient way for resource recovery, but will also substantially reduce the pressure and pollution at treatment/ landfill sites. It is understood that implementation of such practices takes time and requires significant cooperation from the public. However, initiation should be made and efforts should be diverted to progressively increase the segregation practices.

The generation of awareness among the producers and creation of an enabling environment is the key to success towards proper segregation and storage at source. Therefore, the first step would be to have extensive awareness and education campaign to make households realize that the segregation of garbage at source is the best key to solid waste management.

The municipal authority should undertake phased programs to ensure community participation in waste segregation. Awareness campaigns should be intensively carried out using all available means of communication including meetings with all stakeholders. The campaign should be carried over a long period of time, to bring out a change in the perceptions and attitude of the citizens.

Table 3-1: MSW Source Segregation – categories

Wet Waste (Green Bin)	Dry Waste (Blue Bin)
Food wastes of all kinds, Cooked and uncooked, including eggshells and bones, flower and fruit wastes including juice peels and house-plant wastes, soiled tissues, food wrappers, paper towels	Paper, cardboard and cartons; Containers & packaging of all kinds excluding those containing hazardous materials; Compound packaging (tetra pack, blisters etc.) and plastics; Rags, rubber, wood, discarded clothing and furniture; Metals, Glass (all kinds), House sweepings and inert (not garden, yard or street sweepings)

Storage of waste at source is the first essential step of Solid Waste Management. Every household, shop and establishment generates solid waste on day to day basis. Waste should be stored at the source of waste generation till it is collected for disposal by ULB staff or appointed contractors. It is essential to segregate wastes into wet waste and dry waste. Segregation of municipal solid waste needs to be linked to primary collection of waste from the door step and given high priority by the ULBs; unless door to door collection of segregated waste is practiced by the ULBs, source segregation by waste generators will remain a meaningless exercise.

3.2 Segregated Collection

Collection of segregated municipal waste from the source of its generation is an essential step in solid waste management. Inefficient waste collection service has an impact on public health and aesthetics of towns and cities. Collection of wet and dry waste separately enhances the potential of cost effective treatment of such wastes and of deriving optimum advantage from the recyclable material fed into the system. Waste collection service is divided into primary and secondary collection.

Primary collection is collecting waste from households, markets, institutions and other commercial establishments and taking the waste to a storage depot/ transfer station or directly to the treatment & disposal site, depending on the size of the city and the prevalent waste management system. Primary collection of waste is the second essential step of Solid Waste Management activity. Primary collection system is necessary to ensure that waste stored at source is collected regularly and it is not disposed of on the streets, drains, water bodies, etc.

a) Door to Door Collection through tricycles/ push carts using segregated bins

b) Containers placed on streets and will be collected through autos, tipper lorries, dumper placers and compactors

Secondary collection includes picking up waste from community bins, waste storage depots or transfer stations and transporting it to waste treatment site or to the final disposal site. Primary collection must ensure separate collection of certain waste streams/ fractions depending on the separation and reuse system applied by the respective town/ city. Segregated waste must be stored on-site in separate containers for further collection and should be kept separate during all steps of waste collection and transportation.

A well synchronised primary and secondary collection and transportation system is essential to avoid containers' overflow and waste littering on streets. Further, the transport vehicles should be compatible with the equipment design at the waste storage depot in order to avoid multiple handling of wastes and should be able to transport segregated waste.

It is essential to separate street sweeping and drainage waste completely from household waste streams through all stages of collection, transport and treatment since street sweeping and drainage infiltrates significant amounts of toxic substances and is often responsible for contamination of waste streams envisaged for composting and recycling. Street sweeping and drain cleaning waste is to be collected in separate bins and transported directly to the sanitary landfill facility or interim storage point/ transfer station.

In ULBs where regional disposal site are away from the town boundary and smaller vehicles are used for transportation of waste, it may prove economical to set up transfer stations to save transportation time and fuel.

Table 3-2: Elements of Primary Collection System

Source	Primary Collection Service	Transportation
Residential Areas **Societies/ Apartment Complexes**	Door to door collection services for segregated waste Minimum of Two bins for collection of wet waste and dry waste (10-15L) Contract for door to door collection should be given to Private firm/ NGOs/ RWA/ SHGs	Containerized Handcarts Tricycles for both men and women Pick up Vans Motorized waste collection vehicle Any suitable combination of the above
Inaccessible Residential Areas	Two domestic bins for storage of waste at source Two separate community bins/ container of 60 to 120 litre capacity for 20 to 40 dwelling units	Containerized light weight handcarts Waste collected from the area should be transferred to a LCV outside the slum area
Markets/ Bulk Waste Generators	Door step collection services for recyclable material/ dedicated waste streams on full cost recovery basis Markets: Covered bins for storage of waste as per the quantity of waste generated in the market (1.1 m^3 – 4 m^3capacity. Large commercial complexes could use 3.0 m^3 to 7.0 m^3 container	Motorized waste collection vehicle with container lifting devise Compactors compatible with containers Non compactor trucks

3.3 Transportation of Waste

The ULBs should, depending upon the system of primary collection (collection from the source of garbage) adopted in the town, identify the locations where the solid waste intermediate storage facilities should be created. This is required in order to

(1) Optimise the use of transport devices.

(2) Optimise the use of manpower

(3) Timely collection from source and onward treatment/ disposal of solid waste.

Transportation of the waste at regular intervals is essential to ensure that garbage bins/ containers are not overflowing and waste is not seen littered on streets. Hygienic conditions can be maintained in cities/ towns only if regular clearance of waste from temporary waste storage depots (bins) is ensured.

The following strategies can be considered by the Urban Local Bodies for primary transportation (from source of generation to the storage facility) of solid waste.

a) Depending on the quantum of garbage generated and dispersion of the households, the solid waste storage facilities can be in the form of large containers with lid placed at a distance convenient from the area assigned to the sweeping staff / other agency involved in door-to-door collection work. The distance between two containers can be determined on the basis of the load of garbage/ refuse that is likely to be received at this storage facility from the catchment area concerned. These containers should be placed on cement concrete or asphalt flooring having a gradual slope towards the road in order to keep the site clean. The transport

vehicle to be used for primary transportation will vary from ULB to ULB depending upon the quantum of garbage generated. The containers kept at the storage facility should be cleared daily.

b) Depending on the quantity of solid waste generated and nature of primary collection mechanism and the distance between the storage facilities and the final treatment / landfill sites, a mix of different transport devices should be put into place.

c) In the smaller cities, where the local body feels that it will be difficult to maintain hydraulic vehicles for transportation of waste for whatever reason (financial constraint, narrow roads and lanes etc.), the urban local bodies can arrange for a low bed tractor trolley at the waste storage sites and the secondary transportation from the waste generation site to the treatment/ disposal site can be done by this low bed tractor trolley.

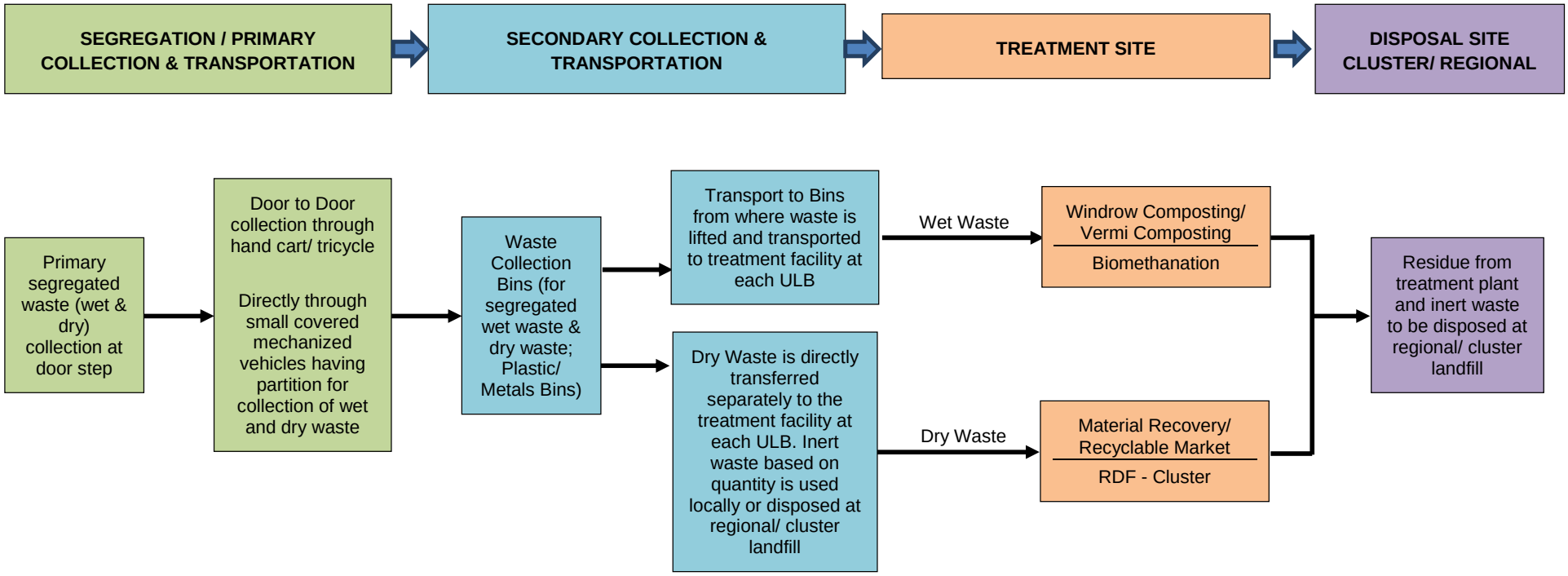
d) The primary transportation in areas where community bins are provided will have to be made more intensive because of the more quantity of solid waste in such community bins.

e) The locations where waste storage facilities should be placed may be assessed in such a way that each container at the storage facility is cleared daily for the biodegradable waste. The recyclable waste should also be transported through the primary collection vehicle and brought to the storage facility, and should be kept separately till it is further disposed. The inert material like street sweeping/ silt from drains if not transported from source directly to the landfill site can be stored initially at intermediate storage facility in a separate container till it is transported to landfill sites.

The routing and number of trips of the secondary transportation vehicle shall be worked out depending on the number of containers and the quantum of garbage and the frequency of clearance of the bins contemplated at the waste storage facility. The timings should be fixed in such a way that the container is nearly fill when it is planned for clearance by the transportation vehicle. Depending on the number of containers on the storage facilities, the container lifting device such as dumper placers Refuse Collectors/ Compactors may be considered for utilisation for transporting the large containers.

From the bulk waste generators like hotels and restaurants, the tractor transportation either departmentally or through outsourced agency may be considered from the source to the storage facility or the treatment site depending on the distance involved. A separate and exclusive storage facility in the form of container may be considered for the bulk producers of garbage and this can be finally transported up to the treatment site directly instead of intermediate storage facility (Transfer Station). The transportation of construction waste should be done exclusively by the waste producers and they should be told about the places where construction waste should be dumped i.e. landfill site or dumping place as the case may be. The urban local body should decide on these aspects. It should be ensured that no concrete bins are put as storage facility since concrete bins are not permitted under Municipal Solid Waste Rules, 2000.

Figure 3-1: Flow Chart – Waste Segregation, Collection, Transportation, Treatment & Disposal



C&D waste is to be collected separately and is not included in the above.

4.0 Technology Options for Treatment of Wet MSW

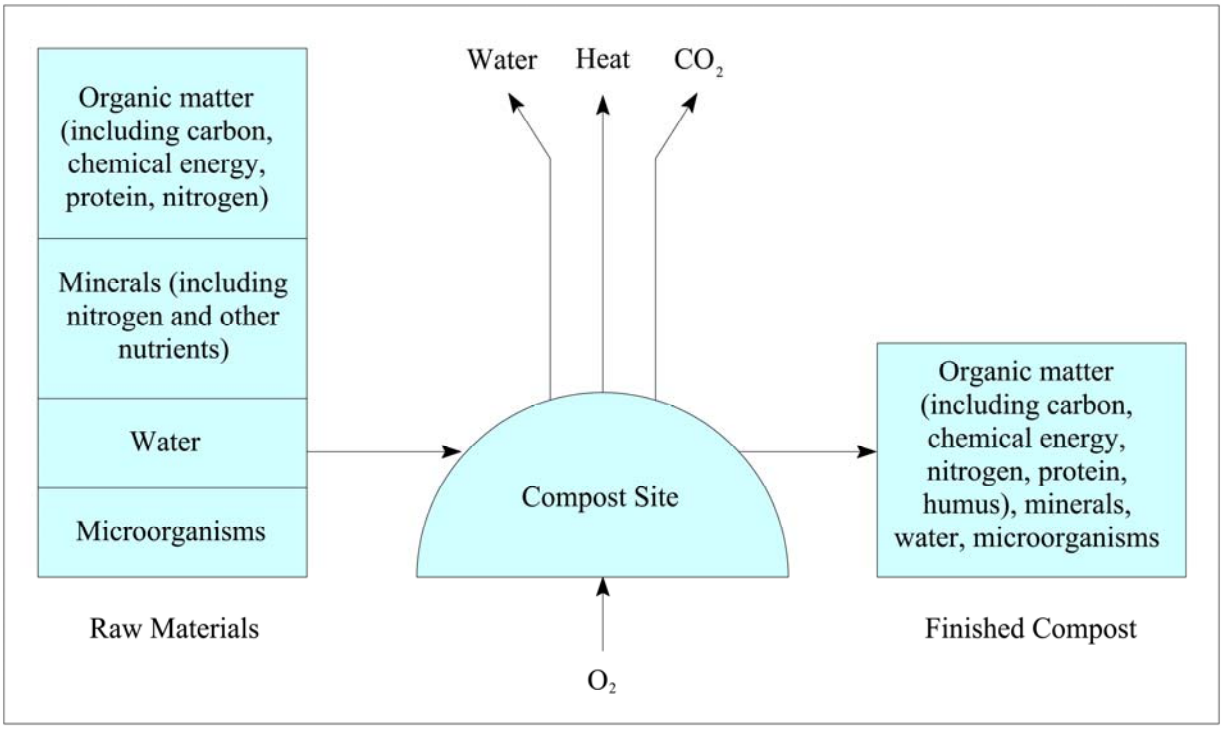
The technology options available for processing the Municipal Solid Waste (MSW) are based on either bio conversion or thermal conversion. The bio-conversion process is applicable to the organic fraction of wastes (wet waste), to form compost or to generate biogas such as methane (biomethanation) and residual sludge (manure). The thermal conversion technologies are incineration with or without heat recovery, pyrolysis and gasification, plasma pyrolysis and pelletization or production of Refuse Derived Fuel (RDF) are applicable for treating dry waste or mixed waste.

4.1 Composting

Composting is a process of controlled decomposition of the organic waste, typically in aerobic conditions, resulting in the production of stable humus like product, compost. Considering the typical composition of wastes and the climate conditions, composting is highly relevant in India. Composting of the segregated wet fraction of waste is preferred. Mixed waste composting, with effective and appropriate pre-treatment of feedstock may be considered an interim solution; in such cases stringent monitoring of the compost quality is essential.

The decomposition process takes place in the presence of air and results in elevated process temperatures, the production of carbon dioxide, water and stabilised residue, known as humus. A high degree of stabilisation can generally be achieved in 3-6 weeks, however ‘curing’ of the humus is normally carried out. For composting to occur in an optimum manner, five key factors need to be controlled; temperature, moisture, oxygen, material porosity and Carbon: Nitrogen ratio. Compost, the final product, because of its high organic content, makes a valuable soil conditioner and is used to provide nutrients for plants. When mixed with soil, compost promotes proper balance between air and water in the resulting mixture, which further helps reduce soil erosion, and serves as a slow-release fertilizer.

Figure 4-1: Composting Process



Technologies for composting can be classified into the following categories:

4.1.1 Windrow Composting

Windrow composting is the most economical and widely accepted composting process. Windrow composting process consists of placing the pre-sorted feed stock in long narrow piles called windrows that are turned on a regular basis for boosting passive aeration. The turning operation mixes the composting materials and enhances passive aeration.

The size, shape, and spacing of windrows depend on the equipment used for turning. For example, bucket loaders are used to build high windrows whereas turning machines create low and wide windrows. Manual labour is also used for windrows of a smaller scale where additional equipment costs and use of machinery is not feasible.

Windrow dimensions should allow conservation of heat generated during composting process while also maintaining diffusion of air to the deeper portions of the windrow. Windrows should be turned frequently, once a week over 5 weeks, to maintain aeration, porosity and enhance degradation. Frequency of turning depends upon – moisture content, porosity of material, rate of microbial activity, and desired composting time.

Fresh water or leachate stored in the leachate tank should be sprinkled during the turning process to maintain the moisture content of the waste. Temperature should also be monitored and maintained within 55-60°C.This is important because low/ high moisture and variation in temperature can slow down the composting process. After about 5 weeks, the compost is successively sieved and the screened material coming out of this section is uniform in texture but contains semi-solid organic compost, which requires further stabilization. Curing of screened material for at least 3 weeks in a covered area ensures complete maturation of compost.

Mature and high quality compost should have C/N ratio around 20:1. Compost with either higher or lower C/N ratio is not beneficial to the soil.

Figure 4-2: Windrow Composting

Image Credit: Imperial Compost

4.1.2 Aerated Static Pile Composting

Aerated static pile composting is a technology that requires the composting mixture (of pre-processed material) to be placed in piles that are mechanically aerated. The piles are placed over a network of pipes connected to a blower, which supplies the air for composting. Air can be supplied under positive or negative pressure. When the composting process is nearly complete, the piles are broken up for the first time since their construction. The compost is then taken through a series of post-processing steps.

Unlike aerobic windrow composting, the aerated static pile has direct control over aeration. This is the strength of this system, which can be used to reduce the fermentation time and also save precious fuel (diesel) used by the turning equipment.

As compost piles are not turned frequently, feedstock should be mixed with bulking agents like straw/ wood chips to ensure air circulation. Pre-processing is pre-requisite which involves segregation, size reduction and blending with bulking agents such as straw as it ensures porosity in the raw materials and hence facilitates efficient air circulation in the pile. Controlled mechanical aeration enables construction of large piles, thus reducing the demand for land. Aerated Static Pile technology usually takes 6-12 weeks for producing mature compost.

Figure 4-3: Aerated Static Pile Composting

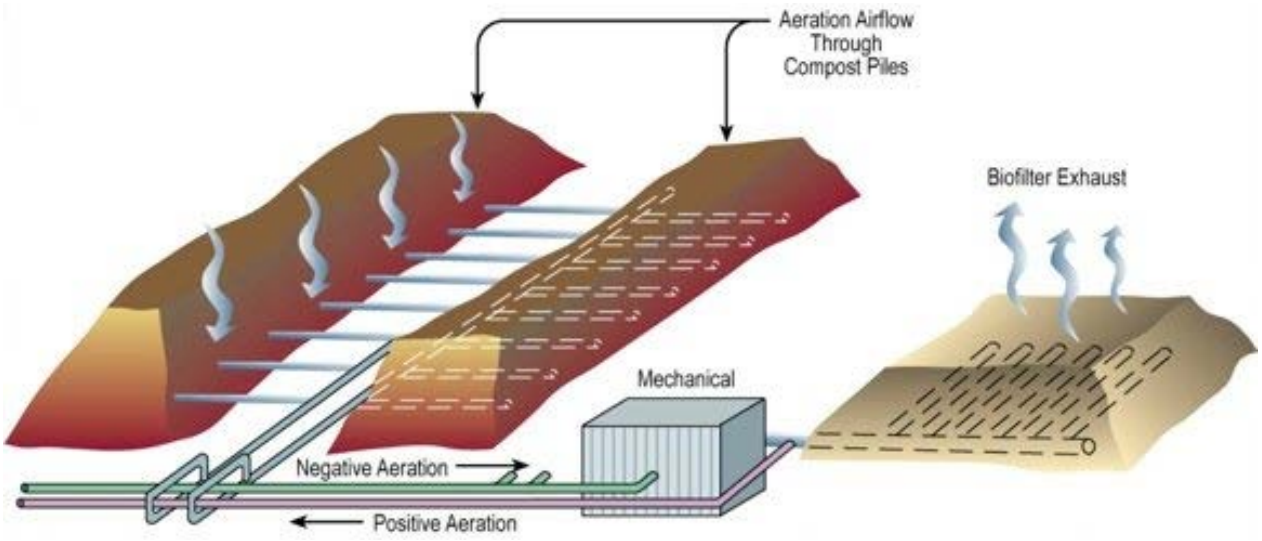


Image Credit: www.oregonlive.com

4.1.3 In-Vessel Composting

The in-vessel composting process is a closed reactor process with aeration and automated process flow. In-vessel composting is a completely enclosed and odour controlled system with continuous loading facility and is available in customizable capacity. The waste can be loaded and discharged either by an automated mechanical system or by simply using a front loader. For loading, a tunnel loading machine or a system of conveyor belts can be used. The most common discharging method is either by a pushing floor system or front loader.

The technology is a continuously loading, fully enclosed, flow-through process that transforms food and other organic material into compost with a 14-28 day retention period. The process output is a soil conditioner suitable for agricultural and horticultural purposes.

The composting vessel can be custom designed to handle a range of capacities. The composting vessel is a double-walled tunnel (stainless steel interior, burnished steel exterior) insulated to control the heat produced when organic materials decompose. Temperature and moisture levels inside the vessel's air zones are monitored constantly, and airflow is independently controlled in the composting zones to assure optimum composting conditions. The mixing zones (between each composting zone) assure proper mixing and aeration for bacterial growth. As the waste travels inside the vessel, it passes through composting zones and mixing zones.

Figure 4-4: In-Vessel Composting

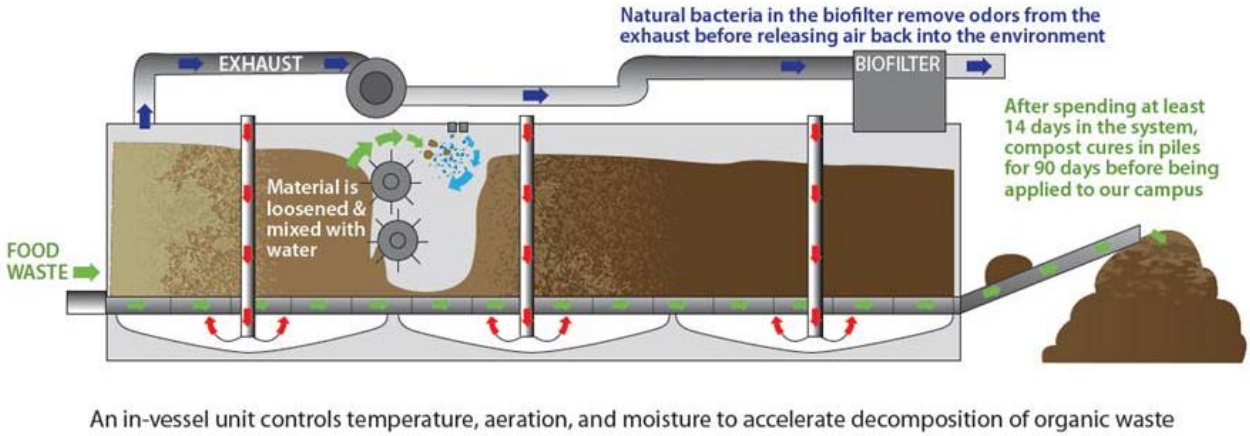


Image Credit: Ohio University

In Vessel composting is recommended especially for kitchen and canteen food waste. Since composting takes place in an enclosed vessel, all environmental conditions can be controlled to enhance composting. Minimal odour and leachate generation are observed.

4.1.4 Vermi composting

Vermicomposting involves the stabilization of organic solid waste through earthworm consumption which converts the material into worm castings. Vermicomposting is the result of combined activity of microorganisms and earthworms. Microbial decomposition of biodegradable organic matter occurs through extra cellular enzymatic activities (primary decomposition) whereas decomposition in earthworm occurs in alimentary tract by microorganisms inhabiting the gut (secondary decomposition). Microbes such as fungi, actinomycetes, protozoa etc. are reported to inhabit the gut of earthworms. Ingested feed substrates are subjected to grinding in the anterior part of the worm's gut (gizzard) resulting in particle size reduction.

Vermicomposting is a tripartite system that involves biomass, microbes and earthworms is influenced by the abiotic factors such as temperature, moisture, aeration, etc. Microbial ecology changes according to change of abiotic factors in the biomass but decomposition never ceases. Conditions unfavourable to aerobic decomposition result in mortality of earthworms and subsequently no vermicomposting occurs. Hence, pre-processing of the waste as well as providing favourable environmental condition is necessary for vermicomposting.

The worm species that are commonly considered are Pheretima sp, Eienia sp and Perionyx excavatus sp. These worms are known to survive in the moisture range of 20-80% and the temperature range of 20-40 °C. These worms do not survive in pure organic substrates containing more than 40% fermentable organic substances. Hence fresh waste is commonly mixed with partially or fully stabilized waste before it is subjected to vermicomposting. The worms are also known to be adversely affected by high concentrations of heavy metals such as cadmium, chromium, lead and zinc. Since earthworms are very sensitive towards heavy metals, it is very important to ensure that waste feed is not contaminated. Vermicomposting is typically suited for managing smaller waste quantities.

The choice of composting technology depends on a number of criteria which include quantity of waste to be processed, land requirement, climatic conditions, stability, energy requirements, financial implications, monitoring requirements and aesthetic issues. Table 4.1 gives a brief overview of different composting technologies.

Figure 4-5: In-Vessel Composting

Image Credit: Yours Naturally

Table 4-1: Summary of different Composting Technologies

Parameters	Windrow	Aerated Static Pile	In-Vessel	Vermi-Composting
Applicable with Population Size	Population above 1 lakh to 10 lakh	Population above 1 lakh to 10 lakh	Population above 1 lakh to 5 lakh	Less than 1 lakh population
General	Simple Technology	Effective for farm and municipal use	Large- scale systems for commercial applications	Suitable for quantities less than 25 TPD generation of mixed MSW
Amount of waste treated	Above 25 TPD, max. 500 TPD	Above 25 TPD, max. 500 TPD	Above 25 TPD, max. 250 TPD	Less than 25 TPD
Land Requirement	8 ha – 500 TPD	5 ha - 500 TPD (Less land required given faster rates and effective pile volumes)	4 ha - 500 TPD (Very limited land due to rapid rates and continuous operations)	2 ha: 50 TPD
Time	8 Weeks	5 Weeks	3 Weeks (3-5 days in vessel; 3 weeks to mature)	8 Weeks
Ambient Temperature	Not temperature sensitive	Not temperature sensitive	Not temperature sensitive	Temperature sensitive (30-40°C ideal range; 35-37°C specific to particular earthworm sp.)
Energy Input	Moderate	Moderate (2-3 hrs. aeration)	High	Low
Financial Implication	Moderate	Costly	Very Costly	Moderate. Purchase of exotic earthworms suitable for MSW composting are expensive
Odour/ Aesthetic Issues	Odour is an issue if turning is inadequate	Moderate. Odour can occur but controls can be used such as pile insulation and filters on air system	Minimum. Odour can occur due to equipment failure or system design failure	
Recommendation	✓			✓

Based on the assessment, Windrow and Vermi Composting is recommended based on implementation experience in India.

The quality of the compost should meet the standards set by Fertilizer Control Order, 2009 and Municipal Solid Waste Rules 2000. The compost which is to be used as fertilizer for food crops should abide by the FCO Rules which are more stringent, while compost used as a soil conditioner and for other purposes should at least meet the requirements of MSW Rules, 2000. The FCO 2013 specified quality standards for PROM which is formed by the mixing of rock phosphate with MSW derived compost considering short supply of phosphatic in the country,

while retaining the standards specified in FCO 2009 for organic compost. Table 4.2 is a comparison of compost quality standards as specified by the FCO Rules 2009, 2013 and MSW (M&H) Rules 2000. As the MSW Rules 2000 is under revision it is recommended to follow FCO 2009 standards.

Table 4-2: Compost Quality Standard as per MSW Rules, FCO 2009 and FCO 2013 (PROM)

Parameters	Organic Compost		Phosphate Rich Organic Manure
	MSW Rules 2000	FCO 2009	FCO 2013
Arsenic (mg/kg)	10	10	10
Cadmium (mg/kg)	5	5	5
Chromium (mg/kg)	50	50	50
Copper (mg/kg)	300	300	300
Lead (mg/kg)	100	100	100
Mercury (mg/kg)	0.15	0.15	0.15
Nickel (mg/kg)	50	50	50
Zinc (mg/kg)	1000	1000	1000
C/N Ratio	20-40	<20	Less than 20:1
pH	5.5 – 8.5	6.5 – 7.5	(1:5 solution) maximum 6.7
Moisture, per cent by weight, maximum		15 – 25	
Bulk density (g/cm3)		<1	<1.6
Total Organic Carbon, per cent by weight, minimum		12	7.9
Total Nitrogen (as N), per cent by weight, minimum		0.8	0.4
Total Phosphate (as P2O5), percent by weight, minimum		0.4	10.4
Total Potassium (as K2O), percent by weight, Minimum		0.4	
Colour		Dark brown to Black	
Odour		Absence of foul Odour	
Particle size		Minimum 90% material should pass through 4.0 mm IS sieve	Minimum 90% material should pass through 4.0 mm IS sieve
Conductivity (as dsm-1), not more than		4	8.2

4.2 Biomethanation/ Anaerobic Digestion

Biomethanation involves controlled biological degradation of organic wastes by microbial activity in the absence of oxygen. The process involves the anaerobic (without air) decomposition of wet organic wastes to produce a methane-rich biogas fuel and a small amount of residual sludge that can be used for making compost. It takes place in digester tanks or reactors, which enable control of temperature and pH levels for optimizing process control. Methane-rich gas produced is suitable as fuel for energy generation. The residual sludge is also produced, which is suitable for enriching compost materials. Input preparation or source separation is required to ensure that waste is free of non-organic contamination.

Anaerobic digestion is best suited to the treatment of wet organic feed stocks such as high moisture agricultural biomass, food waste, and animal wastes including manure and domestic sewage. A prepared feedstock stream with less than 15 percent Total Solid (TS) is considered wet and feed stocks with TS greater than 15-20 percent are considered dry. Feedstock is typically diluted with process water to achieve the desirable solids content during the preparation stages.

The homogeneity of the feed material is an important parameter from the efficiency point of view. The waste must be sorted so that all inorganic products are removed from the refuse prior to entry into the digester. Ideally the refuse should be sorted at source, if not, it could be sorted by hand/mechanical means on delivery to the site.

Single-stage digesters are simple to design, build, and operate and are generally less expensive. The organic loading rate of single-stage digesters is limited by the ability of methanogenic organisms to tolerate the sudden decline in pH that results from rapid acid production during hydrolysis. Two-stage digesters separate the initial hydrolysis and acid-producing fermentation from methanogenesis, which allows for higher loading rates but requires additional reactors and handling systems.

The solid waste management system needs to be modified and improved to make it compatible with the requirements of biomethanation technology covering source separation collection of solid waste. Otherwise, the applicability will be limited to highly organic and homogenous waste streams such as slaughter house waste, market wastes.

The yield of biogas depends on the composition of the waste feedstock and the conditions within the reactor. The modern anaerobic digestion treatment processes are engineered to control the reaction conditions to optimize digestion rate and fuel production. Typically 100-200 m^3 of gas is produced per ton of organic MSW that is digested. Important Operating parameters controlling biomethanation:

- Temperature: Treatment of waste in anaerobic reactors is normally carried out within two ranges: around 25-40°C known as mesophilic range and higher than 45°C known as thermophilic range.
- pH: The anaerobic digestion process is limited to a relatively narrow pH interval from approximately 6.0 to 8.5 pH
- Moisture: The moisture content of waste should not be less than 15% as it can prevent decomposition of waste
- Toxicity: A number of compounds are toxic to anaerobic microorganisms. Methanogens are commonly considered to be the most sensitive to toxicity

- C/N Ratio: Optimum C/N ratio in anaerobic digesters is between 20–30. A high C/N ratio is an indication of rapid consumption of nitrogen by methanogens and results in lower gas production. On the other hand, a lower C/N ratio causes ammonia accumulation and pH values exceeding 8.5, which is toxic to methanogenic bacteria.
- Organic Loading Rate: Organic loading rate is the frequency and speed at which the substrate is added to the digester. For each plant of a particular size, there is an optimal rate at which the substrate should be loaded. Beyond this optimal rate, further increases in the feeding rate will not lead to a higher rate of gas production. Agitation or consistent stirring of the contents in the digester also plays an important role in determining the amount of biogas produced
- Retention Period: The required retention time for completion of the reactions varies with differing technologies, process temperature, and waste composition. The retention time for wastes treated in a mesophilic digester range from 10 to 40 days. Lower retention times are required in digesters operated in the thermophilc range. A high solids reactor operating in the thermophilic range has a retention time of 14 days.

Indian Experience

1. Organic Recycling System has entered into a concession agreement with Solapur Municipal Corporation for processing a 400 TPD waste to energy plant using DRYAD ™ technology for 29 years. The technology is based on principles of Thermophilic Biomethanation (operating temperature 600C) with 40-50% solid content. Average biogas generation rate for the plant as per the discussion with the developer is 110 m3 per tonne of waste processed. The high biogas generation is on account of large availability of tendu leaf in the waste from the region. The biogas from the plant is desulphurised in biological scrubber and fed to the gas engine. Waste heat from the engine is recovered and utilized for heating water which is added to the digester.

   Currently the first phase of the plant is operational (since July 2012) with an installed capacity of 200 TPD. Approximately 9 acres of land has been provided by Solapur Municipal Corporation for development of plant on an annual lease rent of Re 1 per sq. m. The 200 TPD plant currently is developed on 2 acres of land. The plant is expected to generate 4MW from 400 TPD of waste, with approximately 20% captive consumption and will export approximately 3.2MW to the grid. The company has signed a power purchase agreement with MSEDC for 20 years at a preferential tariff of Rs. 6 per unit.

2. The Nisarguna Technology developed by the Babha Atomic Research Centre (BARC)

   The organic solid waste, mainly kitchen waste, obtained through proper segregation is ideal feed stock for biomethanation plants. The waste slurry undergoes both anaerobic and aerobic degradation and release methane gas in the process, while the undigested material settles down and can be used as manure since it is rich in plant nutrients. It must be noted that this technology is suitable both at the community level and at the ward level. Government establishments, housing colonies, big hotels etc. can set up such plants and process their kitchen wastes in the environment friendly manner.

   The success of the Nisargruna technology depends mainly on the proper segregation of the kitchen waste. This technology, while being low cost, has several other advantages which are inherently built into its processes. It would generate employment as well, and itself-sustainable as it generates fertilizers and biogas as outputs. Though its initial cost

maybe relatively higher than conventional gobar gas plants, the BARC model is more reliable and enduring due to modifications made in its design to prevent choking. It is also more versatile in its capacity to tolerate varied biodegradable feed stock.

As per Maharashtra Pollution Control Annual Report 2014-15, there are 16 plants with total capacity of 52 TPD operational in Maharashtra and 8 plants with total capacity of 23 TPD is under construction. The capacity of these plants range from 1 TPD to 5 TPD.

Table 4-3: Indicative Criteria for Selection of Appropriate Technology for treating Wet Waste

Criteria	Windrow Composting	Vermi Composting	Biomethanation
Applicable with Population Size	Above 1 Lakh	Between 5,000 to 1 Lakh	Small scale – between 5,000 to 25,000 Can be extended to Large scale as in case of Sholapur
Facility Location [1],[2]	Plant should be located at least one km away from habitation, if it is open windrow composting. The distance could be 500m in case of covered plants.	Within the residential area (with appropriate environmental safe guards)	Plant should be located at least 500 m away from residential areas, for plant sizes upto 500 TPD.
Buffer Zone (no Development Zone)	500 m for facilities dealing with 100 TPD or more of MSW; 400 m for facilities for dealing with more than 75 or less than 100 TPD; 300 m for facilities dealing with 50-75 TPD of MSW; 200 m for facilities dealing with less than 50 TPD MSW. For Decentralized plants handling less than 1 TPD MSW no buffer zone is required; however adequate environmental controls are required.		
Natural Environment	Composting in coastal/ high rainfall areas should have a shed to prevent waste from becoming excessively wet and thereby to control leachate generation	Composting in coastal/ high rainfall areas should have a shed to prevent waste from becoming excessively wet and thereby to control leachate generation	
Land Requirement	High (For 500TPD of MSW: 6 ha of land is required)	High (Suitable for quantities less than 25 TPD)	Low to Moderate For small units: 500 sq. m for 5MT unit For large scale: 300 TPD of MSW: 2 ha of land is required)
Waste Quantity which can be managed by a single facility	25 TPD and above	1 TPD to 25 TPD	1-5 TPD at small scale to
Requirement for Segregation prior to technology	High	Very high	Very high
Rejects	About 30% including inert if only composting is done	About 30% including inert	About 30% from mixed waste
Potential for Direct Energy Recovery	No	No	Yes
Technology Maturity	Windrow composting technique is well established	Community scale projects are successful	Feasibility for segregated biodegradable waste is proven. Not suitable for mixed waste

[1] *Site selection criteria specified by the EIA Notification 2006 and its amendments shall be considered.*

[2] *CPCB Guidance on Criteria for Site Selection for Landfills shall also be considered*

Criteria	Windrow Composting	Vermi Composting	Biomethanation
Market for By-product/ End Product	Quality compost compliant with FCO 2009 has a good market. IPNM Task Force (vetted by Supreme Court, 1 Sep 2006) has recommended co-marketing of 2-3 bags of compost with 7-8 bags of inorganic fertilizer.	Good market potential in Urban and Rural areas. However it is not adequately explored.	The technology is not fully explored, though it has a potential to generate energy as well as digested sludge manure.
Labour Requirement	Labour intensive	Labour intensive	Less Labour intensive
Predominant skills for Operation and Management	Skilled & Semiskilled labour	Skilled & Semiskilled labour	Skilled labour
Concerns for toxicity of product	The final product is generally applied to soil and used as manure. Can contaminate the food chain if compost is not meeting FCO norms.	The product is generally safe as worms cannot endure significant contamination of raw materials. FCO Standards are to be met with.	
Leachate Pollution	High if not treated appropriately	Insignificant quantities at low waste volumes per vermi-pit.	High if not treated appropriately
Atmospheric pollution	Low (Dust, aerosol, etc.). Odour issues.	Low. Odour issues.	Low Leakage of biogas. Odour issues
Other	Fire and safety issues to be taken care of	Fire and safety issues to be taken care of	Fire and safety issues to be taken care of

5.0 Technology Options for Treatment of Dry MSW

5.1 Material Recovery and Recycling

Recycling is the process by which materials that are otherwise destined for disposal are collected, processed and remanufactured or reused. Recyclables mainly consist of paper, plastic, metal, and glass and can be retrieved from the waste stream for further recycling. If appropriate market mechanisms are established, recycling can generate revenues, contributing to the overall cost recovery for municipal solid waste service provision.

Material recovery starts at the primary level, by households which segregate recyclables like newspapers, cardboard, plastics, bottles etc. from waste, to sell such material to local recyclers/ scrap dealers / haulers or kabadi system. What is not sold to the kabadi system, is discarded and becomes part of the municipal solid waste. Rag pickers pickup parts of this waste and sell them to earn their living. Well segregated recyclables can directly be transferred to the treatment site or to the recyclable market depending on local conditions.

The dry fraction of the segregated waste may be further segregated locally or at the transfer station or at the treatment plant. Different recyclables are sent either directly to locally available recycling facilities or are sold to wholesale dealers.

Material Recovery Facility (MRF) is meant for further segregation of recyclables into separate categories for effective reuse and recycling. The waste pickers and members of Self Help Groups can be used for this purpose. The segregation here can be either done manually or through semi-automatic system depending on the quantum of waste generated and financial resources available with the ULBs.

Dry segregated material is received in a mixed form consisting of a combination of fibres (paper, card board, mixed paper, magazines etc.) and comingled containers (Plastic, glass, metal etc.), among other material. The first stage of processing typically utilizes manual labour or equipment that separate material into various streams (fibre, paper, plastic, containers etc.). These recyclables are also sorted by using automated machines when quantities to be handled are large.

5.2 Refuse Derived Fuel/ Pelletisation

Refuse Derived Fuel (RDF) refers to the high calorific, non-recyclable fraction of processed municipal solid waste which is used as a fuel for either steam/ electricity generation or as alternate fuel in industrial furnaces/boilers (co-processing/co-incineration of waste in cement and steel industry and for power generation). The composition of RDF is a mixture that has higher concentrations of combustible materials than those present in the parent mixed MSW.

The RDF process typically includes thorough pre-separation of recyclables, shredding, drying, and densification to make a product that is easily handled. Glass and plastics are removed through manual picking and by commercially available separation devices. This is followed by shredding to reduce the size of the remaining feedstock to about eight inches or less, for further processing and handling. Magnetic separators are used to remove ferrous metals. Eddy-current separators are used for aluminium and other non-ferrous metals. The resulting material contains mostly food wastes, non-separated paper, some plastics (recyclable and non-recyclable), green wastes, wood, and other materials. Drying to less than 12% moisture is typically accomplished

through the use of forced-draft air. Additional sieving and classification equipment may be utilized to increase the removal of contaminants. After drying, the material often undergoes densification processing such as pelletizing to produce a pellet that can be handled with typical conveying equipment and fed through bunkers and feeders.

Figure 5-1: Refuse Derived Fuel

Image Credit: Clean India Journal

The RDF can be immediately combusted on-site or transported to another facility for burning alone, or with other fuels. The densification is even more important when RDF is transported off-site to another facility, in order to reduce volumes being transported. RDF is often used in waste to energy plants as the primary or supplemental feedstock, or co-fired with coal or other fuels in power plants, in kilns of cement plants, and with other fuels for industrial steam production.

RDF typically consists of dry fraction of MSW including paper, textile, rags, leather, rubber, non-recyclable plastic, jute, multi-layer packaging, and other compound packaging, cellophane, thermocol, melamine, coconut shells and other high calorific fractions of MSW. However from the ISWM hierarchy perspective, the city should give priority to separately recycle relevant components (e.g., paper, plastics, jute, metal, glass, multi-layer packaging used for liquid food items etc.). The composition and resultant energy content of RDF varies according to the origin of waste material and the sorting/ separation/ processing processes being adopted in the treatment facility.

RDF quantity and composition is determined by the nature of the waste and extent of material recovery/recycling processes implemented by the city. The quantity of RDF that can be produced per tonne of MSW varies depending on the type of collection, pre-processing and composition of waste source.

The relative uniformity of properties and higher quality of RDF as compared to mixed MSW has led in the past to a preference for RDF in some applications. Co-processing of RDF in cement/steel/power plants is a preferred option. RDF can also serve as a feedstock for different thermal systems, e.g. MSW incineration, pyrolysis and gasification. In keeping with the present state of technology, RDF is fired in the moving grate furnace or in an appropriate boiler equipped with a grate system.

Table 5-1: Indicative Criteria for Selecting RDF Technology

Criteria	RDF
Applicable with Population Size	Above 5 Lakh, small ULBs can go for cluster approach
Facility Location	Plant should be located at least 500 m away from residential areas.
Buffer Zone (No Development Zone)	500 m for facilities dealing with 100 TPD or more of MSW; 400 m for facilities for dealing with more than 75 or less than 100 TPD; 300 m for facilities dealing with 50-75 TPD of MSW; 200 m for facilities dealing with less than 50 TPD MSW. For Decentralized plants handling less than 1 TPD MSW no buffer zone is required; however adequate environmental controls are required.
Land Requirement	Low to Moderate (For 300 TPD of MSW: 2 ha of land is required)
Waste Quantity which can be managed by a single facility	100 TPD and above
Requirement for Segregation prior to technology	High
Rejects	Around 30% from mixed waste
Potential for Direct Energy Recovery	No (feed stock for energy recovery)
Technology Maturity	Quality of RDF should be based on end use, no clear consensus on quality requirements. Burning of RDF below 850°C for less than 2 seconds residence time can pose serious problems of health and environment. Rules regulating characteristics of RDF and guidelines for appropriate use not prescribed by concerned authority.
Market for By-product/ End Product	Good market potential for RDF. In small cities, RDF plants only become feeders of RDF to large RDF based power plants and cement plants.
Labour Requirement	Labour intensive (based on current practice)
Predominant skills for Operation and Management	Skilled & Semiskilled labour
Leachate Pollution	Low
Atmospheric pollution	Low to Moderate (Dust, aerosols). Very high if RDF is not burnt at required temperature. Odour issues.
Other	Presence of inappropriate material in the RDF (chlorinated plastics). Fire and safety issues to be taken care of.

6.0 Waste to Energy

Waste to Energy (WTE) refers to the process of generating energy in the form of heat or electricity from municipal solid waste. Waste to energy generation technologies can play significant role in an integrated waste management system by treating waste and generating power/ energy and reducing the waste volumes for disposal. In addition to generation of energy the these technologies can

Waste to Energy is generally recommended for cities having population over 10 lakh.

- Reduce the volume of waste to be disposed and preserving landfill space
- Allow for the recovery of energy from the waste stream.
- Allow for the recovery of materials from the waste stream which can then be reused or recycled.
- Destroy contaminants present in the waste stream, thereby reducing potential pollutants in the leachate and subsequent environmental pollution

Proven Waste to Energy technologies include incineration of municipal solid waste with recovery of energy, either as heat or converted to electricity and production of high calorific value Refuse Derived Fuel (RDF) from municipal solid waste, which is fast gaining acceptance. There are various new technologies under discussion such as pyrolysis and gasification, which are not yet proven under Indian conditions. Combustion technologies in India have to cope with the comparably high moisture and inert content, as is common in Indian waste. Application of technologies like pyrolysis and gasification to treat municipal solid waste is at a very nascent stage in the country, with one or two experimental plants in the process of being set-up.

Waste to Energy plants are an expensive option for managing municipal solid waste, requiring skilled manpower and adoption of high-level technologies. They also have the potential to cause significant environmental impacts through emissions and fly ashes, if plants are not operated efficiently and appropriate emission control mechanisms are not adopted.

6.1 Incineration

Incineration is a waste treatment process that involves combustion of waste at very high temperatures, in the presence of oxygen and results in the production of ash, flue gas and heat. Incineration is feasible for unprocessed or minimum processed refuse besides for the segregated fraction of the high calorific waste.

The potential for energy generation depends on the composition, density, moisture content and presence of inert in the waste. In practice, about 65 to 80 % of the energy content of the waste can be recovered as heat energy, which can be utilized either for direct thermal applications, or for producing power via steam turbine generators.

Mass-burn systems are the predominant form of the MSW incineration. It involves combustion of unprocessed or minimally processed refuse. The major components of a mass burn facility include: (1) Refuse receiving, handling, and storage systems; (2) Combustion and steam generation system (a boiler); (3) Flue gas cleaning system; (4) Power generation equipment (steam turbine and generator); (4) Condenser cooling water system; and (5) Residue hauling and storage system.

Mass burn incineration with a movable grate incinerator is a widely used and thoroughly tested technology. It meets the demands for technical performance and can accommodate large variations in waste composition and calorific value.

The main advantage of a mass-burn facility is the amount of energy that it produces and significant volume reduction of landfilled waste. However, it does have the disadvantage of producing significant amounts of air pollution, including heavy metals released during the combustion process. The ash that results from the combustion still has to be disposed. In considering the MSW incineration option, it is important to weigh the benefits of incineration against the significant capital and operating costs, potential environmental impacts, and technical difficulties of operating an incinerator.

The success of a waste incineration plant depends on the type of waste that is being treated. The following parameters and their variability are key drivers:

- The energy content of the waste, the average lower calorific value (LCV) must be at least 4000-6000 KJ/kg[3] throughout all season.
- Waste composition – high combustible material, low moisture, and low inert or ash
- Waste physical composition, e.g. particle size
- The supply of combustible waste should be stable and amount to at least 500 tonnes/day

Greater variability in the above parameters leads to higher costs for pre-treatment of waste and downstream operations such as flue gas cleaning. The external costs of pre-treatment of waste add significantly to the overall cost of waste management and to emissions from the systems. Flue-gas cleaning is often a significant contributor to overall incineration costs (i.e. approx. 15 to 35 % of the total capital investment).

[3] *Municipal Solid Waste Incineration, World Bank Technical Guidance Report*

Figure 6-1: Typical Mass Burn Incinerator

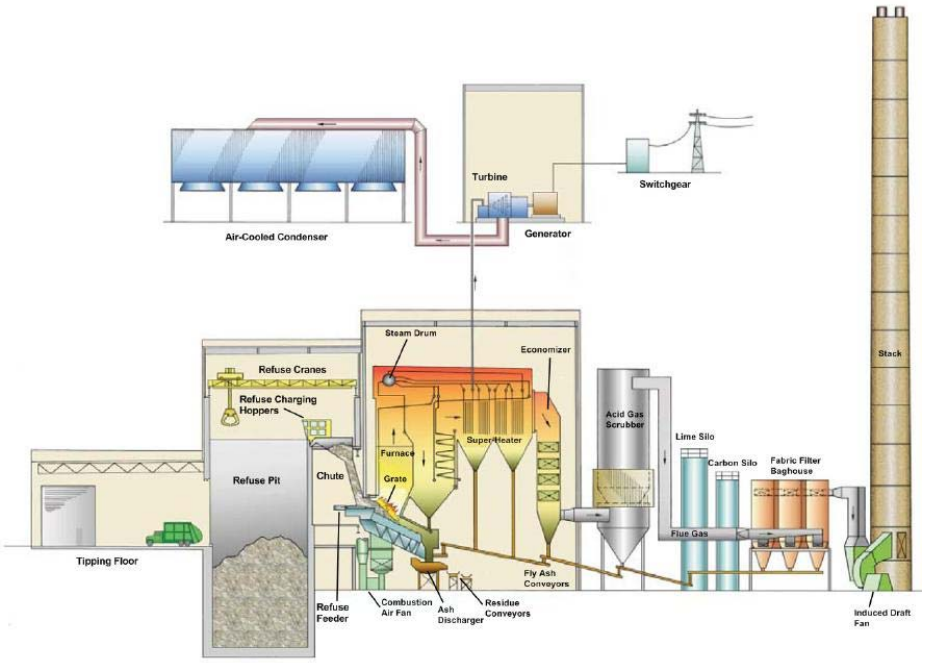


Image Credit: Waste to Energy International

The MSW Rules, 2000 provides operating and emission standards for incineration. The combustion efficiency (CE) shall be at least 99.00%. The emission standard as per MSW Rules 2000 is provided in Table 6.1.

Table 6-1: Emission Standard for Incineration

Parameters	Concentration mg/Nm^3
Particulate Matter	**150**
Nitrogen Oxides	**450**
HCl	**50**
Minimum Stack Height	**30 meters above ground**
Volatile Organic compounds in ash shall not be more than	**0.01%**

Indian Experience

In India, a MSW incineration-cum-power plant is operating at Okhla. The Timarpur Okhla Municipal Solid Waste Management plant is a private-public partnership project of the Jindal ITF Ecopolis and Municipal Corporation of Delhi (MCD).The plant design capacity is 2000 TPD of MSW and to generate 20 MW power and it was commissioned in 2012. In addition, there are other waste to energy at various stages of construction across at Pune, Hyderabad, Delhi and Bangalore.

6.2 Emerging Waste to Energy technology

6.2.1 Gasification

Gasification process involves the partial oxidation of carbon-based feedstock to generate a syngas, which can be used as a fuel or for the production of chemicals.

Gasification produces gases and liquids, as well as residual solids, including ash and carbon char. Inorganic materials in the feedstock are removed as bottom ash. They are usually combined with char, and can be separated out for disposal or used in making block materials.

Gasification typically relies on carbon-based waste such as paper, petroleum-based wastes like plastics, and organic materials such as food scraps. As MSW is a heterogeneous waste stream, pre-processing of MSW is required to make Gasification process more efficient. The pre-processing includes the separation of thermally non-degradable material such as metal, glass and inert along with size reduction and/or densification of the feedstock, if required. If MSW has high moisture content, a dryer may be added to the pre-processing stage to lower the moisture content of the MSW to 25% or lower, because lower moisture content of the feedstock increases its heating value and the system becomes more efficient. The optimal calorific value of waste should be approximately 2000 kcal/kg for proper Gasification.

6.2.2 Pyrolysis

Pyrolysis involves an irreversible chemical change brought about by the action of heat in an atmosphere devoid of oxygen. Synonymous terms are thermal decomposition, destructive distillation and carbonisation. Pyrolysis, unlike incineration is an endothermic reaction and heat must be applied to the waste to distil volatile components. Process of converting plastic to fuels through pyrolysis is possible, but yet to be proven to be a commercially viable venture.

Pyrolysis is carried out at temperature between 500 and 1000°C and produces three component streams.

- Gas: A mixture of combustible gases such as hydrogen, carbon monoxide, methane, carbon dioxide and some hydrocarbons.
- Liquid: Consisting of tar, pitch, light oil and low boiling organic chemicals like acetic acid, acetone, methanol, etc.
- Char: Consisting of elemental carbon along with the inert materials in the waste feed.

The char, liquids and gas are useful because of their high calorific value. Part of the heat obtained by combustion of either char or gas is often used as process heat for the endothermic pyrolysis reaction. It has been observed that even after supplying the heat necessary for pyrolysis, certain amount of excess heat still remains which can be commercially exploited.

Though a number of laboratory & pilot investigations have been made, only a few have led to full scale plants globally.

Mainly plastics, particularly the poly-olefins, which have high calorific values and simple chemical constitutions of primarily carbon and hydrogen, are usually used as a feedstock in pyrolysis process. More recently, pyrolysis plants are being tested to degrade carbon rich organic materials such as municipal solid waste.

Where mixed municipal solid waste is received at the processing site, sorting and pre-treatment of the waste is an essential step to ensure removal of metals, ceramics and other recyclable

material. The remaining feed stock is shredded and the moisture content is reduced. Size reduction is also an essential step in pre-treatment, to ensure appropriate size of the feedstock in relation to the feed equipment of the furnace. Maximum efficiency is achieved when the feedstock quality is homogenous.

Table 6-2: Indicative Criteria for Selecting Incinerator/ WTE Technology

Criteria	Incineration
Applicable with Population Size	More than 10 Lakh
Facility Location	Plant should be located at least 1km away from residential areas.
Buffer Zone (No Development Zone)	500 m for facilities dealing with 100 TPD or more of MSW; 400 m for facilities for dealing with more than 75 or less than 100 TPD; 300 m for facilities dealing with 50-75 TPD of MSW; 200 m for facilities dealing with less than 50 TPD MSW. For Decentralized plants handling less than 1 TPD MSW no buffer zone is required; however adequate environmental controls are required.
Land Requirement	Low To be assessed
Waste Quantity which can be managed by a single facility	500 TPD and above (smaller plants are not techno-economically viable, given the cost of required environmental control equipment & boiler technology
Requirement for Segregation prior to technology	High – Feed stock should be free from inert and low on moisture content
Rejects	Around 15%
Potential for Direct Energy Recovery	Yes
Technology Maturity	Technology is available. However constraints of low calorific value, high moisture content and high proportion of inert waste should be considered while undertaking the project commercially
Indicative Capital Investment	Very High capital, operating and maintenance costs.
Market for By-product/ End Product	Good potential of energy generation if power purchase agreements are made reflecting true cost of production including O&M costs
Labour Requirement	not labour intensive but Requires considerable technical capacity,
Predominant skills for Operation and Management	Highly skilled required
Leachate Pollution	Low (provided fly-ash is managed appropriately and disposed in a hazardous waste landfill.
Atmospheric pollution	Very high if not managed properly. (Emissions due to incomplete combustion of municipal refuse contain a number of toxic compounds, requiring appropriate emissions control systems)
Other	Disposal of bottom ash and slag. Fire and safety issues to be taken care of.

7.0 Construction & Demolition Waste

Construction and demolition waste is generated whenever any construction/ demolition activity takes place, such as, building roads, bridges, fly over, subway, remodelling etc. It consists mostly of inert and non-biodegradable material such as concrete, plaster, metal, wood, plastics etc. A part of this waste comes to the municipal stream. These wastes are heavy, having high density, often bulky and occupy considerable storage space either on the road or communal waste bin/container. It is not uncommon to see huge piles of such waste, which is heavy as well, stacked on roads especially in large projects, resulting in traffic congestion and disruption. Waste from small generators like individual house construction or demolition, find its way into the nearby municipal bin/vat/waste storage depots, making the municipal waste heavy and degrading its quality for further treatment like composting or energy recovery. Often it finds its way into surface drains, choking them. It constitutes about 10-20 % of the municipal solid waste (excluding large construction projects).

According to Technology Information, Forecasting & Assessment Council (TIFAC) report,

- New construction generates about 40-60 kg per sq. of build-up area
- Repair and renovation of existing buildings generates 40-50 kg per sq. meter
- Demolition of buildings generate 300-500 kg per sq. meter

This category of waste is complex due to the different types of building materials being used but in general may comprise of the following materials:

Major components

- Cement concrete
- Bricks
- Cement plaster
- Steel (from RCC, door/window frames, roofing support, railings of staircase etc.)
- Rubble · Stone (marble, granite, sand stone)
- Timber/wood (especially demolition of old buildings)

Minor components

- Conduits (iron, plastic)
- Pipes (GI, iron, plastic)
- Electrical fixtures (copper/aluminium wiring, wooden baton, plastic switches, wire insulation)
- Panels (wooden, laminated)
- Others(glazed tiles, glass panes)

Landfill has been the traditional disposal mechanism for C&D waste, but in accordance with the waste management hierarchy and having regard to the resource value of the discarded materials and the current exhaustive pressures on landfill space, recycling must take over as the main management route for this waste stream.

7.1 Way Forward for ULBs in Construction & Demolition Waste Management

The primary effort therefore should be to engage in waste prevention and reduce the amount of waste generated in the first place i.e. minimise the resources needed to do the job.

Material that is generated should be reused on site or salvaged for subsequent reuse to the greatest extent possible and disposal should only be considered as a last resort. Initiatives should be put in place to maximise the efficient use/reuse of materials. Excavated spoil/topsoil can be carefully set aside and used as landscaping material in the completed development. Innovative initiatives to avoid the need for disposal should be investigated:

- architectural features should ideally be reused in the refurbishment of retained structures on the same site;
- the warehousing of salvaged material can facilitate its reuse on future projects; and
- “architectural salvage sales” can allow the public to acquire material resources that have been removed from decommissioned buildings.

There are a number of established markets available for the beneficial use of C&D waste:

- waste timber can be recycled as shuttering or hoarding, or sent for reprocessing as medium density fibreboard;
- waste concrete can be utilised as fill material for roads or in the manufacture of new concrete when arising at source; and
- in addition, the technology for the segregation and recovery of stone, for example, is well established, readily accessible and there is a large reuse market for aggregates as fill for roads and other construction projects.

ULBs should make arrangements for placement of appropriate containers (skips or other containers) and their removal at regular intervals or when they are filled either through own resources or by appointing private operators. The collected waste should be transported to appropriate site(s) for further processing and disposal either through ULB owned resources or by appointing private operators. ULBs should monitor and record generation of construction and demolition waste within its jurisdiction. Municipal authorities should make bye-laws as well as special arrangements for storage, transportation, processing and disposal of C& D waste

Table 7-1: Role of ULBs – C&D Waste Management

ULBs < 1 Lakh Population	ULBs > 1 Lakh Population
• Notify locations, where waste generators having small quantities of C&D waste under 1 MT load should be allowed to deposit their waste. • Arrange for transportation for C&D waste deposited at collection centre through covered tractor trolley/ trucks to area designated for bulk storage • Plan for reuse and recycling of such waste with private sector participation or the C&D waste could be used for land reclamation by filling in low lying areas. C&D waste can also be used to fill in areas where stagnant water is repeatedly observed in order to prevent from mosquito breeding	• Notify suitable locations in different parts of the city where waste generators having small quantities of C&D waste under 1MT load can deposit their waste conveniently • Create a system of renting skips/ containers for storage of C&D waste at source departmentally or through an authorized private operator, where the generation of such waste is greater than 1 MT • Prescribed rates for collection and transportation of C&D waste to be published/ notified. • Citizens to avail the facility and refrain from disposal of small quantities of C&D waste anywhere else • Arrange for transportation of C&D waste through skip lifting system departmentally or through designated contractor • Plan for reuse and recycling of such waste with private sector participation. The rejects from these plants (soft fines) are used for filling in low lying areas • Private sector may be encouraged to facilitate reuse and recycling of C&D waste • The ULB should fix and notify charges for door step collection and transportation of C&D waste, based on the volume generated

C&D Waste processing and recycling facility needs to be developed either as a standalone facility for large cities or in cluster. This can be developed on a PPP basis. The facility would consist of (a) storage for bulk and retail C&D waste (b) collection from the storage bins and separately from the bulk generators (c) transportation (d) mechanical processing and (e) final C&D waste processed products

C&D waste can be effectively used in several ways

i. Reuse (at site) of bricks, stone slabs, timber, conduits, piping railings etc. to the extent possible and depending upon their condition.

ii. Sale / auction of material which cannot be used at the site due to design constraint or change in design.

iii. Plastics, broken glass, scrap metal etc. can be used by recycling industries.

iv. Rubble, brick bats, broken plaster/concrete pieces etc. can be used for building activity such as levelling, under coat of lanes where the traffic does not constitute of heavy moving loads.

v. As inert fill material for low-lying areas and landscaping. Larger unusable pieces can be sent for filling up low-lying areas.

vi. Fine material such as sand, dust etc. can be used as cover material over sanitary landfill.

vii. Processed C&D waste can be used for road and embankment construction

- Kerb stones (these generally do not have load bearing role)
- Paving blocks, interlocking tiles and drain covers used for pedestrian areas and gardens

8.0 Landfills

Sanitary landfills are facilities for final disposal of Municipal Solid Waste on land, designed and constructed with the objective of minimizing impacts to the environment. The Municipal-Solid Waste (Management and Handling) Rules 2000 and draft revised Rules 2013 provide comprehensive regulations on the siting, design and operation of sanitary landfills.

"Landfilling shall be restricted to non-biodegradable, inert waste and other waste that are not suitable either for recycling or for biological processing. Landfilling shall also be carried out for residues of waste processing facilities as well as pre-processing rejects from waste processing facilities. Landfilling of mixed waste shall be avoided unless the same is found unsuitable for waste processing. Under unavoidable circumstances or till installation of alternate facilities, landfilling shall be done following proper norms.

A modern landfill complying with these requirements is a complex facility with various equipment's to minimize environmental impacts.

Figure 8-1: Typical Cross Section for Sanitary Landfill

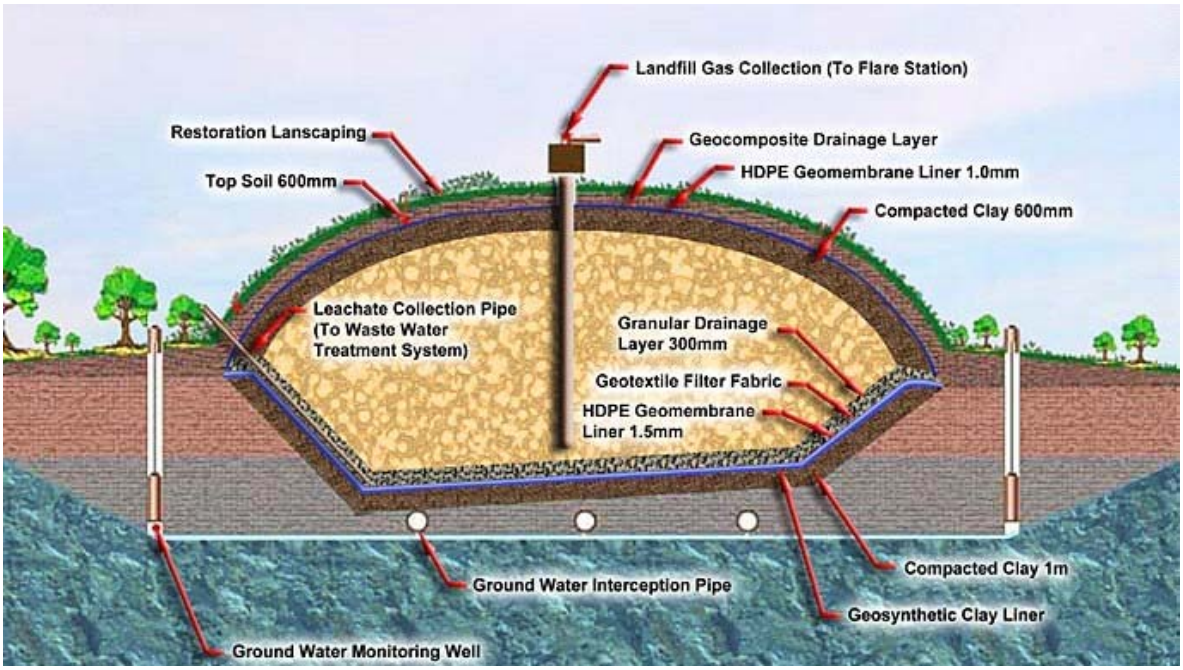


Image Credit: www.eco-web.com

8.1 Location Criteria

The MSW Rules provide criteria for the location of sanitary landfill. Additionally, the CPHEEO manual published by the Ministry of Urban Development has specified guidance for locating a landfill site.

Locational criteria for the selection of Landfill Facility

1. **Lake or Pond**: No landfill should be constructed within 200 m of any lake or pond. Because of concerns regarding runoff of waste water contact, a surface water monitoring program should be established if a landfill is sited less than 200m from a lake or pond.
2. **River**: No landfill should be constructed within 100 m of a navigable river or stream. The distance may be reduced in some instances for non-meandering rivers but a minimum of 30m should be maintained in all cases.
3. **Flood Plain**: No landfill should be constructed within a 100 year flood plain. A landfill may be built within the flood plain of secondary streams if an embankment is built along the stream side to avoid flooding of the area. However, landfills must not be built within the flood plains of major rivers unless properly designed protection embankments are constructed around the landfills.
4. **Highway**: No landfill should be constructed within 200 m of the right of way of any state or national highway. This restriction is mainly for aesthetic reasons. A landfill may be built within the restricted distance, but no closer than 50 m, if trees and berms are used to screen the landfill site.
5. **Habitation**: A landfill should be at least 500 m from a notified habituated area. A zone of 500 m around a landfill boundary should be declared a No-Development Buffer Zone after the landfill location is finalized.
6. **Public Park**: No Landfill may be constructed within the restricted distance if some kind of screening is used with a high fence around the landfill and a secured gate.
7. **Critical Habitat Area**: - No landfill should be constructed within critical habitat areas. If there is any doubt then the regulatory agency should be contacted.
8. **Wetlands**: - No Landfill should be constructed within wetlands. It is often difficult to define a wetlands area. Maps are available for some wetlands, but in many cases such maps are absent or incorrect. If there is any doubt, then the regulatory agency should be contacted.
9. **Ground water Table:** A landfill should not be constructed in areas where water table is less than 2 m below ground surface. Special design measures to be adopted, if this cannot be adhered to.
10. **Airports:** No landfill should be constructed within the limits prescribed by regulatory agencies (MOEF/CPCB/Aviation Authorities) from time to time.
11. **Water Supply Well**: No landfill should be constructed within 500m of any water supply well. It is strongly suggested that this location restriction be abided by at least down gradient wells. Permission from the regulatory agency may be needed if a landfill is to be sited within the restricted area.
12. **Coastal Regulation Zone**: A landfill should not be located in potentially unstable zones such as landside prone areas, fault zone etc.
13. **Buffer Zone**: A landfill should have a buffer zone around it, up to a distance prescribed by regulatory agencies.

8.2 Landfill Operation

Site Preparation:

Preparation of Landfill Base

- Site Clearance (Retain the Vegetation around the site for Buffer)
- Prepare Base for First Cell only (Precede subsequently)
- Earth shall be stored for daily & intermediate covers
- Compact the base
- Provide 2% slope towards leachate collection sump

Laying of Bottom Liner

- Source of clay shall be as near to site as possible
- If clay is not available amend the local soil with bentonite
- Maintain uniformity in grain size
- Carryout onsite permeability test
- Compacted soil liners should be constructed in a series of lifts each of 25cm compacted to about 15cm by compactor / sheep foot roller
- The finished thickness of liner should not be less than 90 cm
- Care has to be taken not to expose the clay liner surface during summer as cracks may develop

Laying of Geo-membrane Layer

- Prepare Surface before laying of liner (particles >10mm should not be present)
- Base should also be checked for any depressions and cracks
- The size of geo-membrane sheet should be easy to handle and work with, if larger sized are used, handling and laying will be difficult and smaller size require more numbers.
- The geo-membrane is usually spread for the active phase and anchor trenches are provided at free ends to safeguard membrane displacement, slipping and to facilitate further laying of adjacent phases
- A protective layer of fi ne grained soil screened of in situ soil of particle size less than 10mm, of thickness 15cm has to be provided over the top of geo-membrane
- The protective layer should be laid without vehicles travelling directly on the geo-membrane

Laying of Drainage Layer and Leachate Collection System

- A comprehensive leachate collection system laying schedule has to be prepared before the commencement of each phase of operation
- The Leachate collection pipe network should be laid on the fl at base as per the network layout
- The Leachate collection pipes should be embedded in drainage layer consisting of gravel of particle size 16 to 32mm and permeability to the tune of 1x10-2cm/sec and should be of 30 cm thickness

Operation Procedures:

Formation of Working Areas

- Working areas are constructed with in a larger area and a number of daily cells will be placed at bottom level over which cells are formed one above the other to cover the total lift of one phase

Waste Unloading, Spreading and Compaction

- Unloading of waste from delivery vehicles is a potentially hazardous operation
- All drivers shall be fully aware of the site rules governing the unloading of waste and obey instructions issued by site operatives
- A minimum of two discharge points should be maintained at all times
- Control should be exercised over the number of vehicles permitted inside the discharge area at any one time
- Comprehensive sign – posting should direct all drivers to the specific discharge point
- The designed tipping slopes should be maintained during tipping operation
- The waste is then pushed to the cell area, spread in layers not exceeding 50 cm and should be compacted by the compactor
- The subsequent loads are pushed above the initial layer to form the design cell height of 3 m and to attain the design slopes

Waste Unloading, Spreading and Compaction

- Considerable care should be exercised when placing the initial lift of waste above the landfill lining and leachate collection layer
- Individual items of wastes may be deemed to be unsuitable if these are large or bulky and likely to penetrate or deform the basal engineering measures
- All such unsuitable wastes should be stockpiled and, as soon as the initial lift becomes sufficient, should be incorporated into an early second lift

Daily Cover

- At the end of each working day the cell should be finally compacted to provide a smooth surface and covered by cover material
- The cover material shall be spread evenly to a thickness of 15 cm to cover the entire exposed face including flanks and working face

Intermediate Cover

- Daily cover fulfils only transient function and an intermediate cover should be provided at the end of each lift.
- Apart from this usual intermediate, a cover is proposed prior to onset of monsoon over the active area. An intermediate cover of 45 cm thickness is proposed using low permeable soil,
- which will be compacted with compactor providing 3 to 5 per cent gradient for surface water runoff

9.0 Way Forward for ULBs

Solid Waste Management is essentially a municipal function and it is mandatory for all municipal authorities to provide this service efficiently to keep the cities and towns clean, recycle and treat the waste and dispose the residual municipal solid waste in an environmentally acceptable manner.

In line with that, Urban Local Bodies (ULBs) should systematically develop their MSWM systems including carefully accessing their requirements of tools, equipment, vehicles, treatment and disposal facilities in a way and at a pace which is locally doable, meets the long term needs of the ULB and is also financially sustainable.

9.1 Preparation of Detailed Project Report

The first step for the ULBs is to prepare an implementable Detailed Project Report (DPR) which has a long term vision and management plan for municipal solid waste. This should include

- Step 1: Understanding of policies, programs and legal framework
- Step 2: Assessment of current situation and gap analysis
- Step 3: Preparation of municipal solid waste management master plan
    - Future Projection for population and waste generation
    - Waste Characterization
    - Waste segregation, collection, storage and transportation plan
    - Identification and notification of land for treatment/ disposal facilities
    - Selection of appropriate technology for waste treatment and waste disposal (centralized/ decentralized)
    - Institutional and financing structure
    - Community Participation and IEC program
    - Implementation schedule

It is very important the plan is developed in consultation with key stakeholders of the ULBs and considering their willingness to participate. It is also important for the state government to facilitate creation of cluster or regional facilities for disposal of rejects and inert.

9.2 Selection of Waste Treatment Technology

Selection of appropriate technology for waste treatment and disposal of rejects and inert is very critical. As multiple technologies for solid waste management are available, appropriate selection of the required treatment option is a major challenge. There is a lack of information among ULBs of the financial viability, sustainability and scalability of the technologies. In order to facilitate decision making and select appropriate technology,

Segregation of waste at source and responsibility for ensuring the same is very important for the effectiveness and success of a treatment technology.

Decentralized treatment is recommended in case of wet waste. Utilization of biodegradable components of waste at a decentralized level will help in minimizing the cost of collection and transportation to centralized processing facilities. Composting and biomethanation are more suited for decentralized mode and is recommended for smaller ULBs. The rejects from the treatment plan and inert can be disposed in centralized landfill facilities.

Certain processes are more amenable to be taken on centralized basis such as incineration, pyrolysis, gasification, RDF production and managing sanitary landfills and are recommended for larger ULBs.

Options based on population size to manage MSW in towns and cities are given is Table 9.1.

Table 9-1: Waste Treatment Technology Options Based on Population Size

Population Range/ Waste Generated (TPD)	Technology Option		Minimum Requirement	Value Added Product
	Wet Waste	Dry Waste		
Population: Less than 50,000 **Quantity: Less than 10 TPD**	• Windrow Composting • Vermi Composting • Biomethanation (Nisarguna)	• Material Recovery & Recycling	Segregate wet organic waste at source for Biomethanation/ Vermi Composting Dry waste for recycling and material recovery Inert to Regional Landfill	Compost (Manure)/ Biogas Recyclables: Paper/ Plastics/ Metals
Population: 50,000 to 1 Lakh **Quantity: 10 TPD to 30 TPD**	• Windrow Composting • Vermi Composting • Biomethanation (Nisarguna)	• Material Recovery & Recycling	Segregate wet organic waste at source for Biomethanation/ Vermi Composting Dry waste for recycling and material recovery Inert to Regional Landfill	Compost (Manure)/ Biogas Recyclables: Paper/ Plastics/ Metals
Population: 1 Lakh to 10 Lakh **Quantity: 30 TPD to 500 TPD**	• Windrow Composting • Biomethanation	• Material Recovery & Recycling • RDF	Segregate wet organic waste at source for Biomethanation Dry waste to be recycled or converted in to RDF as feedstock for centralized facility Inert to Regional Landfill	Compost (Manure)/ Biogas/ RDF Recyclables: Paper/ Plastics/ Metals
Population: 10 Lakh to 20 Lakh **Quantity: 500 TPD to 1000 TPD**	• Windrow Composting • Biomethanation • Waste to Energy	• Material Recovery & Recycling • RDF • Waste to Energy	Segregate wet organic waste at source for Biomethanation Dry waste to be recycled or converted in to RDF as feedstock for power plants	Compost (Manure)/ Biogas/ RDF/ Electricity Recyclables: Paper/ Plastics/

Population Range/ Waste Generated (TPD)	Technology Option		Minimum Requirement	Value Added Product
	Wet Waste	Dry Waste		
			Inert to Landfill	Metals
Population: 20 Lakh and above **Quantity: More than 1000 TPD**	• Windrow Composting • Biomethanation • Waste to Energy	• Material Recovery & Recycling • RDF • Waste to Energy	Segregate wet organic waste at source for Biomethanation Dry waste to be recycled or converted in to RDF as feedstock for power plants Inert to Landfill	Compost (Manure)/ Biogas/ RDF/ Electricity Recyclables: Paper/ Plastics/ Metals

9.3 Project Sustainability

The management of MSW is an organisational, technological and economic challenge. One of the reasons for the present dismal situation of waste management is the lack of financial viability. Operation and Maintenance of waste management facilities is highly essential for sustainability of the plants and the entire waste management chain. Any failure in O&M will have repercussions on the different levels of waste treatment and finally lead to accumulation of waste.

To ensure project sustainability, it is essential for ULBs to:

1. Plan and implement comprehensive awareness program for all stakeholders to ensure segregation of waste at source, collection and transportation of waste in segregated manner
2. Introduction and collection of SWM service charge/ user charge develop and implement recovery mechanism for the same.

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NOTES

Swachh Maharashtra Abhiyan

Urban Development Department

Government of Maharashtra