



Operation review of Faecal Sludge Treatment Plants in Maharashtra:

Case of Erandol, Chopda, Dhule and Igatpuri

Report prepared by Maharashtra Environmental Engineering Training and Research Academy (MEETRA)

Submitted to Center for Water and Sanitation (CWAS), CRDF, CEPT University



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Contents

Foreword.....	iv
Preface.....	v
Abbreviations.....	vi
1. Introduction.....	1
<i>1.1 Background.....</i>	<i>1</i>
<i>1.2 Need for the study.....</i>	<i>1</i>
<i>1.3 Scope of Work.....</i>	<i>2</i>
<i>1.4 About the cities.....</i>	<i>2</i>
<i>1.5 Sanitation scenario.....</i>	<i>4</i>
2. Detailed description of the FSTPs.....	6
3. City wise operation review of the FSTPs.....	8
<i>3.1 Operational procedures.....</i>	<i>8</i>
<i>3.2 Maintenance Procedures.....</i>	<i>10</i>
<i>3.3 Record keeping and testing procedures.....</i>	<i>10</i>
<i>3.4 Cost Study.....</i>	<i>13</i>
4. Conclusion:.....	14
Annexure 1: FSTP photo plate.....	16

List of Tables

Table 1	FSTP capacities in 4 case cities in Maharashtra.....	2
Table 2	Salient features of the four cities.....	3
Table 3	Information regarding desludging of septic tanks in the case cities.....	5
Table 4	Sludge drying time at FSTPs in the cities.....	8
Table 5	Selling price of dried sludge to the farmers in respective cities.....	9
Table 6	Information regarding sludge conveyance from source to treatment plants in the four cities.....	11
Table 7	Test results of the treated effluents in four case cities based on relevant parameters.....	12
Table 8	Detailed costing of the four cities' FSTPs.....	13

List of Figures

Figure 1	Geographical location of the Four case cities- Erandol, Igatpuri, Chopda and Dhule.....	3
Figure 2	Salient features of the Four case cities- Erandol, Igatpuri, Chopda and Dhule.....	4
Figure 3	Diagram representing the general process of sewage and septage treatment at FSTPS in the 4 cities.....	5
Figure 4	Sludge drying beds in Erandol, Igatpuri, Chopda and Dhule.....	6
Figure 5	ABR Units in Erandol, Igatpuri, Chopda and Dhule.....	6
Figure 6	PGF Units in Erandol, Igatpuri, Chopda and Dhule.....	7
Figure 7	Collection of dried sludge at FSTPs in Erandol, Igatpuri, Chopda and Dhule (From left to right)	8
Figure 8	Plantation around the Planted Gravel Filters at FSTPs in Erandol, Igatpuri, Chopda and Dhule (From left to right)	10
Figure 9	Samples of the effluents collected from the FSTPs for quality testing purpose.....	11



Foreword

Maharashtra has been a pioneering state in developing path breaking strategies and concepts to ensure access to safe and clean sanitation for all. With the successful achievement of Open Defecation Free (ODF) status, the Government of Maharashtra (GoM) issued a 7-point sustainability charter in 2017 that included a focus on ODF-Sustainability and ensuring effective collection and treatment of human faecal waste in all cities in Maharashtra.

The state has established a technical support unit (TSU) in partnership with Center for Water and Sanitation (CWAS), CEPT University for delivery of effective sanitation services across urban areas in Maharashtra with a focus on FSSM solutions.

Urban Development Department supported setting up of independent Faecal Sludge Treatment Plants (FSTPs) in over 300 ULBs of Maharashtra which are entirely dependent on onsite sanitation systems. The aim was to implement a cost effective and non-mechanised treatment technology for FSTP construction.

With over 170 FSTPs operational, it became important to assess their performance and ensure their effectiveness. To address this, the Maharashtra Environmental Engineering Training and Research Academy (MEETRA) conducted a comprehensive study to review the operational processes of FSTPs. This study focused on four cities, analyzing the city-wise operations and maintenance practices of FSTPs. The findings of this study aim to identify areas for improvement and share valuable insights to enhance FSTP performance.

CWAS is grateful to MEETRA for undertaking this study. Its findings will be helpful in scaling up and strengthening FSTPs of Maharashtra, and across various cities of India.

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Preface

Maharashtra is the second most urbanised state in India with urban population of 64 million people. Over 300 cities in Maharashtra are dependent on onsite sanitation systems. The state government has taken decisive action to prioritize the entire sanitation value chain, particularly through the implementation of Faecal Sludge and Septage Management systems. To strengthen the Faecal Sludge Management system, the Government of Maharashtra has adapted a robust strategy that includes the construction of new Faecal Sludge Treatment Plants (FSTPs) across the state.

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Center for Water and Sanitation (CWAS), of CEPT University, is a Technical Support Unit (TSU) to Government of Maharashtra, Urban Development Department (UDD), to support implementation of Swachh Maharashtra Mission. MEETRA is constituted as an autonomous institute and State level Training Institute of Govt. of Maharashtra for Training and Capacity building. It is under the Maharashtra Jal Pradhikaran (MJP) and trains staff working in Water supply and sanitation.

CWAS approached Maharashtra Environmental Engineering Training and Research Academy (MEETRA) to review the operational process of FSTPs in Maharashtra. As a part of this, MEETRA has carried out a performance review of FSTPs in four cities of Maharashtra. This report presents the findings and recommendations resulting from the performance review conducted by the MEETRA team.

We gratefully acknowledge the support provided by the four municipalities for the study. Their cooperation was essential in gathering the necessary data and insights.

This report aims to provide valuable insights into the operational processes of FSTPs in Maharashtra and serve as a resource for stakeholders involved in the improvement of sanitation systems. The findings and recommendations presented here will contribute to the ongoing efforts of the Government of Maharashtra in achieving its sanitation goals.

Maharashtra Environmental Engineering Training and Research Academy
(MEETRA)

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Abbreviations

FSTP	Faecal Sludge Treatment plant
UDD	Urban Development Department
SDB	Sludge Drying Beds
ABR	Anaerobic Baffled Reactor
PGF	Planted Gravel Filter
KLD	Kilo Litres per day
TSU	Technical Support Unit
NGTA	National Green Tribunal Act
CPCB	Central Pollution Control Board
MEETRA	Maharashtra Environmental Engineering Training and Research Academy
GoM	Government of Maharashtra

1. Introduction

1.1 Background

Maharashtra is the second most urbanised state in India. The state government has made efforts to ensure underground sewerage facilities and sewage treatment plants (STPs) in all large ULBs. However, majority of small and medium size cities in Maharashtra are fully dependent on onsite sanitation systems. For these towns, Government of Maharashtra has placed special focus on Faecal Sludge and Septage Management as articulated in its resolution and ODF sustainability charter.

With this agenda, the Urban Development Department of Maharashtra (UDD) had resolved to set up independent Faecal Sludge Treatment plants (FSTP) in 311 ULBs which are entirely dependent on onsite sanitation systems and where there are no plans for sewerage project in near future. This decision was conveyed through a Government Resolution (GR-SMA 2019/P.No.124/UD-34).

An FSTP is a treatment facility to treat the faecal sludge and septage from various on-site sanitation systems. The faecal sludge is brought to the treatment location by de-sludging trucks used to evacuate septic/holding tanks at households, Community Toilets, public toilets or commercial establishments. For providing economical and sustainable solutions for safe disposal of faecal waste, FSTP is an ideal solution. The state has adopted a nature-based treatment technology for FSTP that involves five major modules: namely 1) Screening Chamber, 2) Sludge Drying Beds (SDB), 3) Anaerobic Baffled Reactor (ABR) 4), Horizontal Planted Gravel Filter (PGF), and 5) Disinfection unit. As on date, about 170+ independent FSTPs are operational.

1.2 Need for the study

The urban local governments in Maharashtra have made significant investment in setting up faecal waste treatment infrastructure. In order to sustain the FSM operation at scale in Maharashtra, it was decided to carry out FSTP operation review for a few cities which have set up FSTPs using the above-mentioned technology or any other technologies. Based on the experience from these cities, efforts will be made to scale up FSTP operation review in other cities across the state.

Maharashtra Environmental Engineering Training and Research Academy (MEETRA) is constituted as an autonomous institute and State level Training Institute of MJP, Govt. Of Maharashtra, for Training and Capacity building of the peoples working in the sector of Water supply and sanitation. In consultation with CWAS, CRDF, CEPT University MEETRA conducted performance review for FSTP’s in four small sized cities in Maharashtra. (Table 1). The field visits to the four ULBs were conducted during February- May 2022.

City Name	FSTP capacity
Erandol	10 KLD
Igatpuri	10 KLD
Chopda	15 KLD
Dhule	20 KLD

Table 1: FSTP capacities in 4 case cities in Maharashtra

1.3 Scope of Work

1. Develop a framework for operations review of Faecal Sludge Treatment Plants (FSTPs) in Maharashtra. This involved preparation of detailed checklist. (Check list is attached separately)
2. Carry out site visits to the shortlisted operational FSTPs.
3. Collect and examine the samples of incoming raw faecal Sludge load from the vacuum emptier trucks, samples of treated effluent from each unit.
4. Evaluate the performance of each FSTP components.
5. Based on this operations review, identify measures for improving performance of the treatment plant.

1.4 About the cities

MEETRA team made visit to the FSTP sites of four small and medium sized towns namely- Chopda, Erandol, Igatpuri and Dhule. All these four cities are old, carry historic significance and are well connected with their surrounding cities.

Due to heavy rainfalls Igatpuri is also called as Cherapunji of Maharashtra. In Dhule, river Tapi is the main source of drinking water in Dhule and now under the AMRUT scheme, Dhule Municipal Corporation has proposed Akkalpada dam as another source.



Figure 1: Geographical location of the Four case cities- Erandol, Igatpuri, Chopda and Dhule

City	District	City area (Sqkm.)	City Population	No. of Household	Governing body	Influence of any river
Erandol	Jalgaon	46.92	31071	8034	Erandol Municipal Council	Anjani river
Igatpuri	Nashik	15	30989	6613	Igatpuri Municipal Council	nil
Chopda	Jalgaon	44	72783	15668	Chopda Municipal Council	Ratnavati River
Dhule	Dhule	101.08	458294	82567	Dhule Municipal Corporation	Tapi river

Table 2: Salient features of the four cities

1.5 Sanitation scenario

Chopda, Erandol and Igatpuri are dependent on onsite sanitation system with most of the household toilets connected to septic tanks. Study showed that, in all these towns, prior to construction of FSTPs, the faecal sludge was dumped into open area. Wastewater was either released into the waterbodies or disposed into agriculture land. In order to mitigate the gap in the sanitation value chain, all the four towns have constructed FSTPs. The capacities of the FSTPs are mentioned below in figure 2.

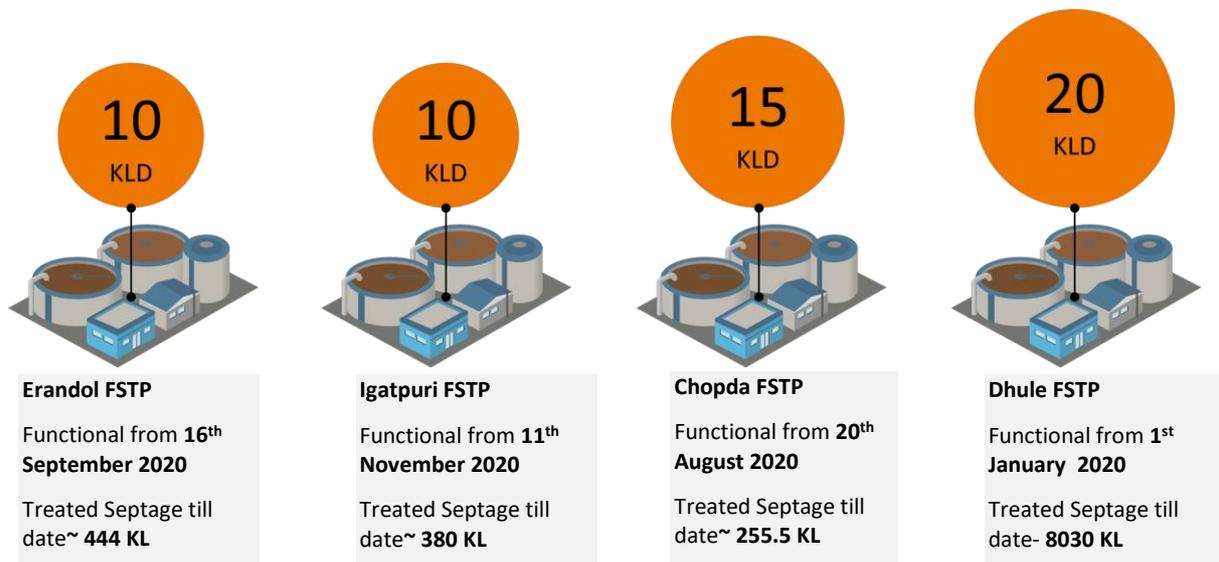


Figure 2: Salient features of the Four case cities- Erandol, Igatpuri, Chopda and Dhule

Unlike the other three towns, in Dhule Municipal Corporation 10-15% population are served with sewerage scheme. Owing to this growing population, the municipal corporation has constructed waste management treatment unit and FSTP in the land owned by municipal corporation of Dhule. Also, a new Sewage Treatment Plant has been proposed for the city with the sewerage scheme.

The following diagram represents the process followed by each of these case cities-

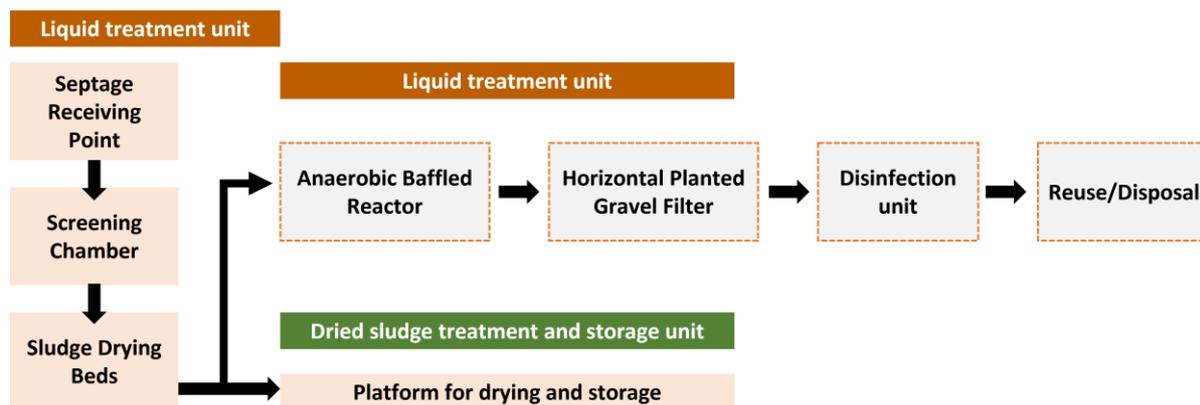


Figure 3: Diagram representing the general process of sewage and septage treatment at FSTPS in the 4 cities

Because of densely constructed houses in these case cities, there are instances where septic tanks are constructed inside the house which makes desludging operation often difficult. There is no designated route to be followed by the desludging vehicle. Hence, number of trips per day in all these three cities varies. With the support of the following table (Table 3), a comprehensive idea of Desludging behaviour of these cities can be ascertained.

City	Number of septic tanks	Number of trucks	Capacity of each truck (Litre)	Average number of trips	Total trips received from date of operation till April 2022
Erandol	7049	1	3000	2-3/day	148
Igatpuri	4700	1	3000	2-3/day	127
Chopda	15668	1	3500	1 trip/week	73
Dhule	65945	4	3000	3-4/day	3440

Table 3: Information regarding desludging of septic tanks in the case cities

2. Detailed description of the FSTPs

Sludge Drying Bed (SDB):

In all four cities, the sludge drying beds consists of 4 No. Of Units with 24 sqmt. of area for each unit.



Figure 4: Sludge drying beds in Erandol, Igatpuri, Chopda and Dhule

Anaerobic Baffled Reactor (ABR) with filters:

ABR units of Erandol, Dhule and Chopda are of same size i.e., 13 sqm. Whereas the size of ABR unit in Igatpuri is comparatively small, i.e., 1.8 X 1.8 sqm. However, in each of the four FSTPs, the ABR units consist of 3 no of baffle walls units. Generally, Sludge and Scum from these ABRs are removed after 2 to 3 months and sent to SDB for further process.



Figure 5: ABR Units in Erandol, Igatpuri, Chopda and Dhule

Planted gravel filter (PGF):

The size of each PGF in the FSTPs of Erandol, Dhule and Chopda is of 43.6 sq.mt size. A single unit of PGF is divided into two compartments. In order to improve the Chemical Oxygen Demand (COD) of water, Musa Paradisiacal plants are planted with large gravel and sand basin. In Igatpuri, the size of PGF is 7.05 X 6.9 sqm. Unlike the other three cities, here Canna Lilly plants are planted with large gravel and sand basin for improving the COD level of water.



Figure6: PGF Units in Erandol, Igatpuri, Chopda and Dhule

3. City wise operation review of the FSTPs

Field visit was conducted at the FSTPs of the four case cities with their respective concerned local government officials. A checklist was prepared and shared with the government Officials in these cities. Information as per checklist was collected and analysed for better understanding.

3.1 Operational procedures -

Sludge Drying Bed (SDB): Septage from the vacuum emptier trucks are conveyed to the Sludge Drying Beds and emptied by directing the sludge into the splash pad. The splash pad

is a permeable bed with sloped base at the bottom holding graded filter media like sand and gravel. SDBs of all the four cities allow sludge to fill up to 40 cm mark and dry subsequently, the duration of drying of the sludge varies in these cities (Table. 5). The units of the SDBs are used in rotation while drying the sludge. In Chopda, it is being observed that the sludge removal process is ceased currently due to construction of road and floor surface. However, the dried sludge in Chopda is removed right after completion of the prerequisite drying period. In all the four SDBs leachates percolate via bottom of bed through the drain and this liquid goes to inlet of ABR.

City	Sludge dry time (from the day of input)
Erandol	15 to 20 days (Approx)
Chopda	30 days (Approx)
Igatpuri	15 to 20 days (Approx)
Dhule	45 to 60 days (Approx)

Table 4: Sludge drying time at FSTPs in the cities



Figure 7: Collection of dried sludge at FSTPs in Erandol, Igatpuri, Chopda and Dhule (From left to right)

In Erandol, Chopda and Igatpuri, the city governments sell the dried sludge to the local farmers at different rates (Table 6). The farmers use the dried sludge as fertiliser for enhancing the quality of their field soil. They sometimes use it for plantation and gardening purpose. At Chopda FSTP, the dried sludge is usually mixed with fertiliser generated through SWM treatment in the adjacent waste management centre.

City	Selling price of dried sludge to the farmers
Erandol	Rs. 2.2/per kg (Approx)
Chopda	Do not sell sludge
Igatpuri	Rs. 2.2/per kg (Approx)
Dhule	Rs. 4/per kg (Approx)

Table 5: Selling price of dried sludge to the farmers in respective cities

Anaerobic Baffled Reactor (ABR) with filters: In the first stage, the liquid from SDB passes through the Anaerobic Baffled Reactor, which has three filtration chambers in series. As wastewater flows through the filter media, particles are trapped, and organic matter is degraded by the active biomass that is attached to the surface of the filter material. Effluent from the ABR gets transferred to inlet of Planted gravel filter (PGF).

Planted gravel filter (PGF): Liquid from the ABR is treated for further treatment in the horizontal planted gravel filter, which is a large gravel-based and sand-filled basin that is planted with either Musa Paradisiacal (in Erandol, Chopda and Dhule FSTPs) or Canna Lily (in Igatpuri FSTP) plants. Effluent collected in the inlet channel flows through filter media which further removes solids, provides a fixed surface upon which bacteria can attach, and also acts as a base for the vegetation. Although facultative and anaerobic bacteria degrade most of the organics by their own, the vegetation transfers a small amount of oxygen to the root zone so that aerobic bacteria can colonize the area and degrade organics as well. The plant roots play an important role in maintaining the permeability of the filter media. The final effluent from outlet channel of PGF is collected in the PVC tank. In Igatpuri it is observed that the PVC tank needs to be covered. After this process, the effluent is sent to chlorinator for further chlorination treatment. In Erandol and Chopda, chlorinator is there but not in use due to less inflow of effluents. Effluent directly collected from PGF outlet is used to maintain the plantation at PGF. In Dhule, the effluent collected from PGF is treated by disinfecting it through chlorination unit and after chlorination, the treated effluent is used for maintaining the garden, tree plantation work and washing the roads. In Igatpuri, no further treatment of chlorination is done by Igatpuri Municipal Council.



Figure 8: Plantation around the Planted Gravel Filters at FSTPs in Erandol, Igatpuri, Chopda and Dhule (From left to right)

3.2 Maintenance Procedures –

- a) **Maintenance activities:** Maintenance of FSTPs is done by their respective Municipal Council/corporation. In all the four FSTPs, Municipal Council/Corporations are engaged in regular maintenance of SDB which includes scrapping of upper layer of dried sludge and reshuffling of base media in the unit. For ABR and PGF no choking issue has been raised till date. Plants in all the four PGF are well maintained. Treated water at Dhule FSTP is used by Dhule Municipal Corporation for various washing and gardening purpose.
- b) **Human resources involved:** In Erandol, Chopda and Igatpuri, two persons from municipal councils are engaged in operation and maintenance of the corresponding FSTPs. In Dhule eight persons are engaged for similar activity. However, for the O&M of the FSTP, the Dhule municipal corporation is planning to appoint third party agency.

3.3 Record keeping and testing procedures

Municipal authorities of all these four cities maintain logbooks of their respective desludging vehicles and keep record of the sold manure. The test reports of the FSTP samples are also maintained by them. In addition, Dhule Municipal Corporation maintains a GIS based activity evidence records as well.

The condition of the FSTPs have been evaluated during the site visits as per the data collected using checklist and construction detail manual of FSTP. It was observed that the SDBs, ABRs and PFGs are in good condition. The level difference between the three components of each

FSTPs are also available and connections of pipes from one unit to next other unit are properly executed in all four FSTPs.

In order to study the performance of the FSTPs, in each of the cities, 4 samples were collected. One sample was collected directly from the desludging vehicle outlet, while another three samples were collected from ABR outlet, PFG inlet and PFG outlet collection tank.

In Erandol, Chopda and Igatpuri, it was observed that persons involved in septage treatment process use gloves and masks while working, while in Dhule this safety practice was found missing. In terms of frequency of desludging, it was observed that, despite all kinds of awareness raising efforts, the citizens do not clean their septic tanks on regular basis, mainly because of lack of interest. Desludging is done through Complaint redressal process, where the citizens call the desludging vehicles when there is foul smell and unhygienic environmental condition.

City	Required time to transfer faecal sludge from collection point (in Hr.)	Time taken for unloading sludge on SDB (in minutes)
Erandol	1.5	15-20
Igatpuri	1	20-25
Chopda	1	20-25
Dhule	1	10-15

Table 6: Information regarding sludge conveyance from source to treatment plants in the four cities

The leachate or liquid from SDB collected in ABR for further treatment. In the ABR unit Anaerobic treatment takes place through filtration chambers. The liquid flows along the compartments through one baffle to other via filter media. Some solids and scum removed in this process and at the end of it effluent of ABR goes to PGF. It is seen that the sample or colour of the inlet and outlet liquid changes. ABR inspection chambers are well closed with covers. Also, proper connectivity to flow ABR effluent in to PGF unit is done at site. The PGF units are also good in condition and the wetland vegetation are maintained using treated water from the PGF in every FSTPs. However, due to hot weather condition the wetland plants look dried in Dhule. Hence the Municipal Corporation has engaged one person to water those plants on regular basis.



Figure 9: Samples of the effluents collected from the FSTPs for quality testing purpose

Test results of the four FSTPs:

Parameters	As per Disposal standards		Erandol				Chopda				Igatpuri				Dhule			
	CPCB Standards	NGT	Inlet	SDB	ABR	PGF	Inlet	SDB	ABR	PGF	Inlet	SDB	ABR	PGF	Inlet	SDB	ABR	PGF
	BOD (mg/l)	30	10	82000	72	48	24	342	150	25	25	17667	569	97	10	3692	61	46
COD (mg/l)	250	50	182000	270	180	90	900	480	210	110	32000	2950	210	21	8000	220	180	90
pH	5.5-9.0	5.5-9.0	6.58	8.12	8.29	8.20	---	7.76	8.64	8.97	6.22	7.023	8.05	7.88	7.04	7.19	7.19	7.85
TSS (mg/l)	---	20	280	28	36	48	---	52	36	16	5120	2950	210	21	78120	44	38	48
TDS (mg/l)	---	---	2040	1612	1346	1148	---	4798	1480	1071	1514	1552	1310	418	1500	2310	2050	2350

Table 7: Test results of the treated effluents in four case cities based on relevant parameters

- The test results suggest that, BOD and COD values of the treated effluents from the PGF outlets are below the standard maximum value prescribed as per CPCB standards. It has to be kept in mind that this was the basis of designing the FSTPs. However, while comparing the values with the maximum standard values as per NGT, it can be observed that, only in case of Igatpuri FSTP, both the BOD and COD value of the final treated effluents coming from the PGF are either equal (BOD value) or below (COD value) the standard value.
- PH values of the treated effluents of all four FSTPs are below their maximum standard value.
- In terms of TSS, only the TSS value of final treated effluent coming from the Chopda FSTP's PGF (16 mg/l) is below the NGT standard (20 mg/l). In case of Igatpuri, the value is almost equal to the standard value (21 mg/l). However, in Erandol and Dhule FSTP, the value is almost double of the standard value (48 mg/l).
- Overall, the test results suggest that values of the parameters of final treated effluents coming from the FSTPs of all the four cities are mostly within their respective safe range. Albeit, among these four, values of the parameters in case of Igatpuri FSTP are better compared to other three FSTPs.

3.4 Revenue Generation

Dhule, Erandol and Igatpuri generate revenue by selling the dried sludge to the farmers. These cities can also explore more options of reuse practice of dried sludge and treated water generated to further improve their revenue incomes. Cost comparison of the four cities' FSTPs are given below.

City	CAPEX Cost (In Lakhs) - Civil components (SDB,ABR,PGF,etc.)	OPEX Cost (In Lakhs) – Human Resource cost and other costs / per year	Revenue - Per year (In Lakhs)
Erandol	17.34	2.30	0.25
Igatpuri	19.84	7.8	2.40
Chopda*	21.99	---	0.39
Dhule	25.00	6.00	8.76

*Chopda currently utilises human resources of SWM. Hence separate opex cost is not available.

Table 8: Detailed costing of the four cities' FSTPs

4. Conclusion:

The observations based on the site visits have been enlisted by the team. The four FSTPs have shown good performance as the treated effluents have shown decrease in the parameters of BOD, COD, and TSS. These low-mechanized technologies require less resources of electricity, human resources, etc. Followings are some general observations for all the four FSTPs:

Good practices which can be scaled up in other cities:

1. All the four FSTP premises are well maintained in consideration of hygiene and other safety precautions. However, followings are few city-specific observations:
 - i) At Erandol FSTP site, considering the hot climatic condition, the municipal council is maintaining the trees quite well, planted inside the FSTP precinct.
 - ii) Both at Chopda and Dhule FSTP sites construction work of internal road and other waste management facilities within premise need to be completed.
2. In Erandol, Chopda and Igatpuri, the sanitation workers use Personal Protection Equipment (PPE) while involved in desludging activities. This is considered to be a good practice and scaled up in other cities as well.

Improvement measures of the FSTPs:

3. At Igatpuri FSTP site a safety concern can be observed. The FSTP is located at the western side near to Vipashyana centre Igatpuri and can be easily accessed. Hence considering safety and security aspect compound wall or fencing should be constructed.
4. At Erandol and Igatpuri FSTP sites, it is suggested to cover the SDB units with proper shed arrangement in order to maintain the quality of the manure.
5. At Erandol, Chopda and Dhule FSTP site the Chlorination units are not in use despite being installed. At Igatpuri FSTP site, there is no presence of any chlorination unit. After completing the final process, Igatpuri Municipal Council collects effluent in the PVC tank and use it for plantation. Although the final effluents are utilised for non-potable uses (gardening), it is suggested to all these FSTPs to chlorinate the effluent first because there can be possibility of some pathogens to be still present in the treated water. Also In addition, The PVC tank at Igatpuri FSTP site, which collects the final effluent has been observed to be open. Therefore, it is suggested to cover it properly.
6. At both Chopda and Dhule FSTP site, the right mechanism for meeting the oxygen requirement in PGF is not occurring due to receiving less load of faecal sludge.

Additionally, it has been observed that adequate maintenance of the units is necessary which is not happening owing to lower loading.

7. At all these four FSTP sites, lack of trained staffs for maintenance of the FSTPs can be identified as a common issue. Hence it is required to provide them hand holding support to train the staffs of the respective Municipal Councils and corporations.
8. Erandol and Chopda Municipal Councils and Dhule Municipal Corporation are required to prepare list of farmers for selling out the dried sludge.

Increasing the demand of desludging in the cities:

9. In order to produce adequate quantity of dried sludge, in cities like Chopda, Igatpuri and Dhule, the respective municipal councils and corporation should sensitize the local citizens for emptying the septic tank periodically by doing IEC. They are suggested to create Task force in each Wards and depute personnel for creating awareness at large scale.
10. At Erandol, looking at the city's current scenario it can be suggested that high power desludging evacuator for evacuating sludge from long distance is the only solution for the densely located area.
11. Lastly for Igatpuri Municipal Council, it is suggested to prepare route map for faecal collection in order to reduce operation cost.



Annexure:

Annexure 1: FSTP photo plate

Erandol:



Chopda:



Igatpuri:



Dhule:





MEETRA is constituted as an autonomous institute and State level Training Institute of Govt. of Maharashtra for Training and Capacity building. It is under the Maharashtra Jal Pradhikaran (MJP) and trains staff working in Water supply and sanitation.

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The Center for Water and Sanitation at CEPT University carries out various activities – action research, training, advocacy to enable state and local governments to improve delivery of services.

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