Swachh Bharat Mission (Gramin)

"Beyond ODF"

Technology Options for

Solid and Liquid Waste Management in Rural Maharashtra

WATER AND SANITATION SUPPORT ORGANISATION
Dept. of Water Supply and Sanitation, Govt. Of Maharashtra
पाणी व स्वच्छता सहाय्य संस्था

Maharashtra Village Social Transformation Foundation
An Initiative of the People of Maharashtra

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Submitted by
Centre for Sustainable Governance
All India Institute of Local Self-Government

Supported by
UNICEF

In collaboration with
Water Supply & Sanitation Department
Government of Maharashtra
Water and Sanitation Support Organisation
and
VSTF

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Acronyms and Abbreviations

ABR	Anaerobic Baffled Reactor
AIILSG	All India Institute of Local Self Governance
ASHA	Accredited Social Health Activist
BOD	Biological Oxygen Demand
C & D	Construction & Demolition
CO	Chief Officer
CPCB	Central Pollution Control Board
CSG	Centre for Sustainable Governance
CSR **CRRU**	Corporate Social Responsibility Community Resource Recovery Unit
CT/PT	Community Toilet/ Public Toilet
DEWATS	Decentralized Waste Water Treatment System
DHW	Domestic Hazardous Waste
DPR	Detailed Project Report
DRE	Deep Row Entrenchment

DTD	Door To Door
FSM	Faecal Sludge Management
GoM	Government of Maharashtra
GP	Gram Panchayat
GR	Government Resolution
H.P.	Horsepower
Ha	Hectare
HH	Household
IEC	Information Education and Communication
IHHL	Individual Household Latrine
INR	Indian Rupee
LWM	Liquid Waste Management
MPCB	Maharashtra Pollution Control Board
MSW	Municipal Solid Waste
NADEP	N.D. Pandharipande Method of Composting
NARSS	National Annual Rural Sanitation Survey
O&M	Operations & Maintenance
OD	Open Defecation
ODF	Open Defecation Free
ODF-S	ODF Sustainability
OWC	Organic Waste Convertor
PMC	Pune Municipal Corporation
RCC	Reinforced Cement Concrete
RDD	Rural Development Department
RDF	Rural Development Fellow
SBM	Swachh Bharat Mission
SLWM	Solid Liquid Waste Management
STP	Sewage Treatment Plant

SWM	Solid Waste Management
TOR	Terms of Reference
TPD	Ton Per Day
UNICEF	United Nations International Children's' Emergency Fund
VSTF	Village Social Transformation Foundation
VWSC	Village Water and Sanitation Committee
WSSO	Water and Sanitation Support Organization
WSP	Waste Stabilization Pond
WSSD	Water Supply and Sanitation Department
ZP	Zilla Parishad

Chapter 1: Introduction

1.1. Background

On 2nd October 2014, the Government of India launched the "Swachh Bharat Mission", conceived with the objective to reinforce progress made towards the realisation of universal sanitation, with a particular emphasis on achieving the elimination of open defecation (ODF). While the State of Maharashtra has been declared open defecation free, it is necessary to move 'Beyond ODF' and focus on issues of sustainability, as well as Solid and Liquid Waste Management (SLWM). This has also been addressed in the SBM (G) strategy under the concept of ODF(S) and ODF Plus.

UNICEF Maharashtra, in consultation with the WSSD of the Government of Maharashtra commissioned a study project, aimed at preparing a costed plan for SLRM in 6 representative villages ranging from rural to peri-urban areas so as to develop standard templates for sustainable sanitation which can then be replicated at other villages with suitable modifications.

The study and detailed assessment was conducted by the Centre for Sustainable Governance of the All India Institute of Local Self-Government (AIILSG), in partnership with WSSO, UNICEF Maharashtra, and VSTF.

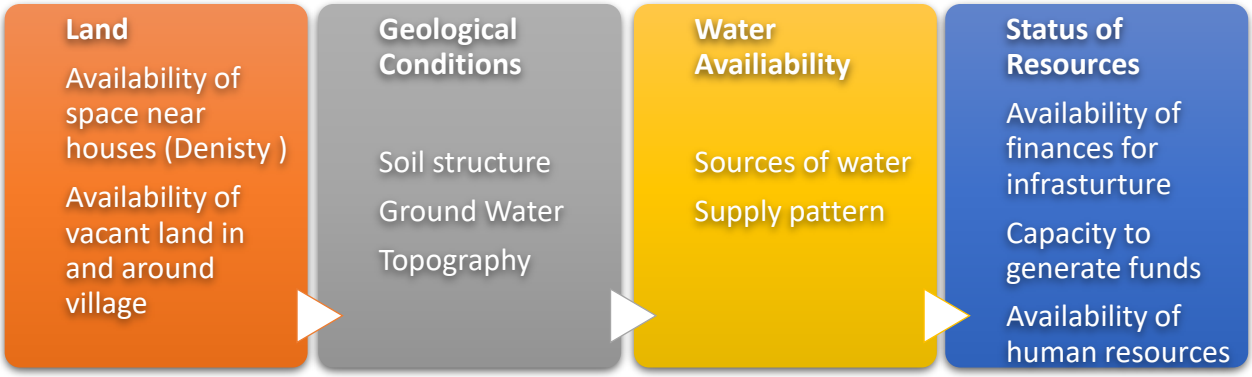
Aside from the requirement of selecting one GP from each of the State's six divisions, it was agreed that the selected GPs should be representative of different topographic, climatic, and demographic conditions. Responsive Panchayati Raj leadership was also considered as criteria, with GPs having a background of community participation in developmental initiatives being preferred in order to get a more spontaneous response for the study.

On the above basis, six GPs were shortlisted for the study viz. Kharsai from Raigad District in the Konkan Division; Vadgaon (Kandali) from Pune District in the Pune Division; Dongaon from Ahmednagar District in the Nashik Division; Jambhali from Aurangabad District in the Aurangabad Division; Shirajgaon (Mozari) from Amravati District in the Amravati Division; and Govindpur from Chandrapur District in the Nagpur Division.

Two rounds of field visits were carried out in the selected project GPs, in addition to several rounds of consultations at the State, Divisional, and District levels. This was followed by an exposure visit of selected GP functionaries to illustrate the shortlisted technologies, and showcase the best practices of some of the leading villages in the State with respect to Sanitation and Waste Management.

The technologies mentioned in this document have been shortlisted based on topographical considerations, technical feasibility cost effectiveness and scalability. Moreover, these technologies should be easy to operate and require minimal intervention of skilled personnel, which is otherwise a limitation in rural areas.

The DDWS, Ministry to Jal Shakti, Government of India laid down the following parameters for selection of technologies:



The other major consideration in selection of technologies is geological formations of the region and the rainfall pattern. All these conditions very across regions and therefore technology options may also differ. Maps of the various geological formations in the state, as well as the major soil and bedrock types across regions, are given below:

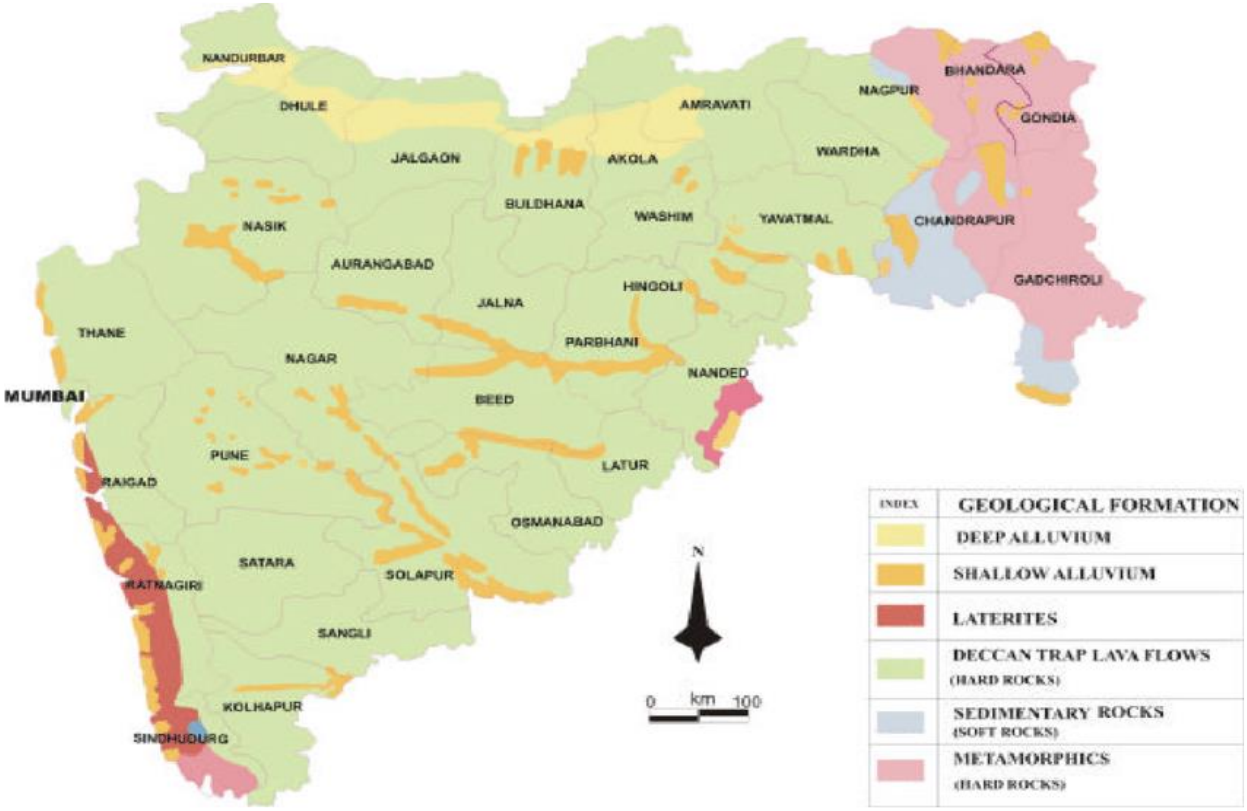


Figure 1 - Geological Formations in Maharashtra

1.2 Purpose and Scope of the Manual

The Technical Manual is intended to provide the reader with suggestive Solid and Liquid Waste Management (SLWM) technology options at different levels of the sanitation value chain for different Gram Panchayat typologies. This includes descriptions, schematics, diagrams, specific strengths and disadvantages, as well as block estimates of the indicative cost. In order to effectively use this document, it must be read with the Process Document for Preparation of SLWM Costed Plans in Rural Maharashtra.

1.3 Primary Target Audience

This Technical Manual is primarily aimed at officials at the District and Block levels, in the Zilla Parishad and Panchayat Samiti respectively, handling charges related to SLWM, including Dy. CEOs (WATSAN), Deputy and Executive Engineers, BDOs, and BRCs; and PRI functionaries at the Gram Panchayat and Village levels such as the Gramsevak, Sarpanch, Members of the VWSCs. Members of SHGs and CBOs, villagers; and NGOs, sanitation experts, and other organisations, though not the primary audience can also find use for this Manual.

1.4 Limitations of the Manual

This Technical Manual is subject to the following limitations:

1. The cost figures provided are block estimates based on the Maharashtra Public Works Department (PWD) State Scheduled Rates (SSR) 2019-2020. The actual cost may vary based on local conditions.

2. The dimensions and figures are based on the figures provided in the Government publications listed in the References section.

3. Even though a particular technology may be recommended for a certain GP typology, specific local factors may render that technology unsuitable.

4. All technological solutions are to be verified/ designed by the engineers and staff at the Block Level.

Chapter 2: Technological Options for SLWM in Rural Maharashtra

2.1. Sanitation Value Chain

In order to manage Solid and Liquid Waste including Grey Water, Black Water, as well as solids in the form of Faecal Sludge, it is required to understand the sanitation value chain (Fig.2). Suitable technological options can then accordingly be selected.

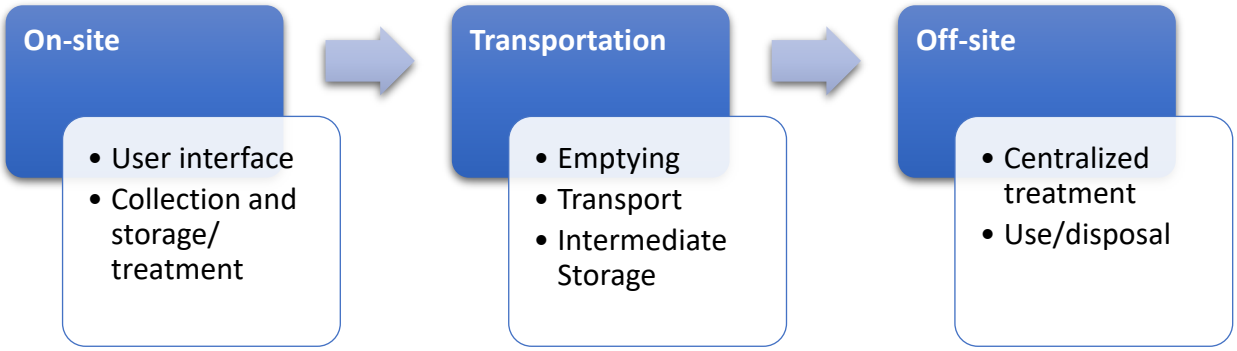


Figure 2- Categorization of functional groups based on sanitation value chain

2.2. Toilet Management and Faecal Sludge Management

A sustainable low-cost option for toilets and Faecal Sludge Management are pour flush twin pit toilets. In case the construction of twin pits is not feasible due to soil characteristics or geographical factors, then the alternative option suggested in those cases would be a septic tank with soak pits.

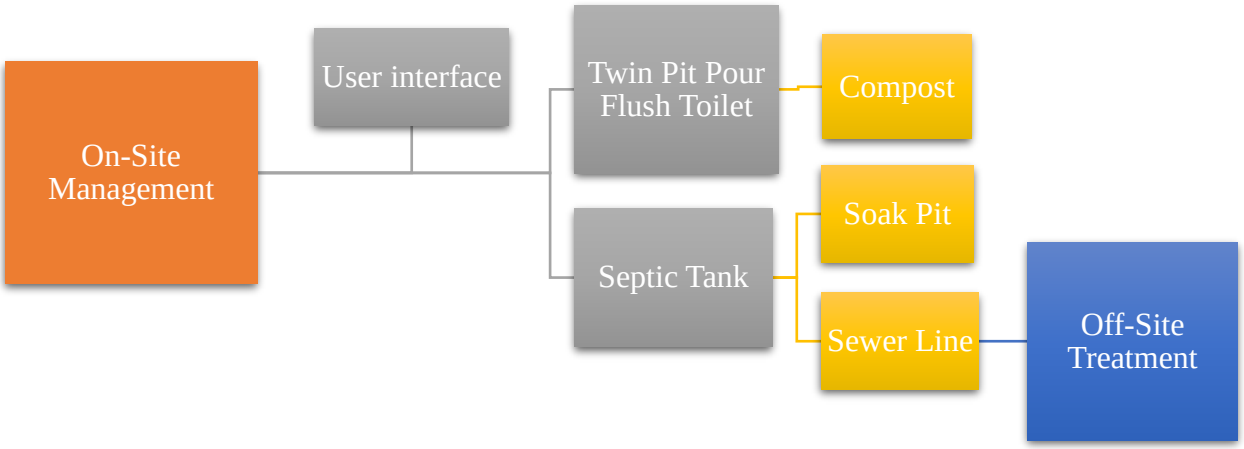


Figure 3- Suggested On-site management technology for Toilets & Faecal Sludge in Rural Maharashtra

The off-site treatment options for handling of faecal sludge and black water can be selected from any one of the following technology options depending on the criteria mentioned in Fig. 1 above.

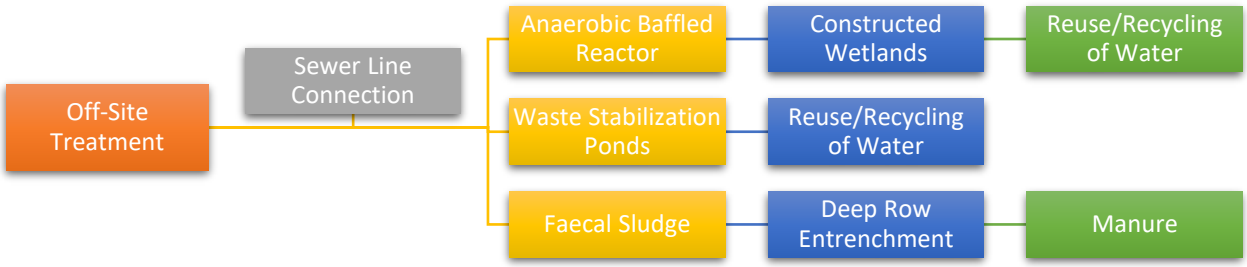


Figure 4- Suggested Off-site management technology for Toilets & Faecal Sludge in Rural Maharashtra

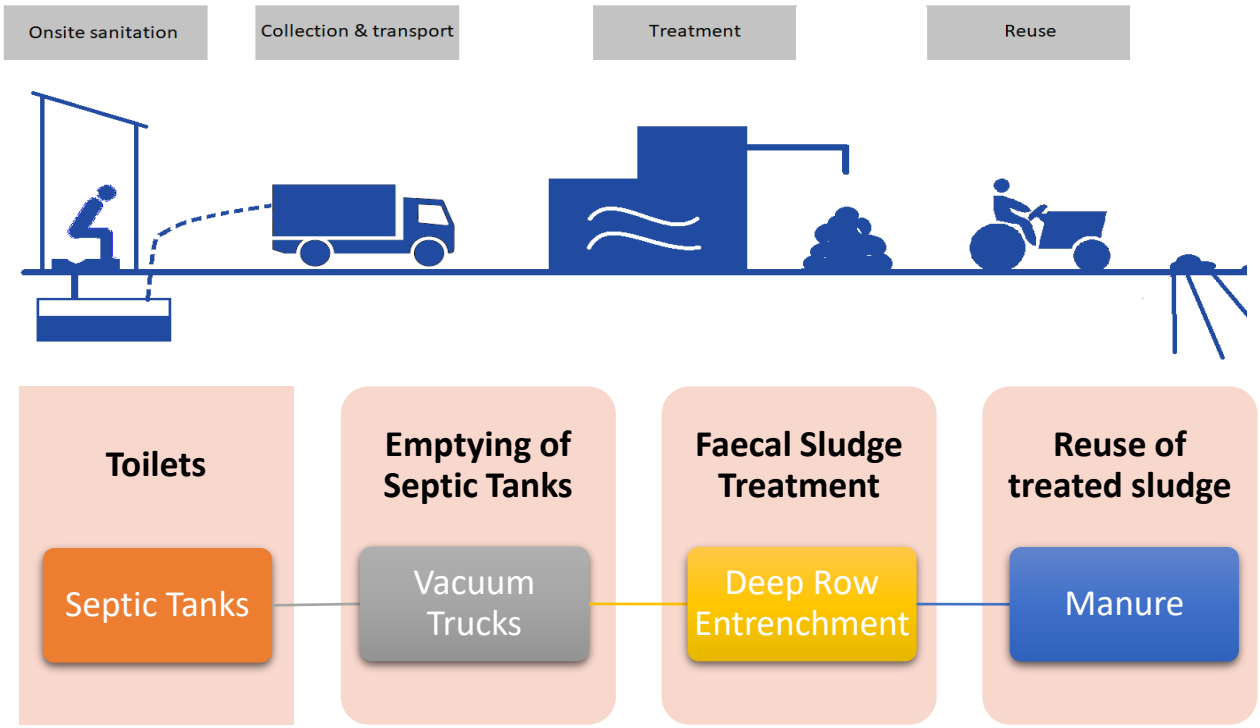


Figure 5- Suggested technologies for collection, conveyance and transportation of faecal sludge and Septage in Rural Maharashtra

Standalone septic tanks units should be connected to a soak pit for management of black water effluent, considering the suitable geological conditions, or should be connected through sewers to the treatment facility.

Regular desludging and emptying of septic tanks with mechanised equipment is suggested. The conveyance and transportation should be done in closed vehicles, which prevent human contact, to the approved temporary storage (transfer station), treatment facility, or disposal site.

2.3. Grey Water Management

Suitable options can be selected for on-site & off-site management of grey water considering the techno-economic feasibility.

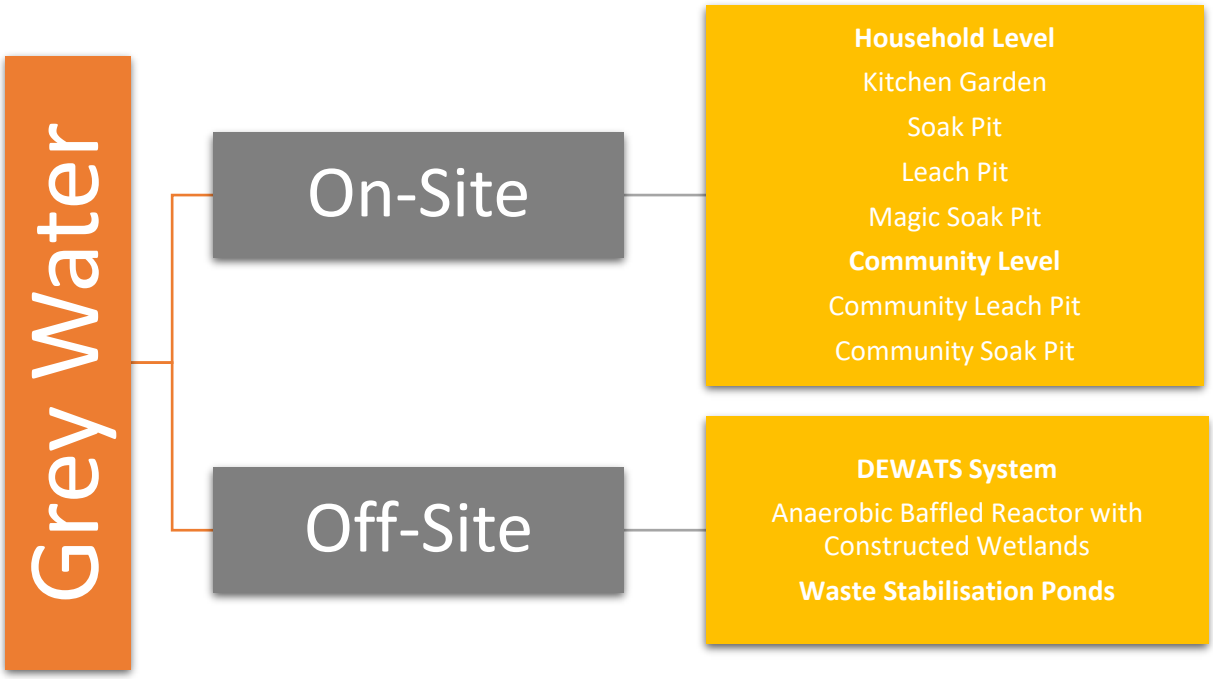
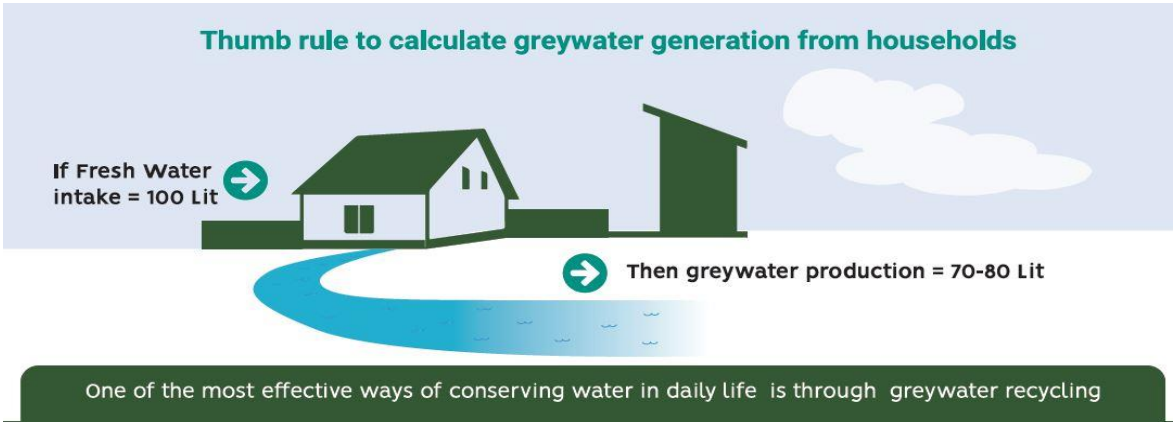


Figure 6- Suggested Technologies for Treatment of Grey Water in Rural Maharashtra



Important:

- **Decentralised management of grey water is the preferred option**
- **Drainage is not a technology for Grey water Management, but is only a means of transport**
- **Pipes are better for carrying grey water than drains but comparatively more costly.**

2.4. Solid Waste Management

For effective management of solid waste in rural areas, the focus should be on management at the household level. That which cannot be managed at the household level should be managed at the community level. In general, the following approach should be followed:

- Segregation of solid waste at the household level (Biodegradable and Non-biodegradable)
- Reuse of non-biodegradable waste at the household level to the extent possible
- Household level treatment of biodegradable waste
- Collection and transportation of segregated waste at the household level to a place identified at the community level (in cases where household level treatment is not possible) i.e. Community Resource Recovery Unit (CRRU)
- Community level treatment or recycling/reuse of waste
- All the biodegradable waste (apart from treated at HH level) should be composted at the community level
- Non-biodegradable waste may be further segregated and sold or recycled
- Waste which cannot be composted, reused or recycled may be disposed at the landfill sites following appropriate procedure, (such waste may usually be construction waste, debris etc.)

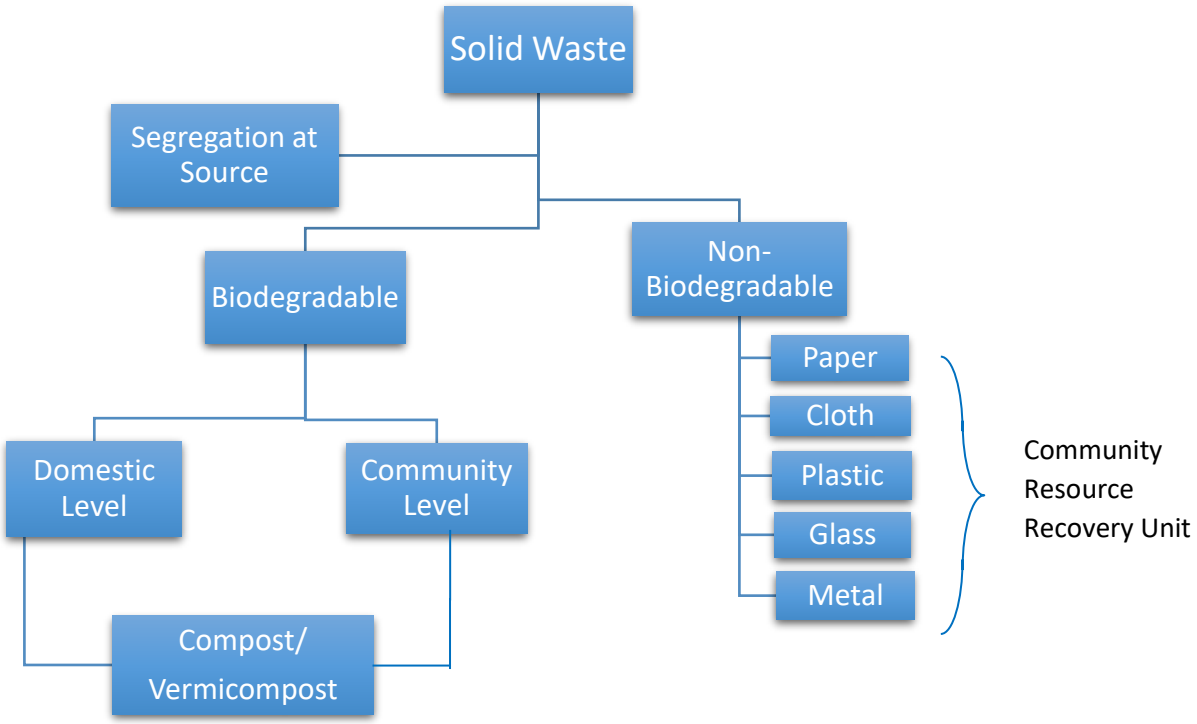


Figure 7- Suggested Technologies for Treatment of Solid Waste in Rural Maharashtra

The recommended SLWM technologies are summarised in the table below:

Technological Options Suggested for SLWM in Maharashtra					
Toilet	**Black Water**	**FSM**	**Grey Water**	**Biodegradable Waste**	**Non-Biodegradable Waste**
Twin pit Toilets **or** **Toilet with Septic Tank and Soak Pit**	• Soak Pit for Septic Tank • DEWATS-Anaerobic Baffled Reactor (ABR)	• Emptying toilet pit and using as manure • Deep Row Entrenchment • Tiger Bio filter	• Kitchen garden • Soak Pit • Magic Soak Pit • Leach Pit • Waste Stabilization Ponds • DEWATS-ABR • Constructed Wetlands • Conveyance for Grey Water	• Manure Pit • Composting NADEP Tank at community level	• Segregation at HH level • Collection and Transportation • Community Resource Recovery Unit (CRRU)
Retrofitting ○ **Second Leach pit for single pit toilet** ○ **Tiger Bio filter**					• Incineration of Sanitary Waste
CT/PT					

SLWM Technology Suggested for Rural Maharashtra

SN	Activities	Toilet Management		Liquid Waste Management (LWM)		Solid Waste Management (SWM)	
	Level of Interventions	Toilet	FSM	Black Water	Grey Water	Biodegradable Waste	Non-Biodegradable Waste
1	HH Level	Twin Leach Pit	Tiger Bio filter	Soak Pit for Septic Tank	Kitchen garden	Underground unlined manure pit	
2		Septic Tank with Soak Pit	Emptying toilet pit and using as manure		Soak Pit	Underground brick lined manure pit	
3					Magic Soak Pit		
4					Leach Pit		
1	Community Level	Community Toilet (CT)	Deep Row Entrenchment	DEWATS-Anaerobic Baffled Reactor (ABR)	Community Soak Pit	NADEP Tank Composting	Community Resource Recovery Unit (CRRU)
2		Public Toilet (PT)			Community Leach Pit		Incineration of Sanitary Waste
3					Waste Stabilization Ponds (WSP)		
4					DEWATS System Anaerobic Baffled Reactor (ABR) Constructed Wetlands (CW)		
5					Three Stage Filtration		

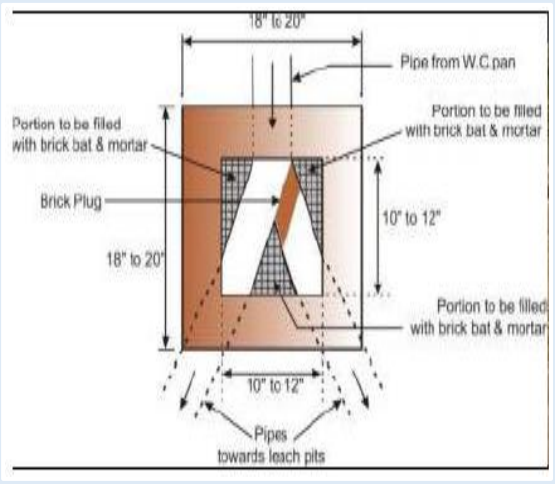
Chapter 3: Technological Options Suggested for Toilet Management/FSM

3.1. Retrofitting Options for Toilets

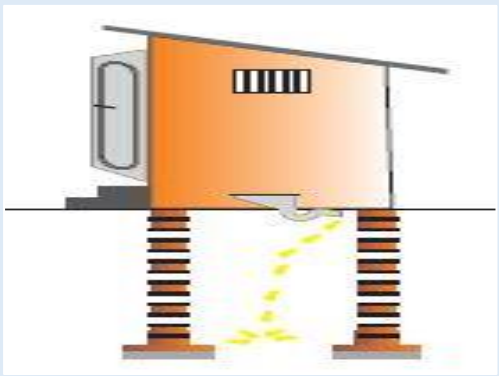
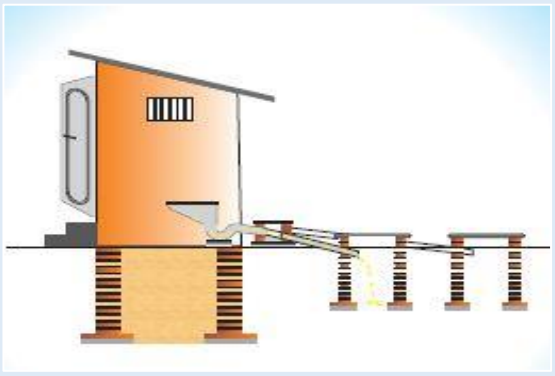
Retrofitting is an action or measure to address a technological gap/problem. Retrofitting of toilets would involve reparing a defective junction chamber or construction of a second pit with an appropriate Junction Chamber.

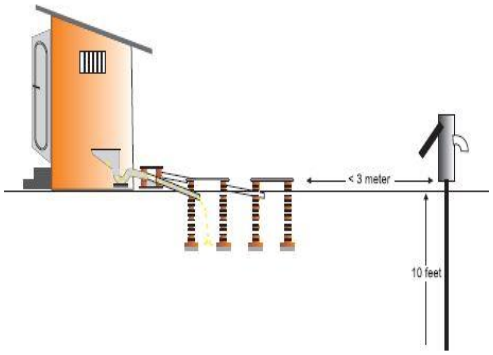
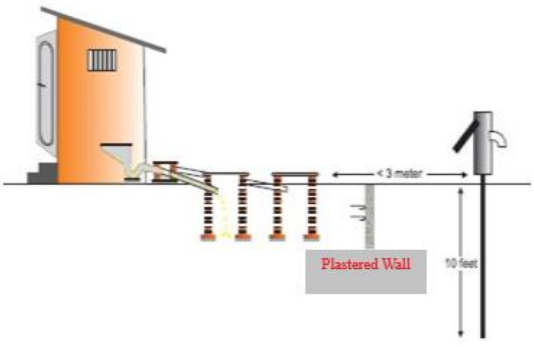
Retrofitting of toilets is necessary to end open defecation.

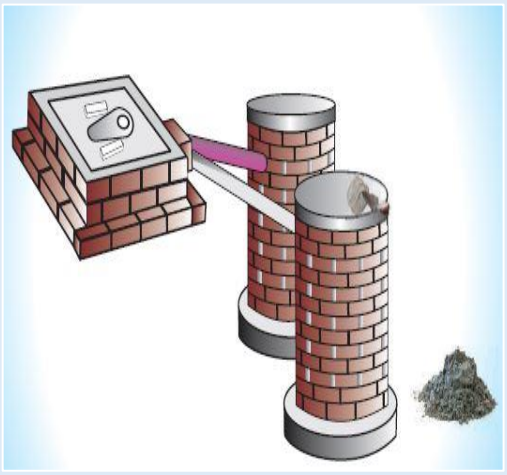
Some examples of problems and retrofitting solutions are presented in the table below.

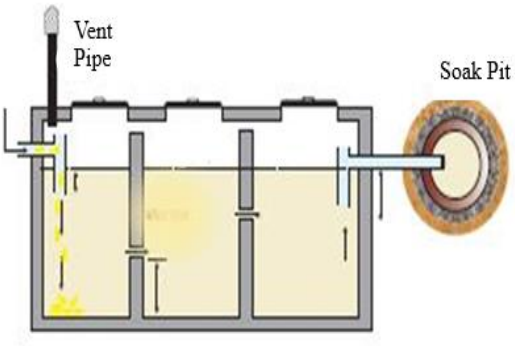
Sr. No.	Problem Area	Possible Solutions
1	**Poor Junction chamber** 	• It is the lifeline connecting the pan and the pit • Junction chamber should be repaired and strengthened 
2	**Both pipes are open** 	• Close the pipe of the pit which is not in use 

3	**Single Pit to Twin Pit** 	 • Stop the use of toilets for two days. Meanwhile, those households whose toilets are being retrofitted can use neighborhood toilets or community toilets. • Flush the toilet with sufficient water so that the faecal matter is completely flushed to the pit. • A second pit (01 m *01 m) may be dug at a distance of one metre from the first pit. • The pipe connecting the first pit with the junction chamber may be cut five inches from the rear wall. The cut should be a feet long from the 5 inch mark. Do not interfere with the remaining portion of the pipe. • Junction chamber of 01 ft * 01 ft (inner size) may be constructed and connected to both the pits • The detailed estimate for second leach pit with junction chamber is given on 3.1.2

4	**Pits too Deep** 	• Growth and functioning of excreta-decomposing pathogens (bacteria) are affected if the depth is more than one metre. • Soil should be filled up to one metre from the ground level or a new pit (one metre deep) should be dug.
5	**The room of the toilet is constructed above the pit** 	• Once this type of toilet is in use, then it cannot be retrofitted. • Before the original pit get filled, construct two leach pits and connect it through a junction chamber as per technical criteria. When the pit under the room is full, close it and connect through the junction chamber. 
6	**Leach pits too close to drinking water source**	The distance of the leach pit from the drinking water source is determined as per the ground water level. 1. If the ground water level is less than 03 meters, then the distance of drinking water level and pit should be 10 meters.

	In such situations there are chances of contamination of the drinking water source which might affect ODF Sustainability, in addition to causing health issues.  	2. If the ground water level is more than 03 meters, then the distance of drinking water level and pit should be 03 meters. 3. The distance of drinking water source and pit should never be less than 03 meters. If the specified distance is not maintained as per above mentioned points 1 & 2, then a wall needs to be built in between the leach pit and drinking water source. The wall can either be a precast, RCC or brick wall with plaster on both sides. 4. In case of scenario 3 as mentioned above the use of leach pit toilet must be immediately stopped and other alternative options like ECOSAN/Bio toilet should be constructed. 

7	**Vent pipe/ gas pipe has been installed for the leach pit toilets.** • The process of composting of faeces into manure is affected. The vent pipe/gas pipe emits foul smell and becomes favourable for mosquito breeding. • Conversion of faeces into manure is an aerobic (absence of oxygen) decomposition process. Therefore, the vent pipes should not be used in the leach pit. 	• Remove the vent pipe/ gas pipe and fill the hole in the pit due to the pipe with a mixture of cement, concrete and sand. 

8	**Septic tank without soak pit** 	• Never allow the effluent of septic tanks to flow into an open space or an open drain. This can cause water pollution and spread of diseases. Instead, make a soak pit of appropriate volume to accommodate the effluent near the septic tank 

3.1.1 Operation & Maintenance of Pit Toilets and its Emptying:

Indicators of filling of pit

- Blockage of pipe and slow passage of excreta from pan to the leach pit.
- The filling time of leach pit varies between three years to 6 years depending upon the no. of users, infiltration capacity of soil etc.

How the changeover from one pit to another is done? Who is to do it?

The changeover is very easy. It can be done at home by the user (him /her self) on confirmation of the filling of one pit.

Steps for Changeover from one pit to another

1. Flush a full bucket of water from the pan. So that the junction chamber will be cleaned.
2. Remove the cover of junction chamber and clean the chamber from inside once again.
3. Remove the plug (the piece of brick) and place it in another position i.e. towards filled pit. If necessary change the brick.
4. Plug the brick with lean mortar.
5. Place the cover of junction chamber and seal it from all the sides with cement mortar.
6. If need be one can wear rubber gloves while performing this task as an extra care.
7. Don’t use the toilet for 5-6 hours after this operation since the mortar in the plug may not be washed off.

Methodology for Pit Emptying (Manure Emptying)

- One year after the changeover of pits, the first filled pit should be ready for emptying.
- The right time to take out the manure is in the summer season.
- The first step is to remove the cover of the filled leach pit.
- Observe the manure carefully.
- If there are any roots of nearby trees found growing in the pit, remove the same.
- Take out the manure with a spade and a *Ghamela*
- As the level of manure goes down, one cannot remove it from above. One can safely get inside the pit and remove the manure. It is important to not forget to wear proper shoes while doing so.
- Sometimes the lower most portions may be wet. However, this is not harmful. The same can be taken out or dried by keeping the pit open for 1-2 days.
- Fix the pit lid properly after emptying and spread soil over it.

3.1.2 Leach Pit with Junction Chamber (Second Pit Option for single pit toilet)

Estimates for Second Leach Pit with Junction Chamber

Sr No	Particular	Quantity	Unit	Rate/Unit	Amount
1	**2**	**3**	**4**	**5**	**6**
1	Bricks	170	No	6.5	**1105**
2	Sand	0.15	Cum	1575	**236.25**
3	Cement	0.5	Bag	235	**117.5**
4	Aggregate	0.03	Cum	800	**24**
5	PVC Pipe (75mm dia.)	2	R. Mt	195	**390**
6	Pit Cover R.C.C. of 1.2m dia.	1		782	**782**
7	Labour for Excavation	0.5	Man-day	493	**246.5**
8	Labour (Construction)	1	Man-day	493	**493**
9	Mason	1	Man-day	539	**539**
10	Junction Chamber	1	No	1016.55	**1110.85**
	Total Cost of Leach Pit				**5044.1**

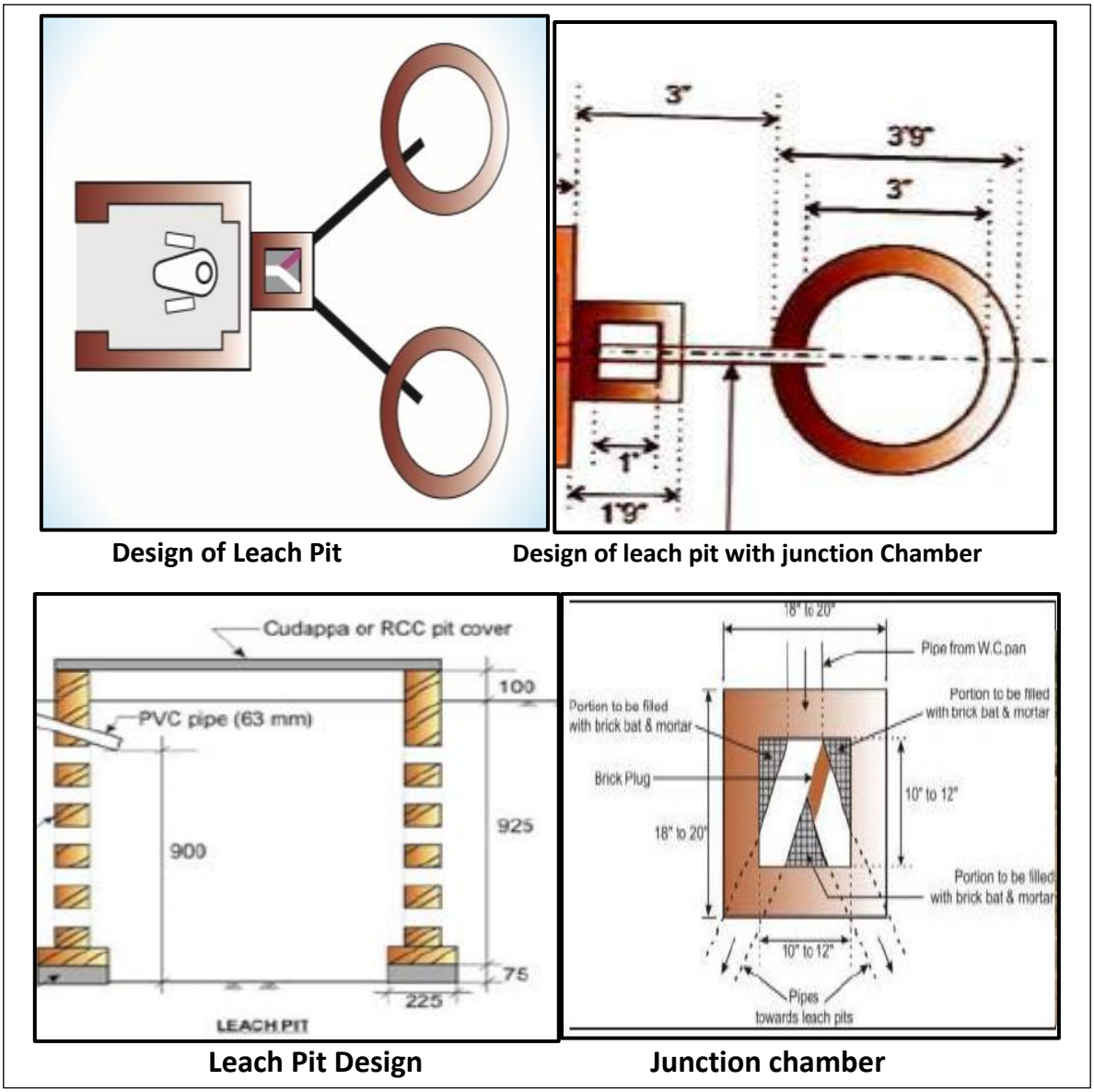


Figure 8 – Second Leach Pit with Junction Chamber

3.1.3 Management of Septic Tanks

Precautions & Maintenance measures to be taken for toilets connected to Septic Tanks

- Never allow the effluent of septic tanks to flow in the open or into an open drain. This is against the law, and causes water pollution and the spread of diseases. Instead, provisions must be made for a soak pit or leach pit of appropriate volume to accommodate the effluent.
- Always provide a vent pipe to evacuate the noxious gases from the septic tank. Cover the vent cap with a net to prevent mosquitoes from entering the tank, which can cause further increase in number of mosquitoes.
- Make sure that water from bathrooms, domestic waste water, and rainwater do not enter the septic tank.
- Use a bleach-based mixture for cleaning the toilet pan
- Emptying of the septic tank is very important for its safe usage. The septic tank must be emptied after regular intervals.

Methodology and system of desludging

- The septic tank needs to be desludged every 3-5 years based on the size of tank
- Sludge pump/vacuum pump is necessary for desludging
- Such facilities may not be available in rural areas as they are costly
- Technologies like Gulper, MAPET are available in the market and can be used for emptying.

3.1.4 Soak Pit for Septic Tank

Soak pit or leach pit is used as a black water-effluent or septic effluent absorption system which flows out of a septic tank.

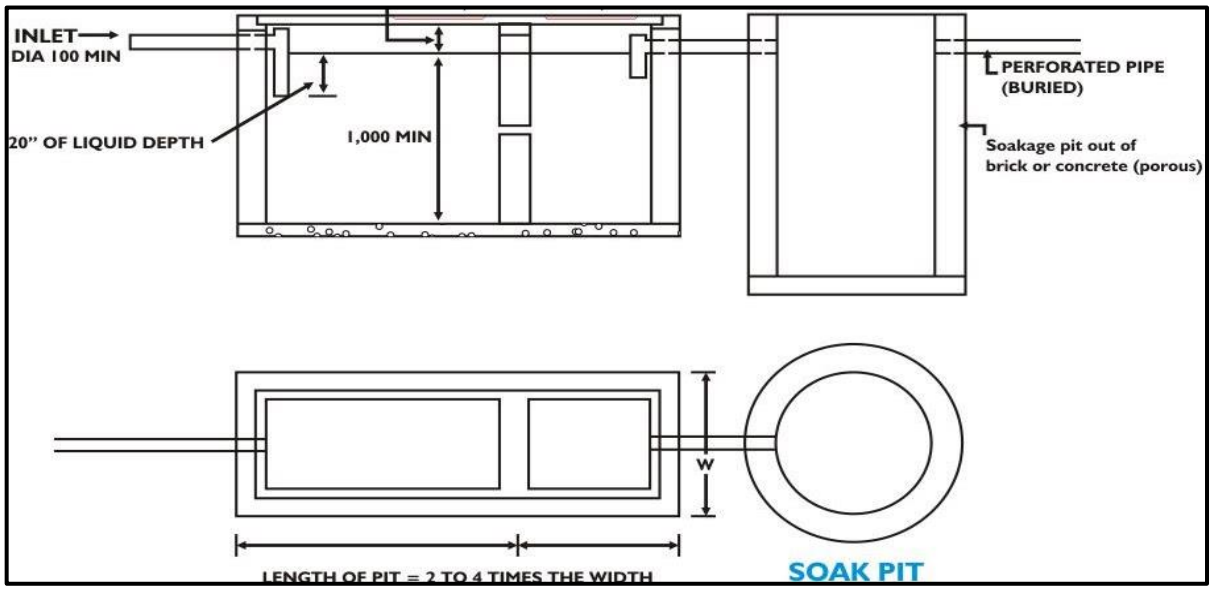


Figure 9 – Soak Pit for Septic Tank

Estimate for Soak Pit for Septic Tank

Sr No	Particular	Quantity	Unit	Rate/Unit	Amount
1	2	3	4	5	6
1	Bricks	170	No	6.5	**1105**
2	Sand	0.15	Cum	1575	**236.25**
3	Cement	0.5	Bag	235	**117.5**
4	Aggregate	0.03	Cum	800	**24**
5	PVC Pipe (75mm dia.)	2	R. Mtr	195	**390**
6	Pit Cover R.C.C. of 1.2m dia.	1		782	**782**
7	Labour for Excavation	0.5	Man-day	493	**246.5**
8	Labour (Construction)	1	Man-day	493	**493**
9	Mason	1	Man-day	539	**539**
	Total Cost of Leach Pit for Septic Tank				**3933.3**

3.2. Technological Options Suggested for Faecal Sludge Management

3.2.1. Deep Row Entrenchment

Technology	Applicability	Action	Advantages	Construction Methodology	Limitations
Deep Row Entrenchment (DRE) **For the purpose of safe septage treatment from septic tank & single pit it is proposed to have Deep row entrenchment (trenching).**	• Feasible at the village level. • DRE is best suitable in soils with good absorptive properties.	Gram Panchayat can make these DRE with little technical knowhow.	• Faecal Sludge rich in nutrients which can be further converted into manure. • It is very simple and requires low cost for construction. • No O & M required • The faecal sludge is buried underground and fencing to plot should protect humans & animals direct contact with the faecal sludge. • It enhances individual and public health status. • It enhances environmental status. • Fulfilment of environmental laws.	• It consists of digging trenches up to 1 metre depth, filling them with sludge and covering them with soil. • The plot identified by the GP will have to be fenced. • The transportation of faecal sludge from the toilet pits to the entrenchment site would be borne by the individual householder through contractual services.	• DRE is not suitable for rocky terrain due to low or zero leaching effects of water from the faecal sludge in the soil/ground. • Availability of land & distance to groundwater and surface water bodies are the main constraints. • It should be constructed in a distance of at least 15 m from drinking water source such as wells and hand pumps in order to prevent cross-contamination. • Desludging of sludge from septic tanks and filling it in the trenches should be avoided in the rainy season.

Figure 10 – Deep Row Entrenchment

Estimate for Deep Row Entrenchment

SN	Particular	No	L	W	D/H	Unit	Qty	Rate/Unit	Amount	Reference
1	2	3	4	5	6	7	8	9	10	11
1	Excavation for foundation in earth, soil of all types, sand, gravel and soft murum, including removing the excavated material upto a distance of 50 m. beyond the building area and stacking and spreading as directed, dewatering, preparing the bed for the foundation and necessary backfilling, ramming, watering including shoring and strutting etc. complete. (Lift upto 1.5 m.) By Mechanical Means.	5	10	1	1	Cum	50	157	**7850**	PWD SSR Page No 198 Item No 21.17
2	Providing and erecting 1.5 metre high **wire fencing** with seven rows of barbed wire supported on M.S. Angles (50mmx50mmx6mm) at 2.5 Metres, Centre to centre including excavating pits for foundation, fixing post in cement concrete 1:4:8 of size 45x45x45 cm fastening the wire and painting the M.S. Angles with one coat of red lead primer and two coats of painting etc. complete.		10	10	1.5	R Mtr	40	908	**36320**	PWD SSR- Page No 374 Item No 44.09
3	Providing and fixing **mild steel grill gate** with angle iron frame 65mmx65mmx10mm with iron bars at 150mmC/C and diagonal flats as per the detailed drawing including hinges, pivot block locking arrangement, welding riveting and oil painting of three coats of approved shade Weight of gate 35 Kg/Smt.		3	2		Sq. Mtr	6	2333	**13998**	PWD SSR- Page No 374 Item No 44.10
	Total Cost of Deep Row Entrenchment								**58168**	

Capacity of Deep row Entrenchment:-

The plot identified for DRE is to be of 10 m by 10 m in dimension. In that plot five trenches will be dug. There should be 1m distance between each trench.

The dimension of 1 trench = **10 m * 1 m* 1 m**

Volume of 1 Trench = **10 m^3**

Volume of 5 Trenches = **50 m^3**

Therefore, the plot identified for DRE of dimension 10 m* 10m will handle **50 m^3** (50,000 litres) of sludge quantity yearly.

Thus, for the planning of Faecal Sludge Management, it is suggested to do intensive data collection at the household level i.e. calculate the number of septic tanks, shape of septic tank & dimension of the septic tank, to calculate the sludge generated in the village. Accordingly, the plot size will depend on the above calculation.

The above given estimates are for 10 m by 10 m plot. The dimension of plot and estimates will be changed according the survey.

Basis for Per Capita Cost for Faecal Sludge Management

1.	Total No. of GPs in Maharashtra	**27841**
2.	Total Rural Households in Maharashtra	**13203245**
3.	Average Households in Rural Village of Maharashtra	Total Rural Households in Maharashtra/ Total No. of GPs in Maharashtra = **13203245/27841 =474.24** **= 475**
4.	Average Population in Rural Village	= Average HHs in rural village * 5 = 475* 5 **=2375**
5.	**Septic Tank Nos in Village**	**25% of Total HHs No.**[1] = 0.25*475 **= 119**
6.	It is assumed that in one year 50% HHs desludged their septic tanks.	= 0.50*119 = 59.5 **= 60**
7.	Yearly 60 Septic Tanks will be desludged in Deep Row Entrenchment	
8.	Amount of Sludge from 1 septic tank (5 users)	Volume of Septic Tank (L*B*D) = 1.5 m* 0.75 m * 1.05 m^2 **= 1.18 m^3 = 1181.25 litre**
9.	Amount of sludge generated in one year from 60 septic tank	= 60*1181.25=**70875 litre**
10	We require trenches to manage 70,000 Litres sludge	
11	Plot Size require a) Fencing Required for 13m *12 m **Amount for Fencing** b) Excavation of one trench of length 12 m, 1 m width and 1 m depth **Excavation cost for 6 trenches** **c) Mild Steel Grill Gate of Size 3m * 2m**	=(13 m* 12 m) =156 m^2 **= 156 m * 908 =1,41,648** =12*1*1 =12 m^3 = 12* 6=72 m^3 **= 72*157 = 10,990** **= 6 * 13998 = 83988**
12	Total Amount Require for 70,000 litre sludge management	=1,41,648 + 10,990 + 83988 **= 2,38,626**
13	**Amount for FSM per capita**	**= Amount Require for FSM/ Total average population of Gram Panchayat** **=2,38,626/2375** **=100.47**
14	**Amount for FSM per household**	**= 100.47*5** **=502.37**

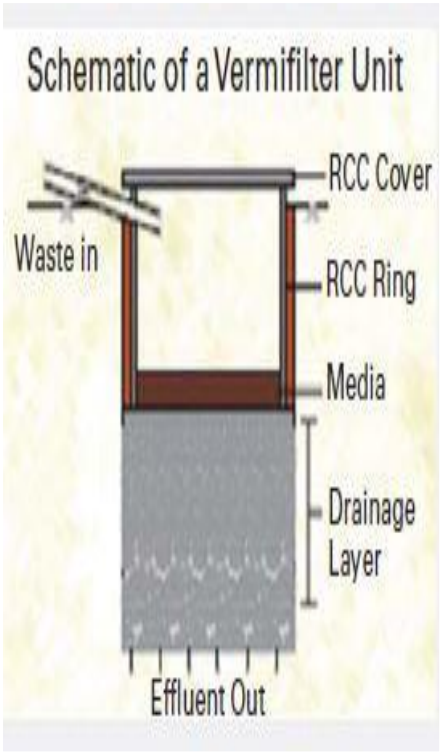
[1] The reference is taken from Census of India (2011), Census 2011: Percentage of Households to Total Households by Amenities and Assets (India & States/UTs-Village and Ward Level)

[2] The reference is taken from Bureau of Indian Standards, (1993), Indian Standard Code of Practice for Installation of Septic Tanks: Design Criteria and Construction.

3.2.2. Tiger Biofilter[3]

Technology	Applicability	Action	Advantages	Construction Methodology	Limitations
Tiger Biofilter • It is based on the process of vermi-filtration. • In this technology, various types of filter media and bio media are used together with worms and bacterial culture, which contributes to easy and natural purification of wastewater. • The percentage of water recovery is about 90-95%. During the process, no sludge is generated and hence there is no need to separately manage the sludge unlike other faecal sludge treatment options.	• It is best suitable in soils with good absorptive properties	• Trained person required for installation of the technology	• No need of handling sludge, as faecal sludge, is rapidly converted into vermicompost • Safer and easier emptying as vermicompost is stable, soil-like material • Cost effective in construction and easy to operate. The vermi-filter is not expensive and does not require special tanks to be constructed. It can be easily installed in existing pit design. Dosage of bio media is required only at time of installation of the system.	• A pit of 1.2 metre diameter and 1.2 metre height is excavated. • First filter media, good quality of aggregates, sand etc. is fill in the pit. • Bio media layer consists of earthworm and bacterial culture which is spread on the filter media. • Filter media is used for supporting the bio media and filtering water.	• Wastewater containing chemical impurities and solids requires pre-processing. • The compost generated by the process contains pathogens and thus need to be handled properly.

[3]Source: Training manual Faecal sludge management in rural areas under SBM(G) by Water Supply Sanitation Department, Government of Maharashtra



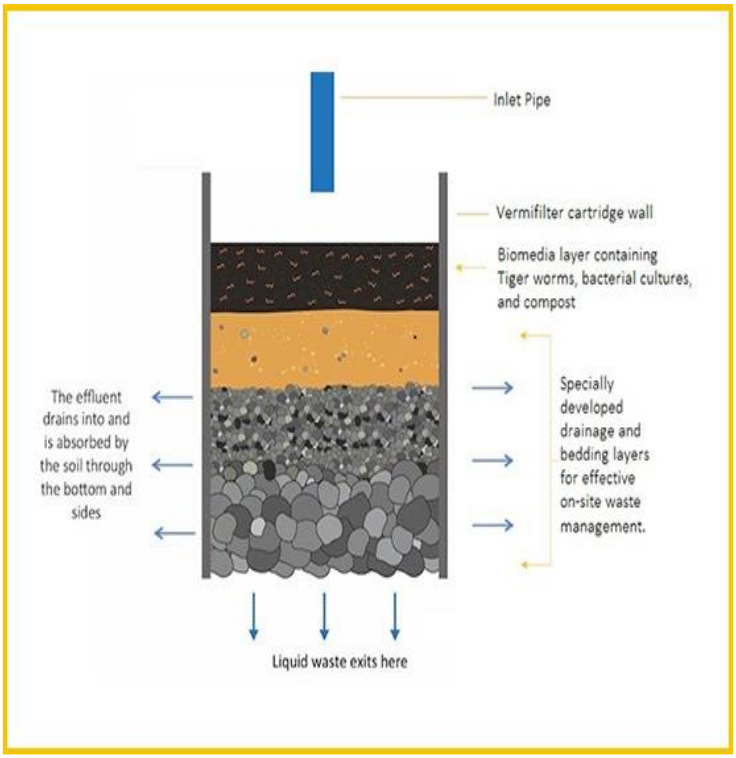


Figure 11- Tiger Biofilter

Budgetary Price for Tiger Biofilter

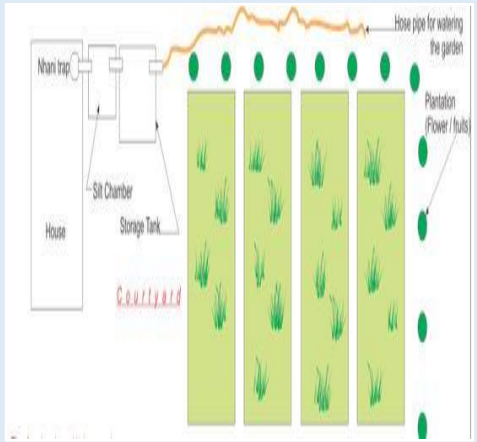
Sr No	Description	Unit	Pricing INR
1	• Supply of Tiger Toilet Bio digester	• No.	• INR 8,500.00 to 10,000.00
2	• Supply of only Bio media for Tiger Toilet Bio digester and commissioning	• Bag	• INR 3,500.00

- GST : Extra as applicable
- The above designs are based on assumption that 5-8 personnel shall use the Tiger Toilet for defecation every day.
- Tiger Toilets should be strictly avoided to be used only for urination.
- Important: Strata and water table need to be studied well for optimum performance of Tiger Toilets. Hard rock areas and areas with high water table should be avoided for Tiger Toilets.

Chapter 4: Technological Options Suggested for Grey Water Management

4.1. Household Based Decentralised Solutions for Grey Water Management

4.1.1. Kitchen Garden

Technology	Applicability	Action	Advantages	Construction Methodology	Limitations
Kitchen Garden 	• Houses with adequate court-yard. • Feasible in all situations including high water table & rocky terrain areas.	• House owner will develop the system with the help of trained person.	• Grey water can be utilized to grow vegetables, flowers or fruits in the court-yard of the house. • Reuse of grey water saves fresh water • Prevents stagnation of grey water • Prevents vector breeding • It enhances individual & public health status. • It enhances environmental status.	• The grey water must pass through a Nahani trap to remove impurities. • A silt chamber to collect silt (750mm x 600mm x 500mm) • Storage tank of capacity 200 to 500 litre capacity. • Making beds for plantation according to size available in court-yard. • Planting species intended to grow • Connecting hose pipe from storage tank to the planted beds.	• Use of strong detergent may be harmful to the plants grown in the kitchen garden. • Adequate slope should be available to help the grey water to flow towards the vegetation/plantation.

Estimate for Kitchen Garden

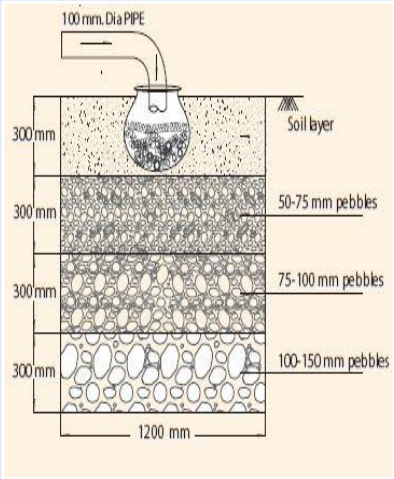
Kitchen Garden with Leach Pit

Sr. No.	Particulars	Quantity	Unit	Rate per unit	Total Amount
1	Silt chamber	1	Nos.	2248.1	2248.1
2	Leach Pit (Optional)	1	Nos.	5335.5	5335.5
3	Storage Tank (capacity 200 to 500 lit) (Cement Tank)	1	Nos.	1782.3	1782.3
4	PVC Pipe (75mm Dia.)	3	R Mtr	195	585
5	Manual labour (Plumbing etc.)	1	Man-day	493	493
	TOTAL				**10443.9**

Kitchen Garden without Leach Pit

Sr. No	Particulars	Quantity	Unit	Rate per unit	Total Amount
1	Silt chamber	1	Nos.	2248.1	2248.1
2	Storage Tank (capacity 200 to 500 lit)	1	Nos.	1782.3	1782.3
3	PVC Pipe (75mm Dia.)	3	m	195	585
4	Manual labour (Plumbing etc.)	1	Man-day	493	493
	TOTAL				**5108.4**

4.1.2. Soak Pit

Technology	Applicability	Action	Advantages	Construction Methodology	Limitations
Soak Pit  	• Houses without adequate space for kitchen garden • Soak pits are best suited to soils with good absorptive properties. • Soak pits are not appropriate for clay, hard packed or rocky soils. • Villages where there is scarcity of water.	• House owner can construct the pit himself by getting the information of the design.	• This is the cheapest technology for management of grey water at household level • Prevents greywater stagnation • Prevents vector breading • In the long-term it can help to recharge the groundwater to some extent • The technology is located underground and thus, human and animals should have no contact with	• A rectangular pit (1.2 metre length, 1.2 metre width and 1.2 metre height) or circular pit (1.2 metre diameter & 1.2 metre height) is excavated. • Then the pit is filled with three layers of aggregates and pebbles as described below: First layer (bottom layer)- 30 cm height, aggregates and pebbles of 100-150 mm size Second layer (middle layer)- 30 cm height, aggregates and pebbles of 75-100 mm size Third layer (top layer) -	• Soak pit is not suitable for rocky terrain • Soak pits are not suitable for high ground water table areas • It will over flow if wastewater flow in the pit exceeds the design flow • If suspended solids get into the pit, the choking of the pit will take place earlier. • Ordinary brick bats or gravel etc. should not be used as filling material because brickbats tend to crumble when wet.

			grey water. • It enhances individual & public health status. • It enhances environmental status.	30 cm height, aggregates and pebbles of 50-75 mm size. • While filling the aggregates in the third and topmost layer of 25 cm, a perforated earthen pot of 6-8” diameter is kept in the center of the pit. Gunny bags, sand and soil are used to fill in the next 15 cm of the pit. • This layer is filled in such a manner that the opening of the earthen pot will remain exposed on the top of the ground. • This earthen pot is filled with dry grass and other filtration materials.	• It should be kept away from high traffic areas. • It should be constructed in a distance of at least 10 m from drinking water wells/hand pumps in order to prevent cross-contamination.

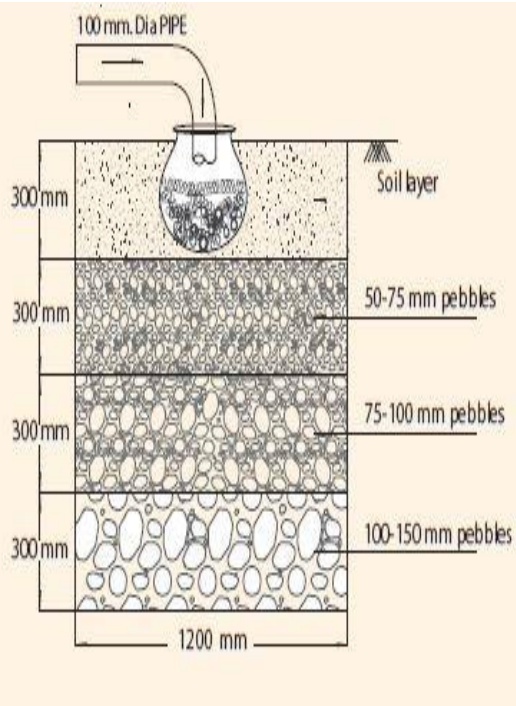
Estimate for Soak Pit

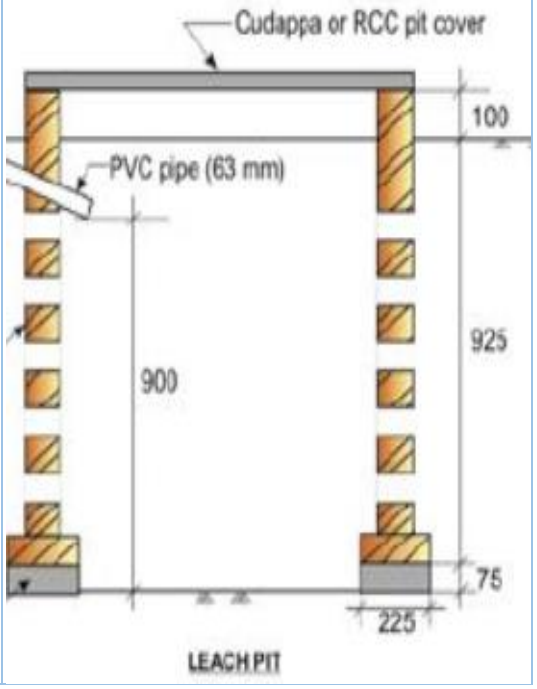
Sr. No	Particular	Quantity	Unit	Rate/Unit	Amount	SSR Item No
1	**2**	**3**	**4**	**5**	**6**	**7**
1	Providing soak pit of size 120cmx120cmx120 cm including excavating and filling with brick bats.	1	No	2363	**2363**	42.19
2	PVC pipe (75mm dia)	2(or as required)	R. Mtr.	195	**390**	Sr no 185 in Building (Bd-V: Water supply and sanitary fittings)
3	PVC Nahani Trap 75 mm	1	No	110	**110**	Sr no 19 in Building (Bd-V: Water supply and sanitary fittings)
4	Pit Cover R.C.C. of 1.2m dia.	1	No	800	**782**	
	Total Cost of Soak Pit				**3645**	

Difference between Soak Pits & Leach Pits

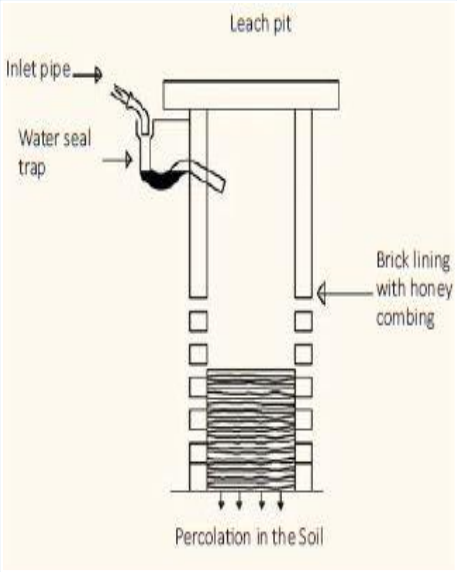
Differences Between Soak Pits and Leach Pits	
Soak Pit	**Leach Pit**
• When the grey water quantity is limited and availability of open land is a constraint, soak pit would be a very simple and cheap option for grey water management. • For domestic purposes, a cubical pit is dug in the soil with dimensions of approximately 1 metre length, 1 metre width and 1 metre depth. • The surfaces of pit walls and the bottom surface of the pit make available more surface area of the soil for absorption of water in the soil. For giving stability to the pit and for distributing incoming water to the available surface area, the pit is filled with stone rubble of graded sizes. • At the top, the pit is covered with supporting material like tree twigs or gunny sacking etc. and topped up with murrum, so that the inflowing water doesn't remain exposed. • In the centre, an inlet with a filter, like grass filled perforated matka is placed, through which water is allowed to flow in the pit. • An important point is, ordinary brick bats or gravel etc. should not be used as filling material because brickbats tend to crumble when wet.	• If availability of open land is a constraint and quantity of grey water is more (mostly suitable for group of houses), a domestic leach pit would be a suitable option. • Leach pit is a brick lined circular pit constructed in honeycomb masonry, having a diameter of approximately 1 metre. • The pit should have a proper insect proof cover. Water should be led into the pit through a water seal trap, so that insect movement and mosquito breeding is avoided. • It has more absorption capacity and filling with gravel not required.

- In due course, they obstruct the flow of water towards the soil surface at the sides of the pit. Stone rubble is also more efficient in distributing water to all the absorbing surfaces.





4.1.3. Leach Pit

Technology	Applicability	Action	Advantages	Construction Methodology	Limitations
Leach Pit  Leach pit is a brick lined pit constructed in honeycomb masonry having a volume of about 0.78 cubic metres.	• Houses without adequate space for kitchen garden where waste water discharge is relatively more. • Leach pits are best suited to soils with good absorptive properties.	• House owner will do the installation of the leach pit with the help of trained mason.	• It can handle large volume of water during peak period of water generation • Requires less maintenance • Prevents stagnation of grey water • Prevents vector breeding • It enhances individual & public health status. • It enhances environmental status.	• A circular pit of 1 metre diameter and 1 metre height is excavated. • Then a brick lined circular pit constructed in honeycomb masonry. • The pit should have a proper insect proof RCC pit cover/lid. • Water should be led into the pit through a water seal trap, so that insect movement and mosquito breeding is avoided.	• Leach pit is not suitable for rocky terrain • Soak pits are not suitable for high ground water table areas. • It will over flow if grey water flow in the pit exceeds the design flow • If suspended solids get into the pit, the choking of the pit will take place earlier.

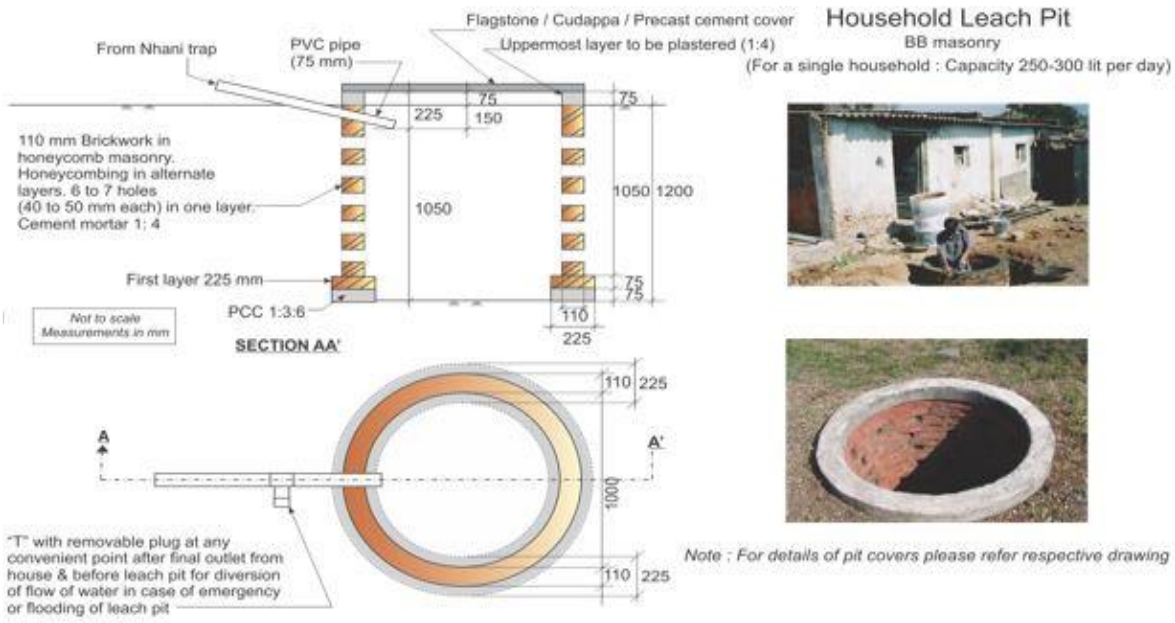
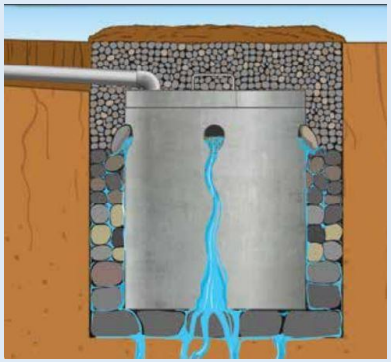


Figure 12- Leach Pit

Estimate for Leach Pit

Sr. No.	Particular	Quantity	Unit	Rate/Unit	Amount
1	**2**	**3**	**4**	**5**	**6**
1	Bricks	200	No	6.5	**1300**
2	Sand	0.25	Cum	1575	**393.75**
3	Cement	1.25	Bag	235	**293.75**
4	Aggregate	0.06	Cum	800	**48**
5	PVC Pipe (75mm dia.)	2	R. Mtr	195	**390**
6	Pit Cover R.C.C. of 1.2m dia.	1		782	**782**
7	Nahani Trap (75 mm Dia)	1	No	110	**110**
8	Labour for Excavation	1	Man-day	493	**493**
9	Labour (Construction)	2	Man-day	493	**986**
10	Mason	1	Man-day	539	**539**
	Total Cost of Leach Pit				**5335.5**

4.1.4. Magic Soak Pit

Technology	Applicability	Action	Advantages	Construction Methodology	Limitations
Magic Soak Pit  • This intervention focuses upon breaking down the life cycle of mosquitoes at the egg-laying and larval stage. • The objective of this path-breaking initiative is to deploy measures to prevent stagnation of water (especially in open gutters). • Instead of following the traditional process in which a proper slope to the gutter prevents the water from stagnating, the water flowing into gutters is stopped and treated with the help of this	• Houses without adequate space for kitchen garden where waste water discharge is relatively more.	• House owner will do the installation of the leach pit with the help of trained mason.	• Low cost and easy to construct • Dry environment since the entire wastewater from a household is absorbed by this underground structure. • Freedom from mosquitoes • Odour-free environment • No drains required • Recharge of groundwater • O&M costs are low and borne by the house owner. • It enhances individual & public health status. • It enhances environmental	• A rectangular pit of 4 feet length, 4 feet width and 4 feet height is excavated initially. • Then the pit is filled with three layers of aggregates and pebbles as described below: 1. First layer (bottom layer)- 12.5 cm height, aggregates and stones of 100-120 mm size • After first layer kept the cement tank of 3 feet diameter in the pit 2. Second layer (second layer from bottom)- 25 cm height, aggregates and stones of 75-100 mm size 3. Third layer (third layer from bottom) - 25 cm height, aggregates and stones of 50-75 mm size. 4. Fourth layer (top layer) - 25 cm height, aggregates and stones of 50-75 mm size. • The stones of second, third and fourth layer laid down in the surrounding of the cement	• Possibility of groundwater contamination especially in the areas with high groundwater table • Pit technologies fail in the areas with hard rocks due to low or zero leaching effects of water on the soil/ground • Operational Life of pit technology drastically decreases without a Nahani trap or screening medium to separate out heavy solids. • It is not efficient in black cotton soil due to less absorption capacity of water. • It will over flow if

unique magic pits of Nanded pattern.			status.	tank. • The cement tank is covered with the lid followed by a polythene sheet that is spread over the magic pit. • The whole set up is then covered in soil and remains concealed.	wastewater flow in the pit exceeds the design flow

Estimate for Magic Soak Pit

Sr. No	Particular	Qty	Unit	Rate/Unit	Amount	SSR Item No
1	**2**	**3**	**4**	**5**	**6**	**7**
1	Providing soak pit of size 120cmx120cmx120cm including excavating and filling with brick- aggregate.	1	No	2363	**2363**	42.19
2	PVC pipe (75mm dia)	2	R. Mtr.	195	**390**	Sr no 185 in Building (Bd-V: Water supply and sanitary fittings)
3	PVC Nahani Trap 75 mm	1	No	110	**110**	Sr no 19 in Building (Bd-V: Water supply and sanitary fittings)
4	Pit Cover R.C.C. of 1.2m*1.2m [4]	1	No	891.15	**891.15**	
5	Cement Tank of 1m dia & 1m height [5]	1	No	1782.3	**1782.3**	
	Total Cost of Magic Soak Pit				**5536.45**	

[4]Detailed estimate Cement Tank estimated detailed in next page
[5]Detailed estimate for RCC pit cover estimated detailed in next page

Cement Tank

Arranement of Cement Tank in the Soak Pit

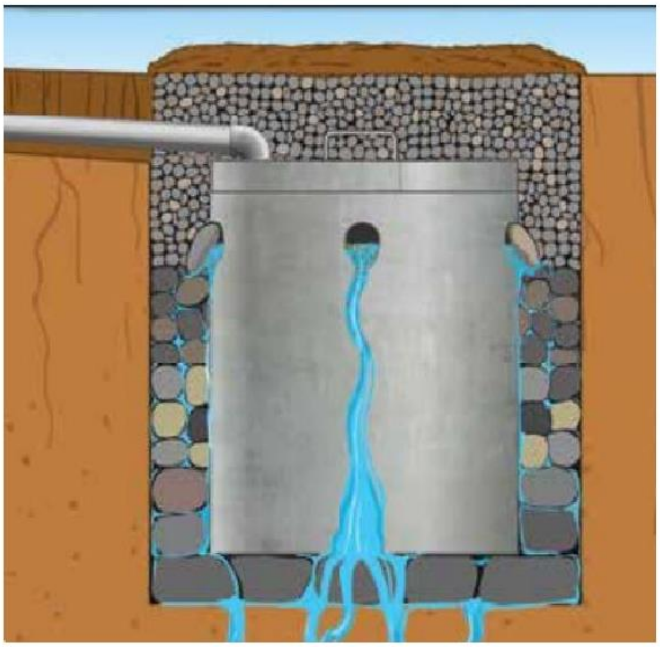
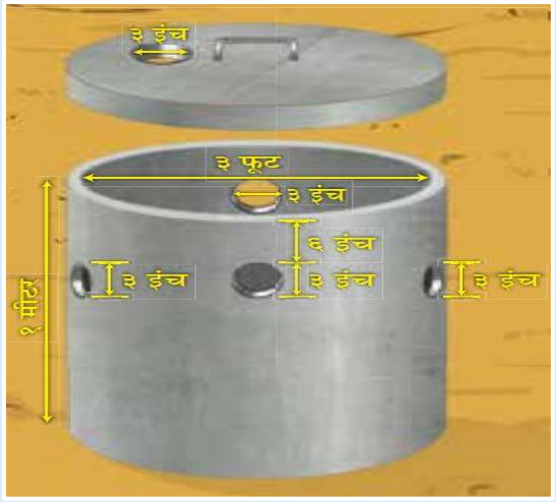


Diagram of Magic Soak Pit

Figure 13- Magic Soak Pit

SN	Diagram with Name	Estimate
1	 **Cement Tank** of 1m dia & 1m height	
2	**Magic Soak Pit Cover** (Pit Cover R.C.C. of 1.2m*1.2m)	

Sr. No.	Particular	Quantity	Unit	Rate/Unit	Amount
1	2	3	4	5	6
1	Sand	0.06	Cum	1575	**94.5**
2	Cement	1.2	Bag	235	**282**
3	Aggregate	0.12	Cum	800	**96**
4	8 mm iron bar	18	Kg	44.1	**793.8**
5	Mason	0.5	Man-day	539	**269.5**
6	Labour (construction)	0.5	Man-day	493	**246.5**
	Total Cost				**1782.3**

Sr. No.	Particular	Quantity	Unit	Rate/Unit	Amount
1	2	3	4	5	6
1	Sand	0.03	Cum	1575	**47.25**
2	Cement	0.6	Bag	235	**141**
3	Aggregate	0.06	Cum	800	**48**
4	8 mm iron bar	9	Kg	44.1	**396.9**
5	Mason	0.25	Man-day	539	**134.75**
6	Labour (construction)	0.25	Man-day	493	**123.25**
	Total Cost				**891.15**

4.2. Community Based Solution for Grey Water Management

4.2.1. Community Leach Pit

Technology	Applicability	Action	Advantages	Construction Methodology	Limitations
Community Leach Pit Leach pit is a brick lined pit constructed in honeycomb masonry having a volume of about 2.21 cubic metres.	• Suitable for group of houses where building individual leach pit is not possible • This option can also be used at the end of drainage lines on which there are a limited number of households.	• Trained mason will do the installation of the leach pit with the help of design of the pit.	• It can handle large volume of water during peak period of water generation • It can handle a 2200 litres of grey water in peak period. • Prevents stagnation of grey water • Prevents vector breeding • It enhances individual & public health status. • It enhances environmental status.	• A circular pit of 2.2 metre diameter and 1.5 metre height is excavated. • The first layer of brick laid is of 450 mm and then above layers are of 225 mm sizes up to 1250 mm diameter. • Corbelling is done in top portion of the brick work so that the opening may be reduced to a diameter of about 3 feet. • This pit is covered with RCC or flag stone cover • The water is allowed to get in the pit via silt cum grease trap. This will restrict the quantity of silt flowing into the pit. • At the same time, by acting as a trap, it will avoid passage of insects and mosquito breeding.	• Leach pit is not suitable for rocky terrain & permanent water logged conditions. • It will over flow if wastewater flow in the pit exceeds the design flow • If suspended solids get into the pit, the choking of the pit will take place earlier. • To avoid clogging regular maintenance should be done in 1-2 months.

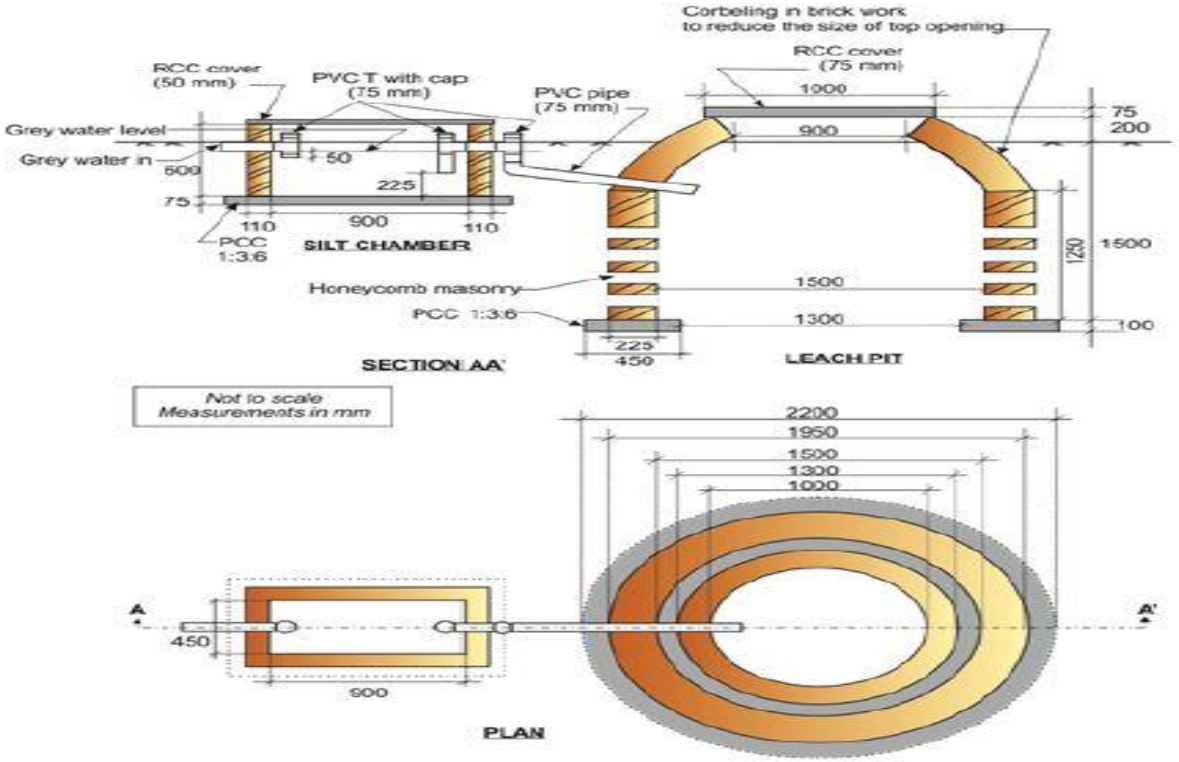
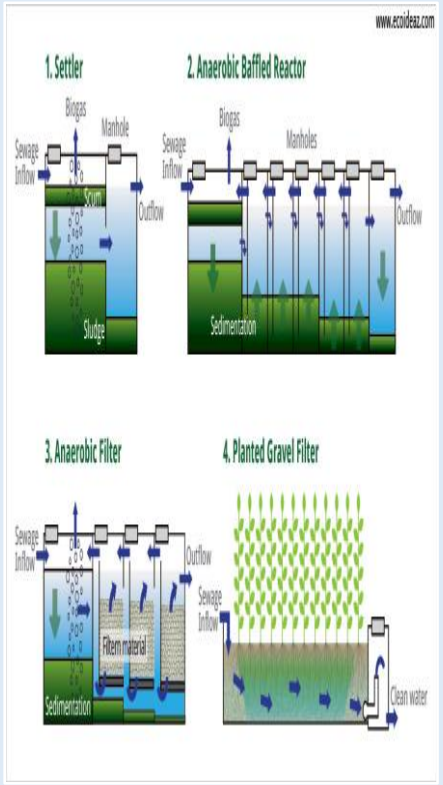


Figure 14- Community Leach

Estimate of Community Leach Pit

Sr. No.	Particulars	Quantity	Unit	Rate/Unit	Amount
1	Bricks	1700	No	6.5	**11050**
2	Sand	1.7	Cum	1575	**2677.5**
3	Cement	7	Bag	235	**1645**
4	Aggregate	0.3	Cum	800	**240**
5	PVC Pipe (75mm dia.)	3	R.Mtr	195	**585**
6	PVC Tee (75 mm dia.)	3	No		**0**
7	Nahani Trap (75 mm Dia)	1	No	110	**110**
8	Pit Cover R.C.C. of 1.2m dia.	1	No	782	**782**
9	Cover for chamber (1050x750mm)	0.79	Sq. Mtr	410	**323.9**
10	Labour (Excavation)	4	Manday	493	**1972**
11	Labour (Construction)	6	Manday	493	**2958**
12	Mason	4	Manday	539	**2156**
	Total Cost of Leach Pit				**24499.4**

4.2.2. Decentralized Wastewater Treatment System (DEWATS)

Technology	Applicability	Action	Advantages	Construction Methodology	Limitations
Decentralized wastewater treatment system (DEWATS) 	• This option can be used at the end of drainage lines. • It will be used for treating grey and black water simultaneously. • It can be constructed anywhere as it is RCC structure.	• Trained mason will do the construction of the DEWATS system with the help of design of the system.	• Cost- efficient as only locally available materials are required • Minimal O&M required. • Treated water can be used for irrigation, gardening etc. • Sludge rich in nutrients which can be further used as a natural fertilizer and soil conditioner • No groundwater pollution through long, leaking underground sewer systems. • Providing treatment for both grey water & black water effluent from septic tanks. • Fulfilment of discharge standard and environmental laws • Resource recovery through greywater re-use. • It enhances individual & public health status. • It enhances environmental status.	• DEWATS is a technology package. • In general, DEWATS comprises a settler, anaerobic baffled tanks, filter beds of gravel and sand, and an open pond. • The construction of the plant requires just five to six skilled and unskilled labours since the plant requires RCC works. • It has to be supervised by an engineer.	• Large area requirement • Regular desludging should be done in 1-2 months from Settler & Anaerobic Baffled Reactor (ABR).

4.2.3. DEWATS System (ABR with CW)

An anaerobic baffled reactor (ABR) is an improved Septic Tank with a series of baffles under which the grey-, black-wastewater is forced to flow under and offer the baffles from the inlet to the outlet. The increased contact time with the active biomass (sludge) results in improved treatment. ABRs are robust and can treat a wide range of wastewater, but both remaining sludge and effluents still need further treatment in order to be reused or discharged properly.

Constructed wetlands (CW) require a good pre-treatment to remove settle-able solids and avoid clogging in the CW, while Anaerobic Baffled Reactor (ABR) requires good aerobic post treatment to achieve the desired quality.

A horizontal subsurface flow constructed wetland is a large gravel and sand-filled channel that is planted with aquatic vegetation. As wastewater flows horizontally through the channel, the filter material filters out particles and microorganism degrade organics.

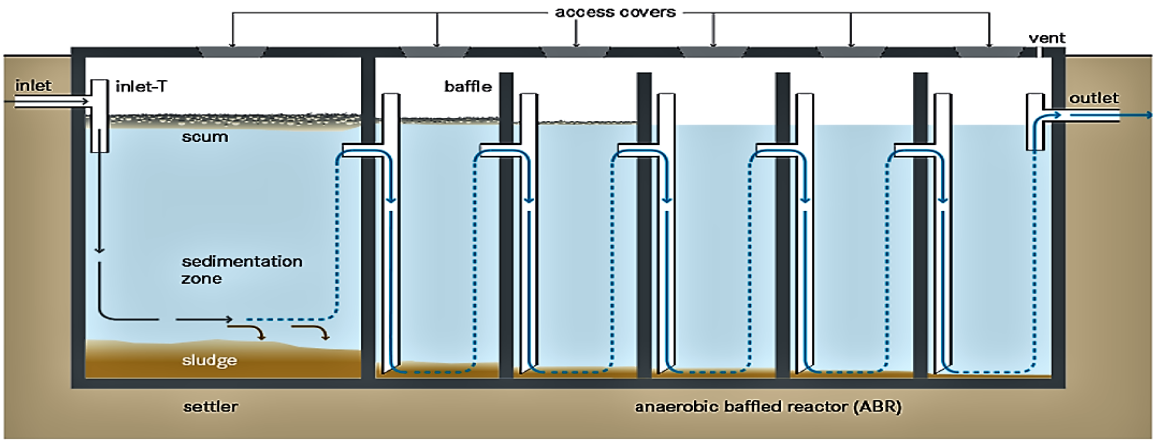


Figure 15- Anaerobic Baffled Rector (ABR)

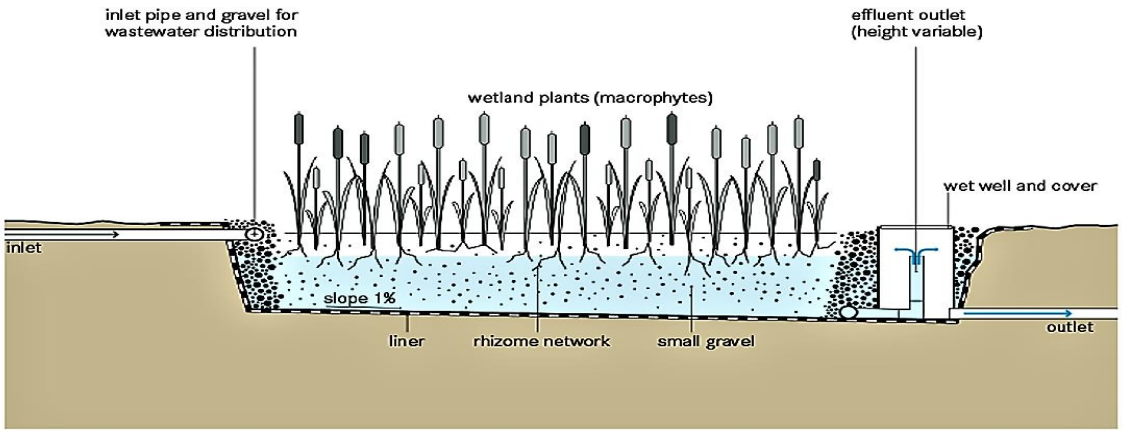


Figure 16- Constructed Wetlands (CW)

Estimate for DEWATS System (Anaerobic Baffled Reactor with Constructed Wetlands) *

Sr. No	Particular	No	L	W	D/H	Unit	Qty	Rate	Amount	Reference
1	Excavation in hard rock for anaerobic baffle reactor	1.00	4.50	3.50	2.00	Cum	31.50	670.00	**21105.00**	PWD SSR Page No 198 Item No 21.17
2	Providing dry/trap/granite rubble stone soling 20 cm thick including hand packing and compacting etc.		4.50	3.50	0.20	Cum	3.15	1050.00	**3307.50**	PWD SSR Page No 201 Item No 21.38
3	Providing and laying cement concrete M20 of metal for R.C.C. structure as per drawing including steel, centering, formwork, cover blocks, laying/pumping, compaction, finishing and curing					Cum	8.45	9908.00	**83722.60**	PWD SSR Page No 234 Item No 25.50
4	Providing, supplying & jointing in standard lengths HDPE Polyethylene Pipes 90 mm dia.					R Mtr	10.00	234.00	**2340.00**	MJP Page No 155
5	Excavation in hard rock for constructed vegetation		6.50	3.50	0.50		11.38	670.00	**7621.25**	
6	Providing dry/trap/granite rubble stone soling 20 cm thick including hand packing and compacting etc.		6.50	3.50	0.10	Cum	2.28	1050.00	**2388.75**	
7	Aggregate		6.50	3.50	0.50	Cum	11.38	800.00	**9100.00**	
	Total								**129585.10#**	

* Estimate for DEWATS System represented above is made for the grey water treatment of upto 30,000 litres per day. So the length, width & breadth of ABR taken accordingly and also the Constructed wetland size taken according to the required capacity.

an amount of estimate will be changed according to the site selected for ABR construction.

4.2.4 Waste Stabilization Ponds (WSP)

Technology	Applicability	Action	Advantages	Construction Methodology	Limitations
Waste Stabilization Ponds (WSP) • Waste Stabilization Ponds (WSPs) are large, man-made water bodies in which blackwater, greywater are treated by natural occurring processes and the influence of solar light, wind, microorganisms and algae. • The ponds can be used individually, or linked in a series for improved treatment.	• This option can be used at the end of drainage lines. • This technology is very suitable for the use by GP for treating greywater collected from the village via drainage system.	• The system will have to be established by the GP with technical inputs from engineers in ZP. Operation & maintenance will have to be managed by GP.	• The process is a natural process. The GP only provides suitable piece of land where ponds are established • Capital cost is very low • O&M cost is also very low & affordable. • The system can be managed by unskilled manpower • Stabilized water pollution due to untreated greywater is avoided • Surface water pollution, due to untreated greywater is avoided.	• Three ponds are constructed. The first pond in this series is an anaerobic pond and has a depth of eight to 10 feet. Wastewater from the gutters is initially collected in this pond and is kept here for 2-5 days • The second pond is a facultative pond with depth ranging from three to five feet. Wastewater from the first pond is carried to the second pond and is kept there for 10-15 days • Third pond is an aerobic pond and has a height of around three to five feet. Wastewater from the second pond is finally collected in this tank. In this tank the water comes in contact with fresh air oxygen and sunlight and becomes pathogen free.	• Requires large land area • Requires expert design and construction • Sludge requires proper removal and treatment • De-sludging (normally every few years) required • Occasional anti mosquito spraying treatment may be necessary. • Not always appropriate for colder climates

Waste Stabilization Ponds (WSP)

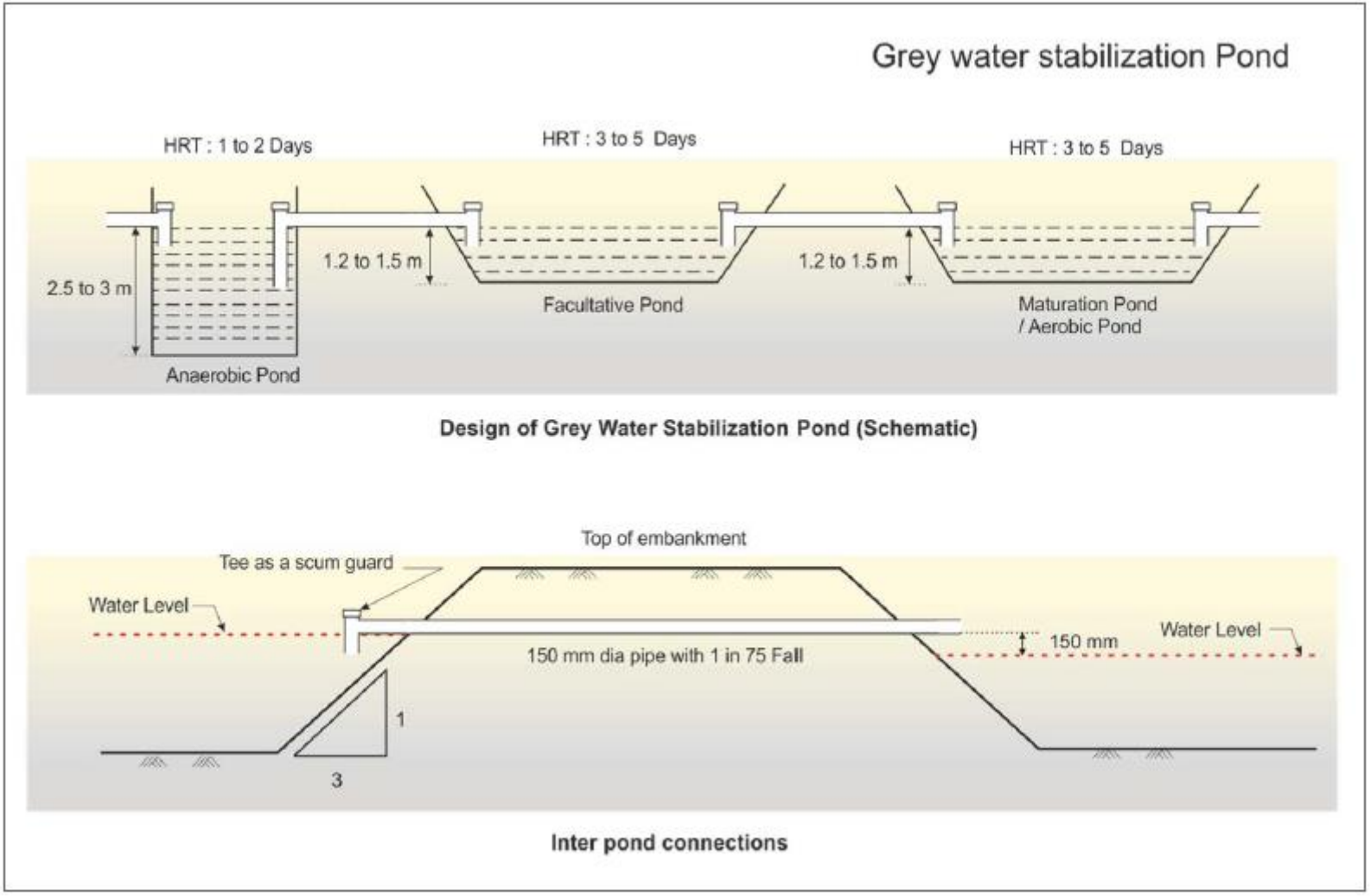


Figure 17- Waste Stabilization Ponds

4.2.5. Three Stage Filtration[6]

Technology	Applicability	Action	Advantages	Construction Methodology	Limitations
Three Stage Filtration • This is a compact filter arrangement using reversed flow technology and having graded sand and gravels in three layers. The whole arrangement is containing in a tank made up of synthetic materials. • This requires sufficient pressure in the waste water to perform efficiently. • It is the system operating in high pressure the retention time is very low and as the hydraulic volume of the system is low.	• This requires sufficient pressure in the waste water to perform efficiently.	• The system will have to be established by the GP with technical inputs from engineers in ZP. • Operation & maintenance will have to be managed by GP.	• Occupied minimum space and using head created by existing topography • Filtration is carried out in an energy efficient manner • Capital cost is very low • O&M cost is also very low & affordable. • Surface water pollution, due to untreated greywater is avoided.	• The three stage sand filtration are built in tank made up of synthetic materials • Inlet to the filter is given at the bottom and the outlet is given at the top ○ First layer (bottom layer)- 30 cm height, aggregates and pebbles of 75-100 mm size ○ Second layer (middle layer)- 30 cm height, aggregates and pebbles of 25-75 mm size ○ Third layer (top layer) - 30 cm height, natural sand of 2-4.75 mm size.	• Requires expert design and construction • Periodic cleaning at inlet and annual cleaning & washing of sand required.

[6]Due to the high pressure in the waste water it is recommended only at Coastal side (for ex. Kharsai) Village

Chapter 5: Technological Options Suggested for Solid Waste Management

5.1. Composting Options at Household Level

5.1.1. Manure Pit Composting

Technology	Applicability	Action	Advantages	Construction Methodology	Limitations
• **Underground unlined manure pit or garbage pit**	• Rural areas with low rainfall • Houses with an open space of about 7 square m • Houses with fewer number of cattle	• House owner can make this pit with little technical knowhow.	• This is the most effective and simplest method of disposal of waste for the rural households. • Animal waste can also be disposed of easily by this method. • Prevents vector breeding and breeding of rodents	• Dig two pits of 1m x 1m x 1m dimension • Give a single layer of broken bricks at the bottom • Make a ridge with the help of mud at the periphery of the pit & compact it by light ramming.	• Not suitable for heavy rainfall areas and rocky terrain.
• **Underground brick lined manure pit or garbage pit**	• Rural areas with low rainfall • Houses with an open space of about 7 square m • Houses with no cattle or with a single cattle • Loose soil structure.	• House owner can make this pit with little technical knowhow.	• This is the most effective and simplest method of disposal of waste for the rural households. • Animal waste can also be disposed of easily by this method. • Prevents vector breeding and breeding of rodents	• Dig two pits of 1.1m dia & 1m depth • Construct a circular pit having an inner dia of 1m, in honey comb 100mm thick brick masonry. The height of the circular pit should be 100mm above ground. • Plaster the top layer of the pit • The bottom of the pit should not be cemented	• Not suitable for heavy rainfall areas and rocky terrain.

Estimate for Brick lined Compost Pit

Sr No	Particular	Quantity	Unit	Rate per Unit	Total Amount
1	**2**	**3**	**4**	**5**	**6**
1	Bricks	350	No	6.5	**2275**
2	Sand	0.4	Cum	1575	**630**
3	Cement	1.5	Bag	235	**352.5**
4	Aggregate	0.1	Cum	800	**80**
5	Labour for Excavation	1	Manday	493	**493**
6	Labour (Construction)	2	Manday	493	**986**
7	Mason	1	Manday	539	**539**
	Total Cost of Bricklined Compost Pit				**5355.5**

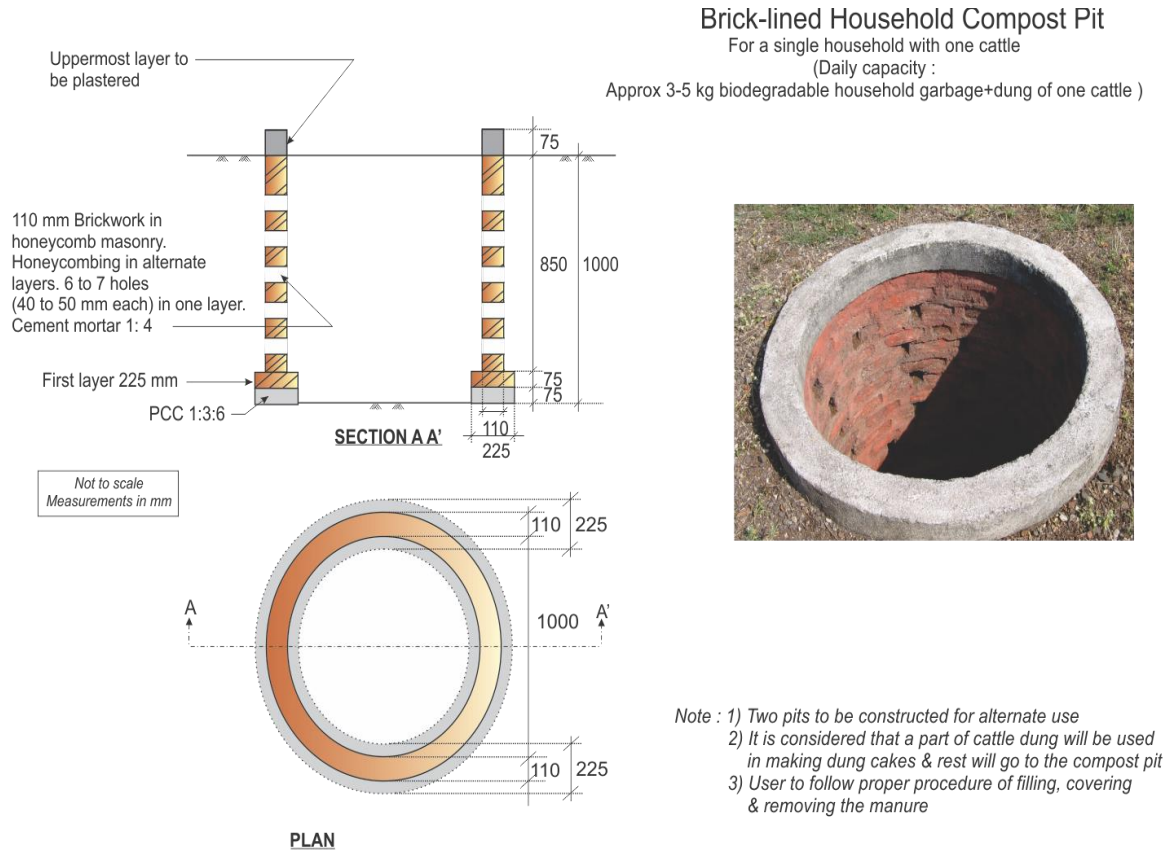


Figure 18- Brick lined Compost Pit

5.2. Composting Options at Community Level

5.2.1. NADEP Tank

Technology	Applicability	Action	Advantages	Construction Methodology	Limitations
NADEP Tank	• Rural areas with high rainfall and rocky terrain • Villages where there is lack of space at household level for composting. • Also suitable for managing waste at village level.	• Gram Panchayat can make these tanks with little technical knowhow.	• It is very simple to construct and easier to operate. • In this method, compost can be prepared with small quantity of cow dung and hence, it can be considered as appropriate rural model. • Percentage of nutrients in manure is high in comparison to other composting methods (except vermin composting).	• This method of making compost involves the construction of a simple, rectangular brick tank with enough spaces maintained between the bricks for necessary aeration. • The size of the tank is 3m*2m*1m in dimensions above the ground. • All the four walls of NADEP tank are provided with 6 inch vents by removing every alternate brick after the height of 1ft. from bottom for aeration. • Plaster the top layer of the tank. • The above ground perforated structure facilitates passage of air for aerobic decomposition.	• More than one tank is required to be constructed for use in rotations since it takes three months to convert the garbage into compost. The construction of more tanks increases the cost. • Large quantities of soil and water are needed which can be difficult to transport in certain areas.

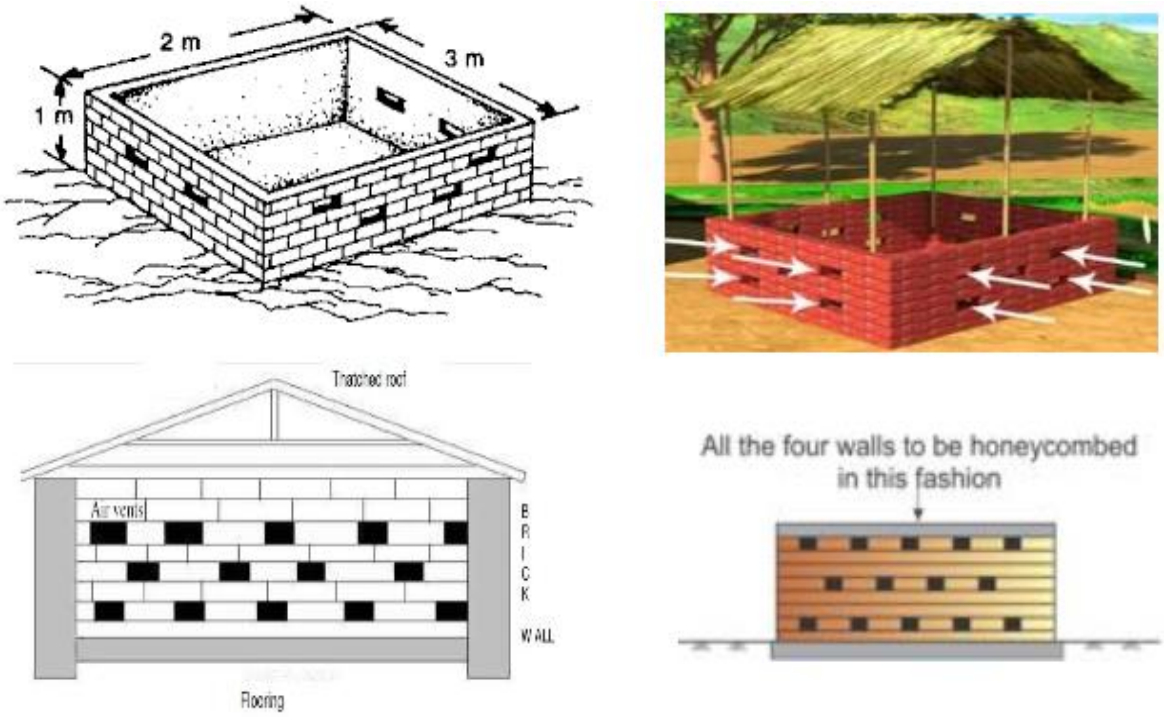


Figure 19- NADEP Tank

Estimate for NADEP Tank

Sr No	Particular	Quantity	Unit	Rate per Unit	Total Amount
1	**2**	**3**	**4**	**5**	**6**
1	Excavation	0.6	Cum	157	94.2
2	PCC	0.3	Cum	4766	1429.8
3	Brick Masonry	2.53	Cum	5628	14238.84
4	Plastering	2.3	Sq. m	234	538.2
5	Material for Shed	1	Number	1000	1000
6	Unskilled Labour	4	Mandays	493	1972
					19273.04
Cost of NADEP Compost Tank					**19275**

5.2.2. Community Resource Recovery Unit

A Centralized Resource Recovery Unit (CRRU) is proposed on an identified plot to be allotted by the GP. This centre shall have 3 NADEP tanks for composting biodegradable waste and 5 constructed brick structures for collecting segregated non-biodegradable waste (i.e. plastic, dry & wet paper, rags, glass & metal). An incinerator has also been planned at this location for the disposal of sanitary waste.

The planned area also provides space for parking the solid waste collection vehicle, a toilet for the use of the handlers and water connection.

There will be a space allotted for Information, Education & Communication (IEC) regarding community cleanliness, environmental pollution, and information regarding the CRRU. It is advised that the periphery of the selected area be duly planted with suitable greenery.

Estimate for Community Resource Recovery Unit

Sr No	Particular	No	L	W	D/H	Unit	Qty	Material Rate	Total Amount	Reference
1	Excavation for foundation in earth, soil of all types, sand, gravel and soft murum, including removing the excavated material upto a distance of 50 m. beyond the building area and stacking and spreading as directed, dewatering, preparing the bed for the foundation and necessary backfilling, ramming, watering including shoring and strutting etc. complete. (Lift upto 1.5 m.) By Mechanical Means.	1	10	10	0.6	Cum	60	157	9420	Page No 197 Item no 21.10
2	Excavation for foundation in Hard Murum	4	10	0.25	0.5	Cum	5	191	955	Page No 197 Item no 21.10
3	Plain cement concrete for foundation	4	10	0.25	0.45	Cum	4.5	4766	21447	
4	Plain cement concrete for flooring	1	10	10	0.1	Cum	10	4766	47660	

5	Brick Masonry in 1:4 cement mortar for the peripheral wall	4	10	0.225	1	Cum	9	5628	50652	
6	Brick Masonry in 1:4 cement mortar for the internal partition					Cum	3.05	5628	17165.4	
7	Toilet (standard twin pit design)	1				No	1	12000	12000	
8	Plastering 20 mm thick in 1:4 Cement Mortar for internal & external brickwork	2	44			Sq Mtr	88	392	34496	
9	Providing structural steel work in trusses, other similar trussed purlins and members with all bracing, gusset plates etc. as per detailed designs and drawings or as directed including cutting, fabricating, hoisting, erecting fixing in position, Making riveted/bolted/welded connection and one coat of anticorrosive paint and over it 2coats of oil painting approved quality and shade etc. complete.	1				Metric Tonne	1	87744	87744	
10	G.I. Pre coated trapezoidal 0.50 mm thick roof Metallic Coloured Sheet		12	12		Sq Mtr	144	700	100800	
11	G.I. Nut Bolt					Kg	10	115	1150	
12	Hand Wash Basin (White glazed wash basin 45*30cm)					No	1	1105	1105	
13	Providing and fixing mild steel grill gate with angle iron frame 65mmx65mmx10mm with iron bars at 150mmC/C and diagonal flats as per the detailed drawing including hinges, pivot block locking arrangement, welding riveting and oil painting of three coats of approved shade Weight of gate 35 Kg/Smt.		3		1.5	Sq Mtr	4.5	2333	10498.5	

14	Providing and fixing crimped with G.I. mesh and size 20mmx20mm 10 gauge to iron angle frame including welding crimp mesh to angle frame and steel flat, fixing the frame in its original position and oil painting etc. complete (excluding cost of structural steel)		40		2	Sq Mtr	80	600	48000	
	Total Cost								**443092.9**	

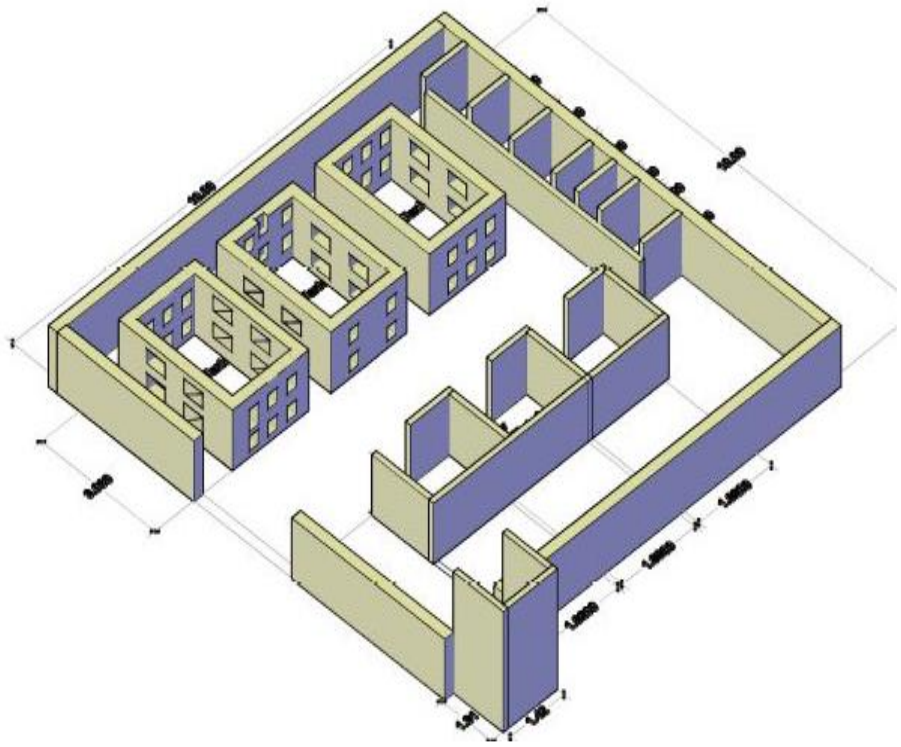


Figure 20 – Community Resource Recovery Unit

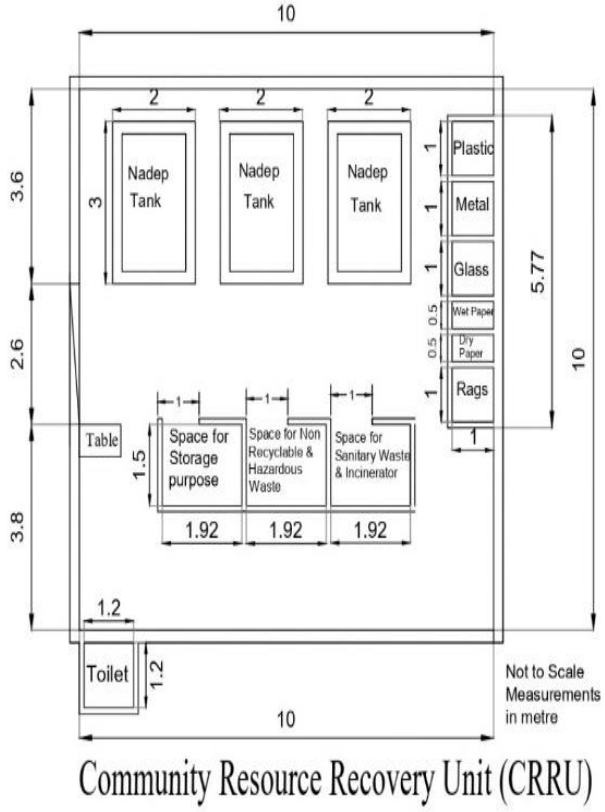


Figure 21 – Community Resource Recovery Unit (Plan)

5.2.3. Tricycle for Solid Waste Collection

Estimate for Tricycle

Sr. No.	Particular	Quantity	Unit	Rate per Unit	Amount
1	**2**	**3**	**4**	**5**	**6**
1	Tricycle Rickshaw Dustbin Wheel (KT) (TRICYCLE) 500 Litres Bin Capacity	1	No	30,000	30,000
	Total Cost for Tricycle				**30,000**

Figure 22-

Tricycle for Solid Waste Collection

5.2.4. Dustbins for Household Level

Estimate for Household Level Dustbins

Sr. No	Particular	Quantity	Unit	Rate per Unit	Amount
1	**2**	**3**	**4**	**5**	**6**
1	**Household Dustbins (AMCO) set of 2 containers with 10-12 litres capacity ***	1	Pair	250	250
	Total Cost for Dustbin				**250**

Figure 23 – Household Level Dustbins (Pair)

5.2.5. Dustbins for Community Level

Estimate for Community Level Dustbins

Sr. No.	Particular	Quantity	Unit	Rate per Unit	Amount
1	**2**	**3**	**4**	**5**	**6**
1	**Wheel Dustbins (80 litres Capacity)**	1	Number	8000	8000
	Total Cost for Dustbin				**8000**

Figure 24- Community Wheel Dustbins

Note – The rates taken of Tricycle and Dustbins are taken from **Government E-Marketplace (GeM) Portal**

Chapter 6: Technological Options Suggested for Bio-Medical Waste

"Bio-medical waste" refers to any waste which is generated during the diagnosis, treatment or immunization of human beings or animals or from research activities pertaining thereto or in the production or testing of biological or in health camps, including the categories mentioned in Schedule I appended to the Government of India's Bio-Medical Waste (Management and Handling) Rules 2016.

"Bio-medical waste treatment and disposal facility" means any facility wherein treatment, disposal of bio-medical waste or processes incidental to such treatment and disposal is carried out, and includes common bio-medical waste treatment facilities.

Disposal by deep burial is permitted only in rural or remote areas where there is no access to a common bio-medical waste treatment facility.

6.1 Deep Burial for Bio-Medical Waste Disposal

(1) A pit or trench should be dug about two meters deep. It should be half filled with waste, then covered with lime within 50 cm of the surface, before filling the rest of the pit with soil.

(2) It must be ensured that animals do not have any access to burial sites. Covers of galvanised iron or wire meshes may be used.

(3) On each occasion, when wastes are added to the pit, a layer of 10 cm of soil shall be added to cover the wastes.

(4) Burial must be performed under close and dedicated supervision.

(5) The deep burial site should be relatively impermeable and no shallow well should be close to the site

6) The pits should be distant from habitation, and located so as to ensure that no contamination occurs to surface water or ground water. The area should not be prone to flooding or erosion.

(7) The location of the deep burial site shall be authorised by the prescribed authority.

(8) The institution shall maintain a record of all pits used for deep burial.

(9) The ground water table level should be a minimum of six meters below the lower level of deep burial pit.

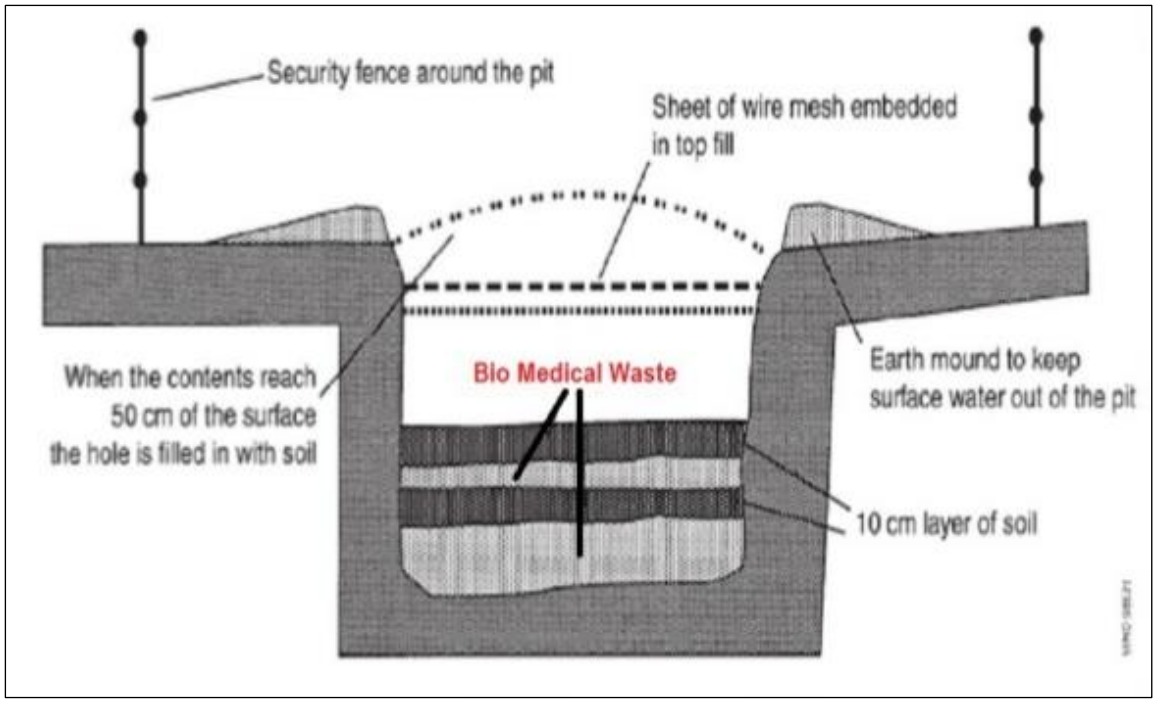


Figure 25-Deep Burial

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