CHAPTER 8: DECENTRALIZED SEWERAGE SYSTEM

8.1 DEFINITION

Decentralized sewerage system is defined as the collection, treatment, disposal / reuse of sewage from individual homes, clusters of homes, isolated communities or institutional facilities, as well as from portions of existing communities at or near the point of waste generation. Typical situation in which decentralized sewerage management should be considered or selected include:

1. Where the operation and maintenance of existing on-site systems must be improved.
2. Where individual on-site systems are failing and the community cannot afford the cost of a conventional sewage management system.
3. Where the community or facility is remote from existing sewers.
4. Where localized water reuse opportunities are available.
5. Where freshwater for domestic supply is in short supply.
6. Where existing STP capacity is limited and financing is not available for expansion.
7. Where, for environmental reasons, the quantity of effluent discharged to the environment must be limited.
8. Where the expansion of the existing sewage collection and treatment facilities would involve unnecessary disruption of the community.
9. Where the site or environmental conditions that require further sewage treatment or exportation of sewage are isolated to certain areas.
10. Where residential density is sparse.
11. Where regionalization would require political annexation that would be unacceptable to the community.
12. Where specific sewage constituents are treated or altered more appropriately at the point of generation.

8.2 CHALLENGES IN SUSTAINING A CENTRALIZED SEWERAGE

A centralized sewerage de facto is perceived as an underground sewer system to collect the sewage from all over a habitation and involves the challenges as described below.

8.2.1 Financial Sustainability

It implies a huge capital cost and mandates a full-fledged occupation of the coverage area to generate the revenue for its upkeep. In practice however, in the peri-urban areas and rural habitations, these are nearly impossible and the situation is escalating.

8.2.2 Idle Volumes and Time in Conventional Sewerage

Invariably, the sewers as a convention are designed for the ultimate population some 30 years away and the realization of the sewage volumes to use the designed sewer capacities results in idle volumes and idle expenditures as in Figure 8-1 and the underground sewers laid there merely become defunct with time and eventually go into repair. This is a non-productive expenditure in a sense, implying that the investment could have been utilized elsewhere as brought out in a classical illustration in Figure 8.1 .

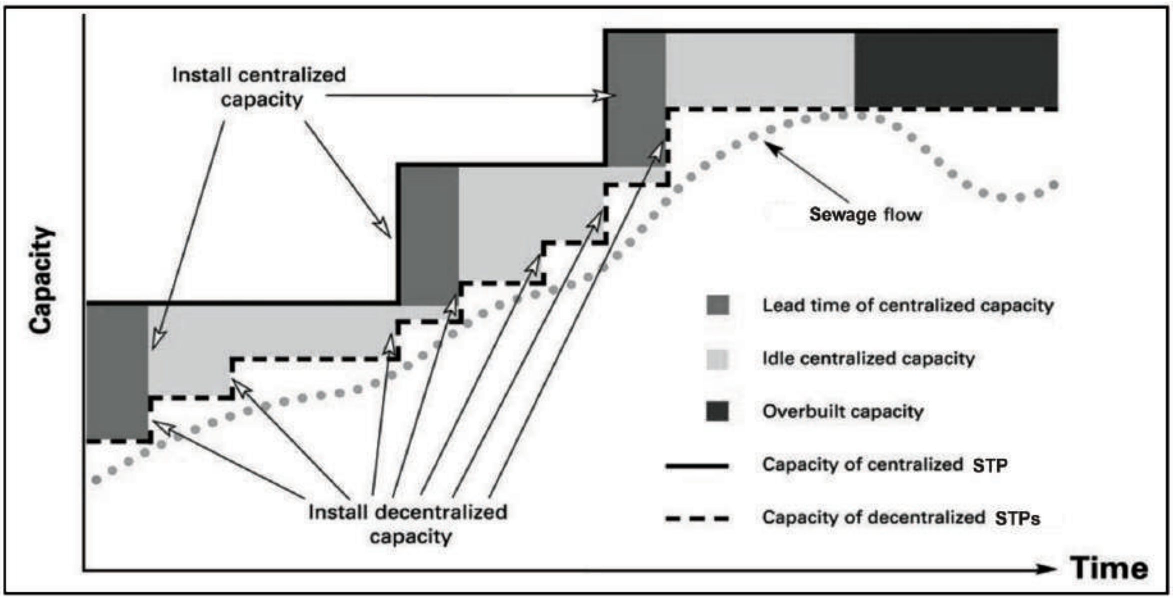


Figure 8.1 Logistics of capacity building in sewerage provision in centralized planning and decentralized planning of the collection and treatment facilities

8.2.3 Idle Investment in Conventional Sewerage

In conventional sewerage, the sewer sizes are also bigger and this brings in additional redundancy as in Figure 8.2.

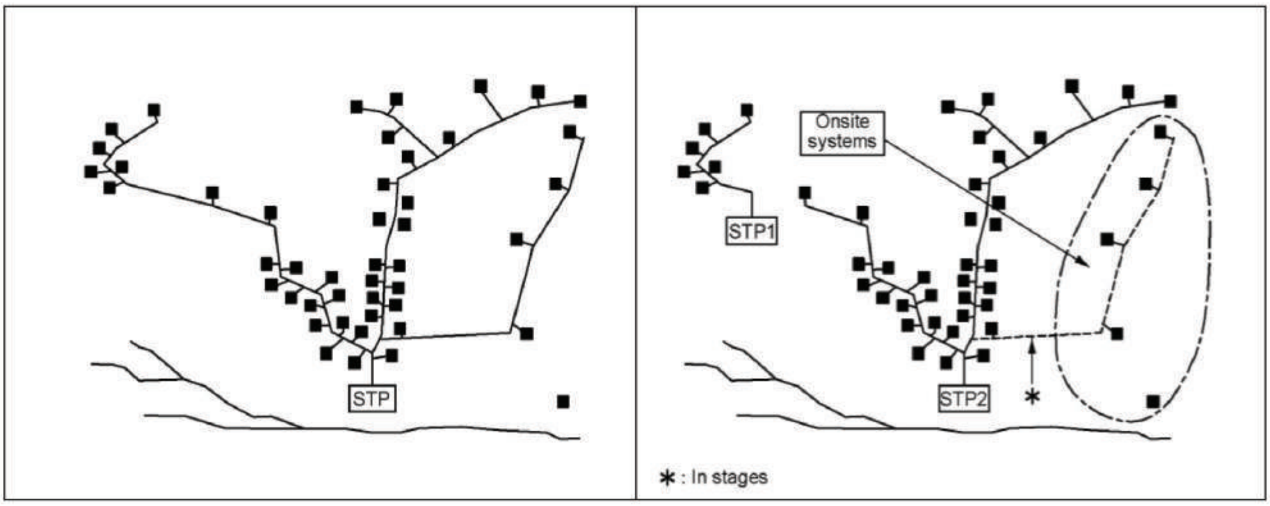


Figure 8.2 Concept of centralized system at left Vs. decentralized system at right

For example, by considering the illustration in Figure 8-2, the map to the left shows the typical conventional sewerage with all the sewers funneling to a single STP and the sector to the top right is actually sparsely developed and the sewers are designed for a flow some 30 years hence. This results in a situation where the manhole covers get stolen and people start using the manholes as a virtual garbage bin, which in turn is compounded by rainfall and lead to a near complete choking of the sewer system. The net result is, if and when the sector gets populated, a massive rehabilitation programme of the sewer system becomes implied often leading to indiscriminate cutting open of the roads. A further difficulty is the STP, which is grossly underutilized and the treated sewage quality suffers due to prolonged hydraulic retention. By contrast, if we consider the same sector to be served by a decentralized sewer system as in the map to the right, it can be seen that the above problems are surmounted not only physically, but also financially investments are saved to begin with.

8.2.4 Problems of House Service Connections

It is also a fact that while the investment on provision of sewerage is usually met out of capital grant funding, the cost of house service connections is to be met by the house owners and herein lies another conflict. Whereas houses have not come up in some sectors, these house service connections get time deferred and to that extent, repeated road cuts become a perpetual affair over a long time. As and when the houses are built, service connection requests arise. An approach that has been tried out is the provision of house service connection sewers even in the beginning itself and blank it at the property boundary and connect it only when the house gets built up and the applicant pays up the costs thereof.

Here again, it is a question of idle investment at start with no foreseeable return of the same on the house service connection costs.

Another issue is surreptitious connections by house owners and the impracticality of checking each and every such connection by the limited staff of the local body and may well be connivance also. By opting for decentralized sewer system, first of all, the command area to be supervised for such surreptitious connections get much smaller and the monitoring mechanism becomes effective.

8.2.5 Conflict of Levies for Recovering the Sewer Costs

Whereas the capital costs are mostly met out of grant funding, the O&M expenses are to be generated by the local body at most times. The meagre revenues generated by taxes and water and sewerage charges are too meagre to even break even in the local body accounts, leave alone increasing the reserve funds. When an unwieldy coverage of a conventional sewerage is implemented, the problem gets compounded all the more because the house service connections do not keep pace and the revenues are meagre. Thus, even the cost spent on the house sewer connections becomes a virtual write-off over a period of time.

8.3 CONCEPT OF DECENTRALIZED SEWERAGE

The decentralized sewerage concept implies localized collection and localized treatment of excreta and sullage in micro zones within a major habitation, keeping it in tandem with densification and progressively duplicating it, as and when other micro zones densify.

It will ensure that every micro zone owns up its excreta and sullage management and cannot expect a faraway habitation to receive and inherit it a prospect, which will sooner or later lead to inter conflicts and destabilize progress. Thus, the provision of both the collection system and treatment can be made compatible to the pace of development by juxtaposing on-site sanitation as well in its fold. The treatment systems of sewage in the on-site system and the off-site system are shown in Figure 8.3 hereunder.

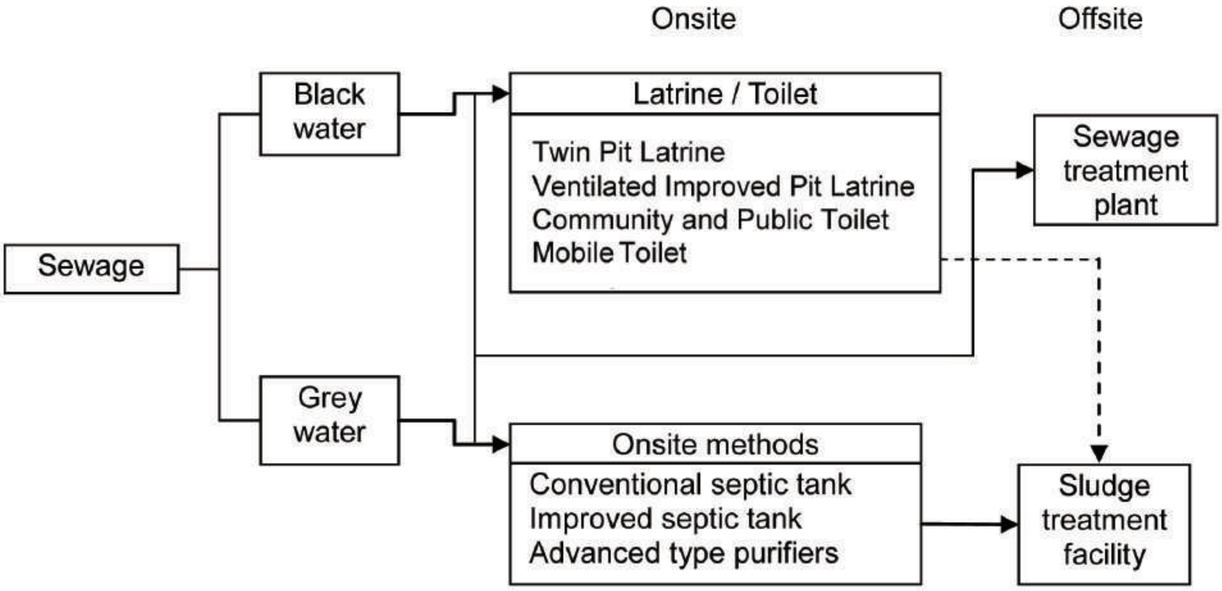


Figure 8.3 On-site and Off-site sewage treatment system

Note: There can be cases where both black and grey water can be treated together.

8.3.1 Advantages of Decentralized Sewerage

1. In general, prediction of sewage volumes is far easier in decentralized sewerage micro collection areas and to that extent the design becomes realistic.
2. Flows in a decentralized sewerage are relatively smaller than conventional sewerage and this implies that environmental damages from any mishaps are also minimal.
3. Given the smaller flows, the sewer sizes are also smaller and the depths of cut are also less thus, making it easy to construct and maintain.
4. Additions of new service areas which are independent of the existing system and the need to augment or enlarge the existing sewers and STPs are avoided.
5. The STPs are smaller and it is easier to find the reuse prospects nearby as compared to all the sewage being treated in one far corner.
6. It is also easier to layout return lines of treated sewage for use in medians, industrial supplies, flushing far flung head manholes, etc.
7. The ecology of rivers, streams and receiving waters are better managed by smaller volumes of discharges of treated sewage at multiple locations than one massive volume in a single location and also if the single STP is out of order, the entire stretch of the water course is polluted.

8.4 TECHNOLOGIES OF DECENTRALIZED SEWERAGE

8.4.1 Simplified Sewerage

Simplified sewerage is a technology widely known in Latin America, but much less known in Africa and Asia. It has been successfully demonstrated in the Orangi habitation of Pakistan (having a population of about 7.50 lakh, where per capita water supply is about 27 lpd) and since adopted there in situations similar to the status in the preamble here. Duncan Mara defines simplified sewerage as “An off-site sanitation technology that removes all wastewater from the household environment.” Conceptually it is the same as conventional sewerage, but with conscious efforts made to eliminate unnecessarily conservative design features and to match design standards to the local situation. The simplified sewerage approach is now widely used. Figure 8.4 is one such example at Brazil as an in-block system rather than – as with conventional sewerage – an in-road system.

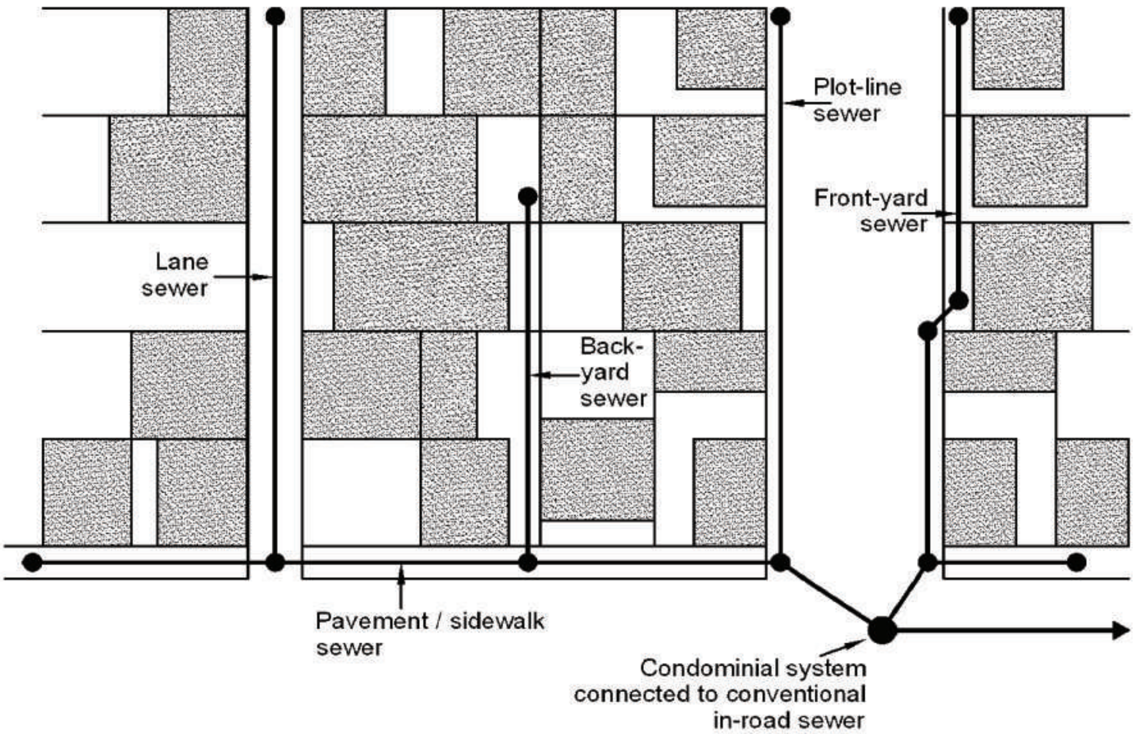


Figure 8.4 Simplified sewerage as avoiding public roads unless actually required

The key feature of an in-block system is that sewers are routed in private land, through either back or front yards. This in-block or back-yard system of simplified sewerage is often termed condominial sewerage in recognition of the fact that tertiary sewers are located in private or semi-private space within the boundaries of the ‘condominium’. These simplified sewers are laid at shallow depths, often with covers of 400 mm or less. The minimum allowable sewer diameter is 100 mm, rather than the 150 mm or more that is normally required for conventional sewerage.

The relatively shallow depth allows small access chambers to be used rather than large expensive manholes as in Figure 8-5, Figure 8.6 and Figure 8.7 overleaf.

Source: Mara et al.

Figure 8.5 Pavement (sidewalk) simplified sewerage being installed in the high-income area of Lago Sul in Brasília in 1999

Figure 8.6 Simplified sewerage in the footpath and main road free of manholes in French Puducherry - early 20th century

Source:Mara et al., 2001

Figure 8.7 Junction chamber for simplified sewerage using larger diameter concrete pipes, used in Guatemala

8.4.1.1 Design Criteria

In regard to design, the basic procedures are the same as any hydraulics. For example, for serving 500 people with a water consumption of 80 lpcd and using a return factor of 0.85, the average daily sewage flow will be 0.85 × 500 × 80 / 24 / 3600 = 0.4 lps.

Depending on the peak factor as given in Chapter 3, the design flow will be its multiplication and the design will be as per Manning's formula as in Chapter 3. The design guidelines are available in *http://www.efm.leeds.ac.uk/CIVE/Sewerage/manual/pdf/simplified_sewerage_manual_full.pdf.*

The long-term sustainability of simplified sewer systems can be ensured by a good partnership between the community served by simplified sewerage and the sewerage authority along with the following key factors:

1. Good design
2. Good construction
3. Good maintenance
4. An adequate, but affordable, tariff structure.

It is in item 4 that the success of the system resides and requires a public hearing and acceptance, instead of taking the public acceptance for granted. Eventually, when the habitation becomes fully developed, of course the conventional sewerage can still be incorporated in lieu of the simplified sewerage.

8.4.2 Small Bore Sewer System

Small bore sewer system is designed to collect and transport only the liquid portion of the domestic sewage for off-site treatment and disposal. The solids are separated from the sewage in septic tanks or aqua privies installed upstream of every connection to the small bore sewers. Where conventional sewers would be inappropriate or infeasible, this system provides an alternative. This system also provides an economical way to upgrade the existing on-site sanitation facilities to a level of service comparable to conventional sewers. Since the small bore sewer collects only settled sewage, it needs reduced water requirements and reduced velocities of flow. This in turn reduces the cost of excavation, material and treatment. This is also called as settled sewerage.

8.4.2.1 Components of the System

The small bore sewer systems consist of house connections, interceptor tanks, sewers, cleanouts and manholes, vents and in some cases lift stations.

8.4.2.2 Suitability of the System

This system is suitable under the following conditions, where

1. Effluent from pour-flush toilets and household sullage cannot be disposed off on-site
2. Installation of new schemes is taken up, especially for fringe areas

3. A planned sequence of incremental sanitation improvements with small bore sewers as a first stage is contemplated

4. Existing septic tank systems have failed or where there are a number of septic tanks requiring the effluent to be discharged, but soil and ground water conditions do not permit such a discharge.

8.4.2.3 Design Criteria

Each house sewer is usually connected to an interceptor tank, which is designed as a septic tank. The optimum number of house sewers to be connected to an interceptor tank can be worked out for each case. The effluent from the tank is discharged into the small bore sewer system, where flow occurs by gravity utilizing the head resulting from the difference in elevation of its upstream and downstream ends. The sewer should be set deep enough to carry these flows.

The diameter of sewer pipe shall be designed for incremental flows between successive sections. First consider the available ground slope and choose a minimum of 100 mm sewer pipe and use Manning's formula for pipes flowing full and find out the flow carrying capacity. If this is lesser than the actual flow in that section, increase the pipe diameter in that section as needed. Velocity is not a criterion.

Design decisions regarding the location, depth, size and gradient of the sewer must be carefully made to hold hydraulic losses within the limits of available head. Minimum pipe diameter of 100 mm is recommended. Maintenance of strict sewer gradients to ensure minimum self-cleansing velocities is not necessary. The sewer may be constructed with any profile as long as the hydraulic gradient remains below all interceptor tank outlet inverts. Ventilation is not necessary for small bore sewers, if they are laid on a falling gradient. A vent cleanout to release air may be provided at every hump. Profiles are shown in Figure 8.8 (overleaf). An example on design calculation is also presented in Appendix A.8.1.

8.4.3 Shallow Sewers

8.4.3.1 System Description

Shallow sewers are designed to receive domestic sewage for off-site treatment and disposal. They are a modification of the surface drain with covers and consist of a network of pipes laid at flat gradients in locations away from heavy imposed loads (usually in backyards, sidewalks and lanes of planned and unplanned settlements). They are usually laid at a minimum depth of 0.4 m. Where vehicular loading is present and the invert depth of sewer is less than 0.8 m, a concrete encasement is provided for the sewer.

8.4.3.2 Components of the System

The shallow sewer system, like the conventional sewer system consists of house connections, inspection chambers, laterals, street collector sewers, pumping stations where necessary and treatment plants. Low volume pour flush or cistern-flush water seal toilets are connected to the inspection chamber by means of a 75 mm diameter sewer.

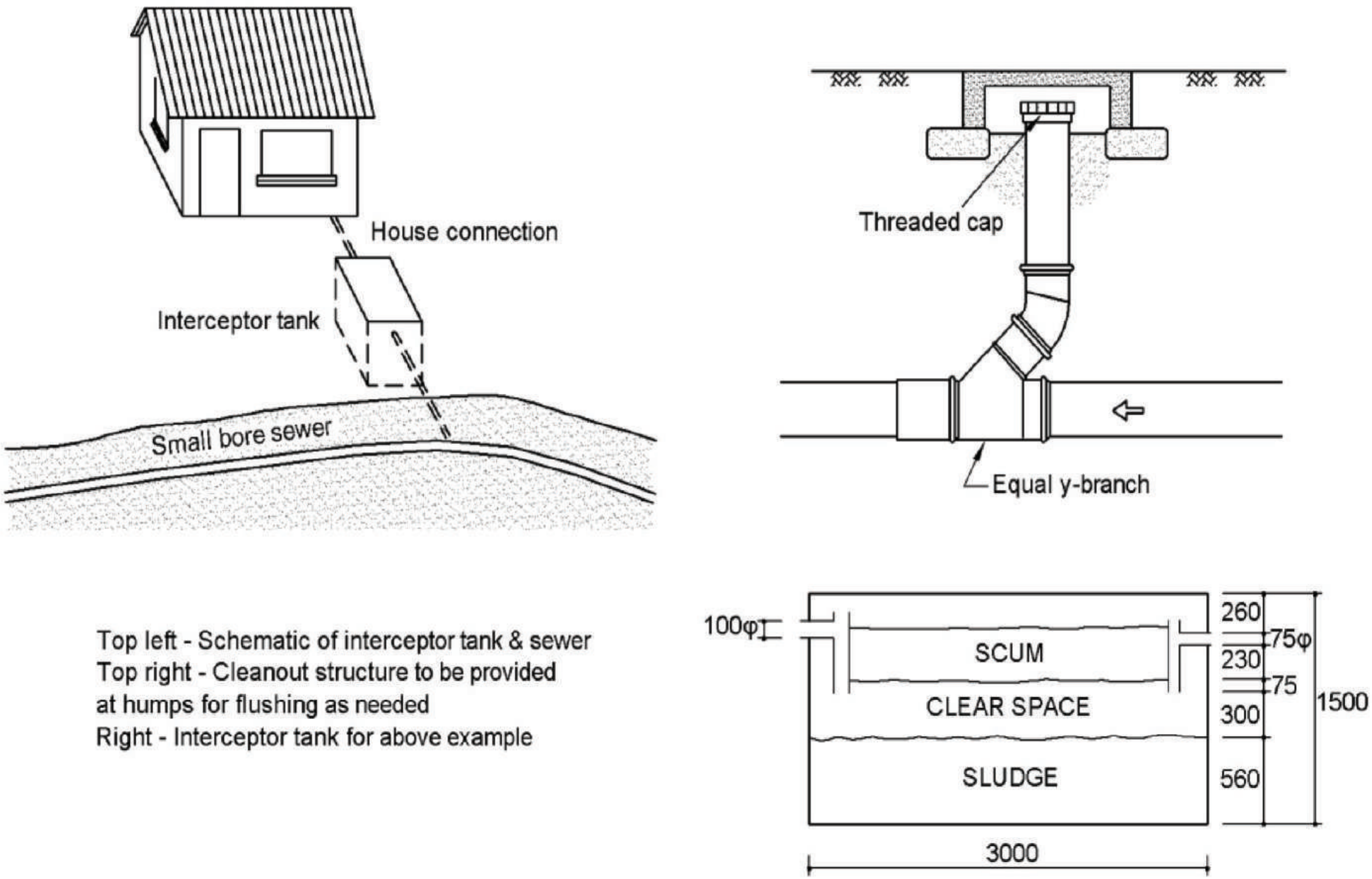


Figure 8.8 Schematics of small bore sewer system

A vertical ventilation column of the same diameter is provided on the house connection. The sullage water generated in the house is also connected to the inspection chamber directly when water consumption is more than 75 lpcd. Where the water consumption is lesser and where grit is used for cleaning purpose, it is connected through a grit/grease trap. Inspection chambers are provided along the street collector sewers and along the length of the laterals at intervals not exceeding 40 m. Usually one chamber is provided for each house. However two or more houses may share a single inspection chamber. The chamber is provided with a tight-fitting RCC cover. The laterals are of small diameter (minimum 100 mm) and of stoneware or concrete, which are buried in a shallow trench. The minimum depth of pipe invert is 0.4 m. In general, they have a straight alignment between inspection chambers and are suitably aligned around existing buildings. They may even pass under property boundary walls and also under future building areas. The inspection chamber however, is located is an open area. The street collector sewer has a usual minimum diameter of 150 mm, however, 100 mm sewers may also be used if hydraulic capacities permit. Where community septic tanks are provided at the exit of the lateral sewers, the street sewers should be designed as small-bore sewers. The pumping stations should, as far as possible, be avoided in such cases.

8.4.3.3 Design

The design procedure is as much the same as that of gravity sewer design in Chapter 3.

8.4.3.4 Applicability

Shallow sewers are suitable where

1. high density, weaker sections, squatter settlements (100 to 160 persons per hectare) exist
2. adverse ground conditions exist and on-site disposal is not possible
3. sludge also has to be disposed off and where the minimum water consumption rate is 25 lpcd.

8.4.3.5 Limitations

Shallow sewerage system is suitable where adequate ground slopes are available. Since these sewers are laid at flat gradients the solids are likely to get deposited unless flushed at peak flow conditions. Otherwise, these sewers may get clogged and require frequent cleaning.

8.4.4 Twin Drain System

This is an integral twin drain on both sides of the road. The drain on house side receives the sewage. The drain on road side is the storm water drain. It is in use in coastal areas of Tamilnadu particularly in Tsunami affected habitations. The advantage is that even if the per capita sewage falls to low quantities, say 28 lpcd as is still there in some cases, where water is scarce like in coastal fishermen communities this can be adopted. The design of the drain with removable cover slabs permits the daily scraping forward of sediments progressively by each house owner in the portion of the drain before his premises to the destination treatment site, something that the other options do not permit that easily.

8.4.4.1 Installation at Kolachel, Tamil Nadu

This is a decentralized sewerage and sewage treatment for Tsunami Rehabilitation for a population of 2,000 and 350 dwellings and it is in use since July 2007 at Kolachel which is located near the backwaters of Bay of Bengal in Tamilnadu. A schematic drawing of the self-contained system is shown in Figure 8.9. The photographs are in Figure 8.10 and Figure 8.11

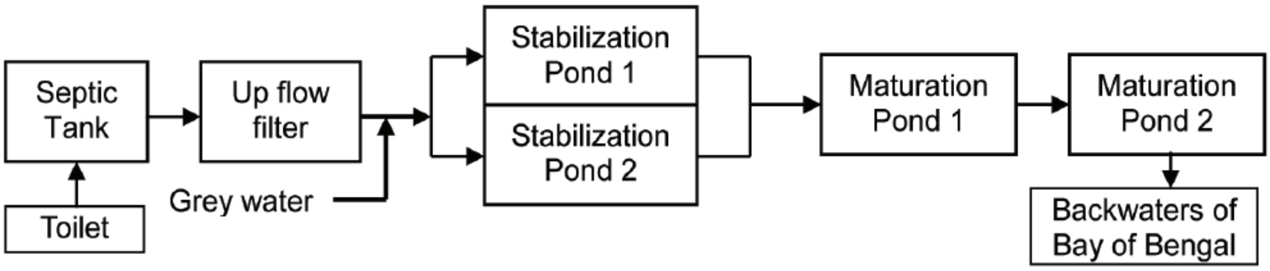


Figure 8.9 Schematic of the twin drain decentralized sewerage

8.4.4.2 Design Adopted for the System

1) The daily flow is 1,89,000 litres (350 houses – 6 persons per dwelling – 90 litres per head).
2) The septic tank was sized at 2 m × 0.9 m × 1.4 m liquid depth for cleaning at 3 year interval.
3) The up flow filter was sized at 0.7 m × 0.9 m × with floor depressed by 0.5 m.
4) The ablution water is about 6 litres/person/day.
5) The drains were designed for a velocity of 0.3 m/s to conserve depth of excavation.
6) The loading for oxidation pond design was 275 kg BOD/hectare/day.
7) The pond was designed for liquid depth of 1.5 m and sludge accumulation of 0.5 m.
8) The detention in maturation ponds was 3 days and was 1.5 m deep.
9) The facultative ponds were provided in two parallel modules of each 50% capacity.
10) The maturation ponds were provided in series with two modules of each 50% capacity.
11) The pond bottom was dense clay for 1.5 m and hence, lining was not needed.
12) The treated sewage was flowing out into the backwaters of the Bay of Bengal.

8.4.4.3 Performance of the System

The biochemical parameters of performance are given in Table 8-1.

8.4.4.4 Financial Aspects of the System

By way of comparison, the cost of the collection system starting from septic tank and up to the ponds was only 38% of what would have been the cost for a conventional underground sewer system. In respect of the O&M costs, the twin drain system is only 8% of that for the conventional system. This illustrates the relative sustainability of this system.

Top: Septic tank up flow filter under construction in brickwork and as completed
Middle: Terminal chamber & twin drain under construction and as completed
Bottom: Stabilization pond and maturation pond and safe walkway all-round.

Source: M/s Kottar Social Service Society, Nagercoil and M/s Caritas India and M/s Caritas Germany

Figure 8.10 Twin drain system

Twin Drain with top perforated cover slabs for storm drain, Salt pan totally spoiled by Tsunami waves overflowing on it and since reclaimed to accommodate the STP pond system.

Source:M/s Kottar Social Service Society, Nagercoil and M/s Caritas Swiss

Figure 8.11 Another set up of twin drain system at Kodimunai

Table 8.1 Physico-chemical characteristics of the Kolachel System (Mean values)

No	Location	BOD	COD	SS	TKN	Total P
1	Septic Tank entry	1294	2565	4142	170	30
2	Up flow filter entry	702	1509	1450	111	24
3	Up flow filter outlet	399	1003	628	88	14
4	Grey water	362	615	359	28	16
5	Stabilization pond inlet	51	212	57	14	11
6	Stabilization pond outlet	31	144	42	10	8
7	Maturation pond 1 outlet	32	144	42	10	8
8	Maturation pond 2 outlet	23	124	38	7	6

8.4.4.5 Applicability

In most of new layouts the septic tank and open drains on road sides for storm water are a matter of routine and invariably the septic tank effluent is discharged into the drain which complicates the environmental hazard in rainy seasons. The twin drain system can stall the pollution by containing the septic tank effluents, which can be collected and provided with treatment. For new layouts, it will be useful if the bye-laws can be strengthened to mandate the twin drain instead of the roads drain alone, which is anyway mandated by the Town and Country planning act.

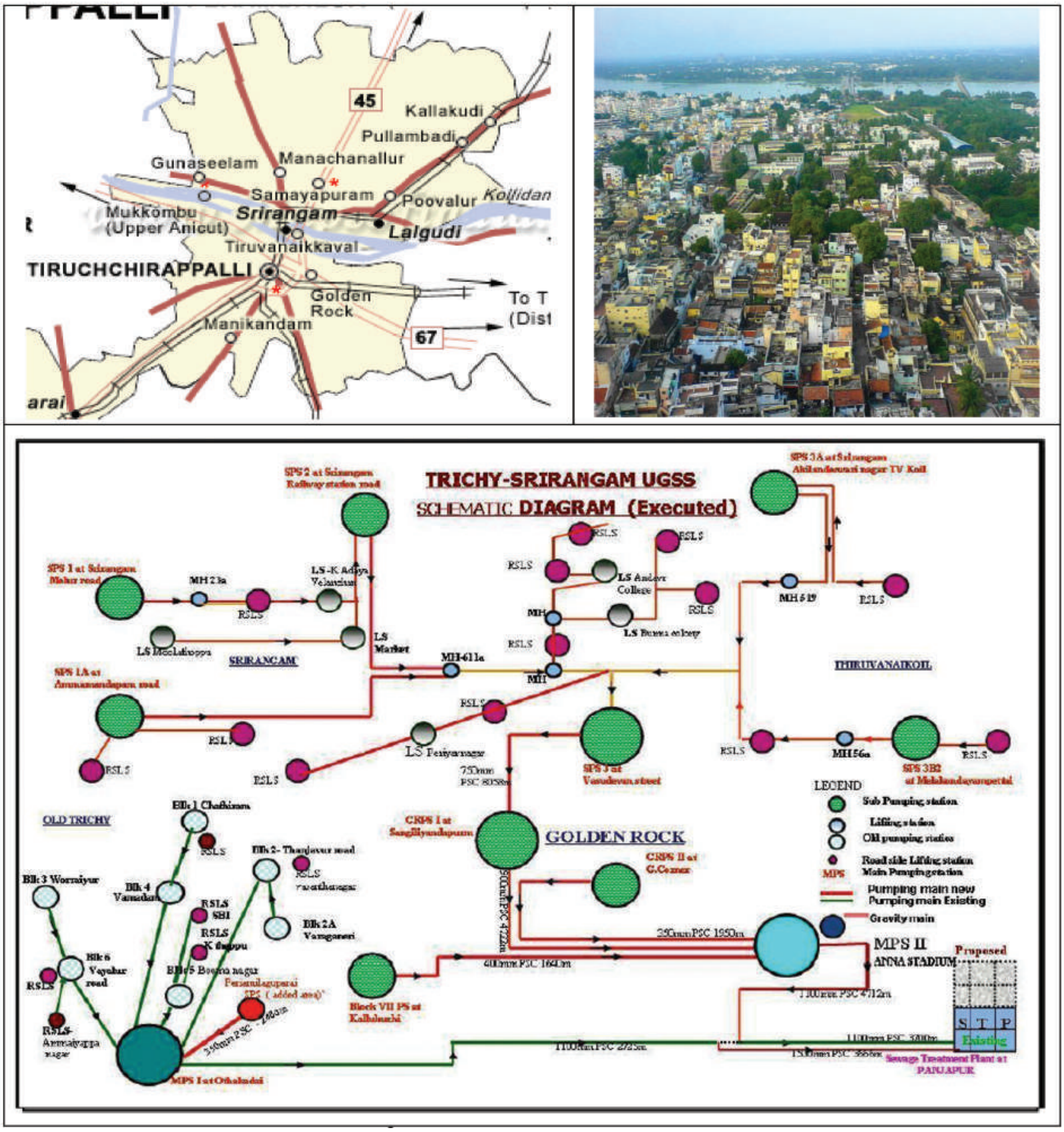
8.5 APPLICATION OF DECENTRALIZED SEWERAGE IN URBAN AREAS

It is not as though the decentralized sewerage is meant for peri-urban and rural settings alone. In fact, it is as much applicable to even metropolitan centres as in the case of our major State capitals like Chennai, Bangalore, Delhi, Ahmedabad, etc. except that the treatment is decentralized, but the sewerage is conventional sewerage. This is understandable in these locations, but Trichy for example where over the decades, a decentralized sewerage could have been evolved, but it has been a case of the entire sewage going down to one far corner and the sewage from one side of the river Cauvery being pumped to the other side 330 m across. While apparently this may appear paradoxical, it is not so because the tiny Srirangam habitation from where the sewage is pumped across the major river, is a highly revered and very densely populated religious centre and positioning a STP at Srirangam was ruled out from public acceptance point of view. Hence, it has not been possible to decentralize as shown in Figure 8.12 (overleaf).

The Cauvery and Coleroon (Kollidam) are, perhaps, the biggest rivers in South India.

Trichy (Tiruchirapalli) is situated on the banks of river Cauvery and the STP of the city is located on the South Eastern corner of the city.

The sewage of the entire habitation between Cauvery and Coleroon rivers could have been routed towards Coleroon river.



Top left - Trichy town of 150 km^2 area lying on both sides of the perennial river Cauvery

Top right - Panorama of the town illustrating the efficacy of decentralized sewerage

Bottom - Paradox of centralized sewerage over a century

Source: TWAD Board webpage

Figure 8.12 Historical sewerage system of an Indian city

However, the sanctity of the Srirangam town in this location is revered by the followers so highly that STP was not acceptable by the public and hence, the entire sewage is pumped across the Cauvery river to the existing STP. This is a case where decentralized sewerage, though technically justifiable has to give way to public acceptance.

8.6 PUBLIC TOILETS AS DECENTRALIZED SEWERAGE

In effect public toilets are a further decentralization within decentralized sewerage in that it answers the needs of the floating population in locations as market places, bus terminals and super markets. These are a compelling necessity as the user is a stranger to the location, who may be passing through it and may not know what to do and is unable to control the urge to relieve him or herself.

8.6.1 Norms for Public Toilet facilities with focus on attention to gender issues

Provision of public toilet facilities to meet the demands of opposite genders entering a toilet which is not designated for the accompanying child should be given importance while designing these kinds of facilities. Mostly the child caring facilities are provided in Women's toilet section and not generally in Men's toilets section. Absence of such facility would put the men with difficulties, when they required caring for the accompanying children and kids. Provision of dedicated toilets for differently abled persons and transgender is also need to be taken care of while designing the public toilet facilities. The General Norms for Public Toilets and norms for provision of sanitary facilities as recommended by the Town and Country Planning Organisation (TCPO) in the Model Building Bye-laws are given in Table 8-2 and Table 8-3 respectively.

Table 8.2 Norms for Toilets in Public spaces

Public Toilet	On roads and for open areas @every 1 km, including in parks, plazas, open air theatre, swimming area, car parks, fuel stations. Toilets shall be disabled-friendly and in 50-50 ratio (M/F). Provision may be made as for Public Rooms (Table 8.3).
Signage	Signboards on main streets shall give directions and mention the distance to reach the nearest public convenience. Toilets shall have multi-lingual signage for the convenience of visitors. Helpline number shall be pasted on all toilets for complaints/queries.
Modes	Pay & use or free. In pay and use toilets entry is allowed on payment to the attendant or by inserting coin and user gets 15 minutes.
Maintenance/ Cleaning	The toilet should have both men and women attendants. Alternatively automatic cleaning cycle covering flush, toilet bowl, seat, hand wash basin, disinfecting of floor and complete drying after each use can be adopted, which takes 40 seconds. Public toilet shall be open 24 hours.

Table 8.3 may well ipso facto apply for transit stations like bus stations, markets and most importantly road side users. The determination of the numbers for roadside toilet users can be computed by considering the number of people transiting that road in the day time and providing the toilets at strategic locations.

Toilets for transgenders can also be appropriately allocated as stand alone without clubbing with gender based toilets and the doors opening directly into the vastness of the hall instead of a narrow passage. Toilets for differently abled person's are easily constructed and identified and will almost invariably have a western toilet, guide rails on both walls, water faucet for ablution and wash basins at chair level.

Table 8.3 Norms for sanitary facilities in Public Toilets

No.	Sanitary Unit	For Male	For Female (A)
1.	Water Closet	One per 100 persons up to 400 persons; for over 400 add at the rate of one per 250 persons or part thereof.	Two for 100 persons up to 200 persons; over 200 add at the rate of one per 100 persons or part thereof.
2.	Ablution Taps	One in each W.C.	One in each W.C.
3.	Urinals	One for 50 persons or part thereof.	Nil
4.	Wash Basins	One per W.C. and urinal provided	One per W.C. provided

Note:

i) It may be assumed that two-thirds of the number are males and one- third females

ii) One water tap with drainage arrangements shall be provided for every 50 persons or part thereof in the vicinity of water closet and urinals.

* At least 50% of female WCs may be Indian pan and 50% EWC

8.6.2 Off-Site Treatment

As these locations are amidst habitation, it should be possible to connect them to the existing collection system, whether it is conventional sewerage or a decentralized sewerage or in its absence, provide a collection tank duly covered and transfer the contents by a sewer lorry to the existing disposal site/sites. In any case, on-site disposal of these public toilets shall be totally banned.

8.6.3 One-way See through Public Toilets

A key issue of public toilets amidst downtowns especially for women in software firms, etc. brings up the security concerns which may be possible to be got over by the pay and use type and see through mirror wall toilets reported to be in use abroad as in Figure 8.13 (overleaf). It shows the view of the roadside from inside the toilet, thereby facilitating a much needed security for the lone user in metros at odd hours.

8.7 COMMUNITY TOILETS AS DECENTRALIZED SEWERAGE

The community toilet is to be defined as a facility to be continuously used day in and day out by a fixed number of users at public locations or residential locations, and where a reasonable control over the number of users is possible.

Examples are those in economically weaker sections, educational institutions, sites of religious centres situated away from the main habitation, whether used daily or seasonally or for clusters of dwellings far away from sewerage and most important meeting locations, which are used in high numbers by the population though infrequently.

Source: http://www.toxel.com/tech/2009/05/27/transparent-public-toilets-from-switzerland/

Figure 8.13 A toilet reportedly in Switzerland affording security to the user to be aware of the surroundings through the one way mirror viewable from inside only

8.7.1 Norms

The norms for the number of seats, wash basins, etc., can be appropriated from the nearest category as in the NBC for railway stations, hostels, educational institutions, which border on community facilities. In respect of economically weaker sections, the design approach in Chapter 3 shall be followed to assess the volume of sewage. The issues already discussed under public toilets in respect to gender related and differently abled persons shall be considered here also. The designs for community toilets, which also include a washing section and bathing section have been developed for easy utility by the variety of users in common domain by the National Institute of Design and needs to be considered for suitable adoption. Their designs of pre-fabricated toilets and their networking, both in horizontal plane and vertical plane are worthy of adoption. The problem arises in assessing the needs for fairs, festivals and public meetings in locations where large number of people congregate though infrequently, like for example the foregrounds of Ana Sagar in Ajmer. The Norms for Toilet facilities for infrequent events is given in Table 8.4 herein.

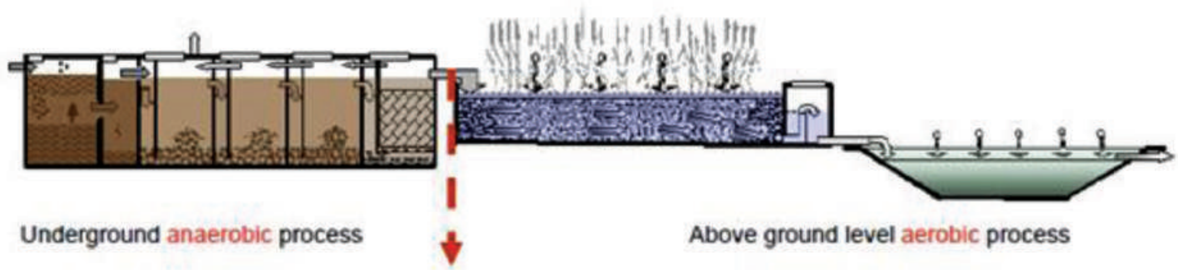
Table 8.4 Norms for Toilet facilities for infrequent events

Patrons	Male						Female			
	Toilets		Urinals		Sinks		Toilets		Sinks	
	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)
<500	1	3	2	8	2	2	6	13	2	2
<1000	2	5	4	10	4	4	9	16	4	4
<2000	4	9	8	15	6	7	12	18	6	7
<3000	6	10	15	20	10	14	18	22	10	18
<5000	8	12	25	30	17	20	30	40	17	20

(a)- Where alcohol is not available; (b)-Where alcohol is available

8.8 DEWATS

This is an abbreviation of Decentralized Wastewater Treatment System (DEWATS) and has been assigned to a typical system of sewage treatment and resource utilization for greening in isolated habitations. The generalized treatment sequence is shown in Figure 8.14.



Source: ISPIRATION webpage

Figure 8.14 Schematic treatment process of DEWATS technology

This system is addressed to isolated habitations, where there is a need for non-mechanized and self-operating treatment technology given the premise that adequate land area is available and at reasonable distance from the habitation itself. Another aspect will be to group the toilets or at least bring the sewage from the various centres to the Dewats facility. The typical treatment units are:

a) Pre-treatment settler: retention time of about 2 hours; BOD reduction by about 30%
b) Anaerobic Baffled Tank Reactor: retention time of about 24 hours; BOD reduction by about 80%
c) Anaerobic filter: retention time of about 8 hours; BOD reduction by about 90%
d) Planted gravel filter: retention time of about 36 hours; BOD reduction by about 90%
e) Polishing pond.

These have been installed and commissioned in quite a few habitations in India and a compilation of the facility at the earthquake ravaged place of Bhuj in Gujarat is shown in Figure 8.15. The treatment process has its advantage of not dependant on mechanized units but requires relatively large areas away from the habitation and vector propagation control in the planted gravel filters and ponds.

Source: ISPIRATION webpage

Figure 8.15 Typical DEWATS treatment plant components

8.9 RECOMMENDATIONS

The decentralization concepts and technologies in sewage management need to be systematically investigated, with focus on its development and practical implementation in India. It may be borne in mind that the approach adopted for decentralized sewage management system (DSMS) is area specific and governed by number of issues and conditions prevailing, and also the methodology adopted and is influenced by (i) technical aspects as covered in this chapter and (ii) financial aspects, (iii) social aspects, (iv) environmental aspects, and (v) legal aspects that will be covered in the part C of the manual. It needs to be realized that this aspect and programme of decentralized sewerage is what the country needs urgently if the MDG is to be achieved especially in the peri-urban, rural and outlying areas and habitations. Accordingly, the following recommendations are brought up in deciding on implementing this.

1) As Incremental Sewerage - Decentralized Sewerage has an enormous significance by way of incremental sewerage and sanitation especially in newly developing peri-urban and rural settings, where conventional sewerage needs time to qualify itself physically and financially.

2) As a Combination of Collection System Options - It is the interim period from start of the layout to such time that underground conventional sewerage will qualify itself that is the bane of all environmental hazards of indiscriminate pollution. Ingenuity of a combination of decentralized collection systems and incremented treatment capacity of the STP are the remediations for the country as a whole.

3) Public Acceptance is the Key - However, with the mindset of the people that sewerage de facto implies only to the underground conventional sewerage, any deviation from a conventional system will require a public acceptance before implementation and as such, decentralized sewerage is not an exception. The Srirangam case study is an ideal example. Any attempt in starting a decentralized treatment there would have never seen the light of the day. This aspect must not be underestimated and hence, the public consultation process shall be announced well in advance in local media and repeated one more time giving notice of at least two weeks and making the venue as local marriage hall or public hall with adequate space and hired chairs and expenses being met by the local body. The technicalities are to be toned down and the benefits and costs alone need to be cited elaborately and the opinion elicited. Understandably, it will not be a full acceptance by all the habitation and there will be various cost recovery models thrown up for example, built-up area based on; number of families based, history of residence in terms of years, economically weaker sections, clusters, non-commercial Vs. commercial occupancies, etc., and these are to be debated to bring the issues on hand to a reasonable level of acceptance. The exercise needs to be repeated for a second time. At the end, if a consensus is reached, the project can be considered forward and if it still eludes, the best is pose a conventional sewerage system to JnNURM and await its turn.

4) Design of Collection System - With regard to design procedures of the collection systems, the Manning’s formula holds good whether it be a circular conduit or a drain.

5) Design of Treatment Plants - With regard to treatment, the guidelines in Chapter 5 will however, apply as it becomes appropriate to each location.

CHAPTER 9: ON-SITE SANITATION

9.1 OVERVIEW OF ON-SITE SANITATION

The areas that are not served by piped sewer systems can adopt on-site systems. The treatment can be either on-site or off-site like in the case of septage management. These are interim measures till a decentralised or a full sewerage system is implemented.

It is strongly recommended that the town planning agencies / authorities / ULB / metropolitan development authorities earmark adequate spaces for laying of sewer lines, construction of SPS and STP.

9.1.1 On-site Sewage Treatment System

Unlike off-site centralized treatment (sewerage), on-site sewage treatment features individual and distributed treatment. The on-site treatment system includes a wide range of facilities, such as a basic sanitation facility like a pit latrine, a simple sewage treatment system that consists of a septic tank and a soak pit for anaerobic treatment, and an advanced facility like Johkasou that treats sewage by sophisticated methods.

In an urban area with high population density, an STP intensively treats sewage collected by pipes laid over a wide area. The on-site system treats sewage near the source.

Accordingly, the latter uses various kinds of treatment technologies according to treatment scale and the surrounding conditions. Sludge generated in each on-site treatment facility is collected and treated separately.

9.1.2 On-site Classification

This subsection summarizes the classification of toilets and on-site treatment methods as well as their features.

9.1.2.1 Historical

The historical pit latrines are rather rudimentary sanitation facilities atleast serving to contain the spread of faecal organisms from the night soil and bringing about interactions between soil organisms and feacal organisms in the pit. These have since been upgraded to various types as in Figure 8.3. In respect of community toilets, installations such as Dewats have also come up.

9.1.2.2 Simple Treatment Method

A septic tank system is a typical on-site treatment facility that consists of a septic tank and a soak pit and employs two technologies: the first is anaerobic treatment and the second is the methods of letting treated sewage penetrate the ground.

It shows stable performance, provided that the water temperature is kept suitable to digestion and the soil has good permeability.

However, the septic tank reduces BOD up to 50%, so if underground penetration is impossible due to high groundwater levels, rocky strata, non-availability of land for soak-pit, another method must be employed to hygienically treat sewage passing through the septic tank such as anaerobic filter and contact aeration. When this system is applied to an urban area with high population density, care must be taken not to have a negative effect on the surrounding environment.

9.1.2.3 Advanced Treatment System

Conventional septic tanks system, if properly designed and with proper septage removal frequency can effectively remove about 40-50% BOD and 50-70% TSS. However, due to partial treatment and associated health hazards the effluent can only be discharged into soak pits. Due to recent groundwater pollution related episodes, unavailability of space for soak pits and under rocky strata, soak pits are avoided and the effluent is commonly discharged to open stormwater drains. Hence, it is causing another type of pollution menace such as unsightly conditions, eutrophication, odour, vector and water related diseases.

Some of the interim solutions are the improved design of septic tanks such as anaerobic baffled reactor or the post treatment of septic tank effluents by anaerobic filters. Both configurations can partially solve the pollution related problems by increasing the overall BOD removal to more than 70%. These systems can lessen the burden of organic pollution without any extra energy cost. The capital cost of these systems may not be more than 20-30% of the conventional septic tank cost. Nevertheless, due to the limitation of anaerobic sewage treatment, these systems cannot bring down the BOD and TSS levels up to the national effluent discharge standards. Hence, alternate solution could be the aerobic type post treatment such as contact aeration. This system can bring down effluent BOD to less than 30 mg/l and TSS to less than 50 mg/l but at the expense of electrical power requirement for 24×7 operating air blower with standby equipment and standby power.

One such system is the Japanese type Johkasou system. This system is an integrated septic tank-anaerobic filter-contact aeration-final settling tank and effluent disinfection facility. However, due to higher cost considerations, these systems may be affordable only in very fragile environment. These systems have also been upgraded for even nitrogen removal by providing internal recirculation. The detail of these systems is provided in the following sections. There are many other similar package treatment systems elsewhere that can also be used.

9.2 THE PROHIBITION OF EMPLOYMENT AS MANUAL SCAVENGERS AND THEIR REHABILITATION ACT, 2013

The aforesaid act was notified by the GOI in September 2013. The act shall come into force from 6th December 2013. The text of the act as in the Gazette is in Appendix A 1.1. The time frame specified under the Act for the fulfilment of responsibilities and carrying out certain activities are mentioned in Appendix A 1.2.

9.3 INTERIM MEASURES

There are various on-site systems which can be used but with a caution to prevent ground water and surface water pollution due to indiscriminate disposal of sewage from these on-site systems.

9.3.1 Public and Community Toilets

A public toilet, a kind of common toilet installed in stations and on streets, is open to everyone rather than specified users. In contrast, a community toilet has limited users such as residents. These common toilets are controlled by local governments, residents, or private sector organizations. A common toilet normally has two sections: one is for males and the other is for females. In addition, another section special to persons in a wheelchair (unisex) is sometimes provided.

In general, an on-site common toilet includes a special sewage treatment facility such as a septic tank. The flow rate of sewage to be treated is derived from the total number of users based on how many toilet bowls are installed and how frequently they are used.

The toilet is equipped with a water supply unit, a ventilator, and a lighting device. Figure 9.1 shows example arrangements of faeces, urine, and hand-washing units.

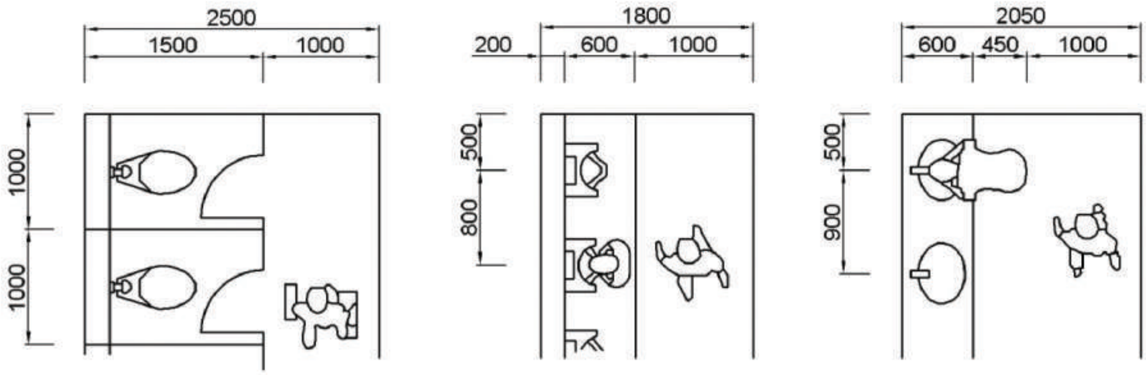


Figure 9.1 Examples of common toilet arrangements

Example of design

The following shows an example of estimating the number of public toilet users.

Basic Setting

Number of toilet bowls [c]: 10 (in total)

Total number of users [n]

$$n = 16c$$
$$= 16 \times 10 = 160$$

9.3.2 Mobile Toilet

Mobile toilets are temporarily installed in places where there is no toilet, such as shelters during natural disaster, venues for events, and construction sites, or where the number of existing toilets is short. A mobile toilet box has a tank for storing excreta in its lower part. If the tank is full, a vacuum tanker collects the stored sewage. Each toilet has a single room or multiple rooms with a hand washing unit, which is selected according to the flexibility of installation sites and ease of transport by a truck. In addition, there is a mobile flush toilet that is equipped with a water tank and a pedal.

Stepping on the latter activates a manual pump to cause washing water to flow. The box is made by assembling fiberglass-reinforced plastic (FRP) side panels, so its weight is light. Local governments keep these toilets to prepare for disasters and events, or rental companies lease them. The mobile toilet features easy installation work on the ground. Figure 9.2 shows a mobile toilet having faeces, urine, and hand washing units.

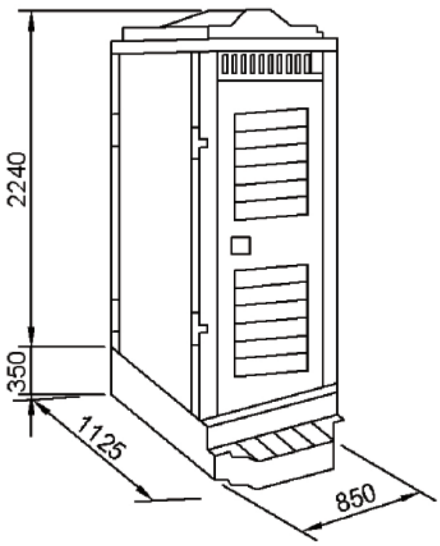


Figure 9.2 Mobile toilet

9.3.3 Pour Flush Water Seal Latrine

In a conventional water flush latrine, the excreta is normally flushed with 10 to 14 litres of water from a cistern. In a pour flush latrine, as the name suggests, excreta is hand flushed by pouring about 1.5 to 2.0 litres of water. These pour-flush leaching pit latrines were first developed in India in mid-forties with a single leach pit and squatting pan placed over it. When the pit in use gets filled up another pit is dug and the squatting slab is removed and placed over the new pit. The first pit is covered with earth and the excreta is allowed to digest. After one or two years, the digested excreta is used as manure.

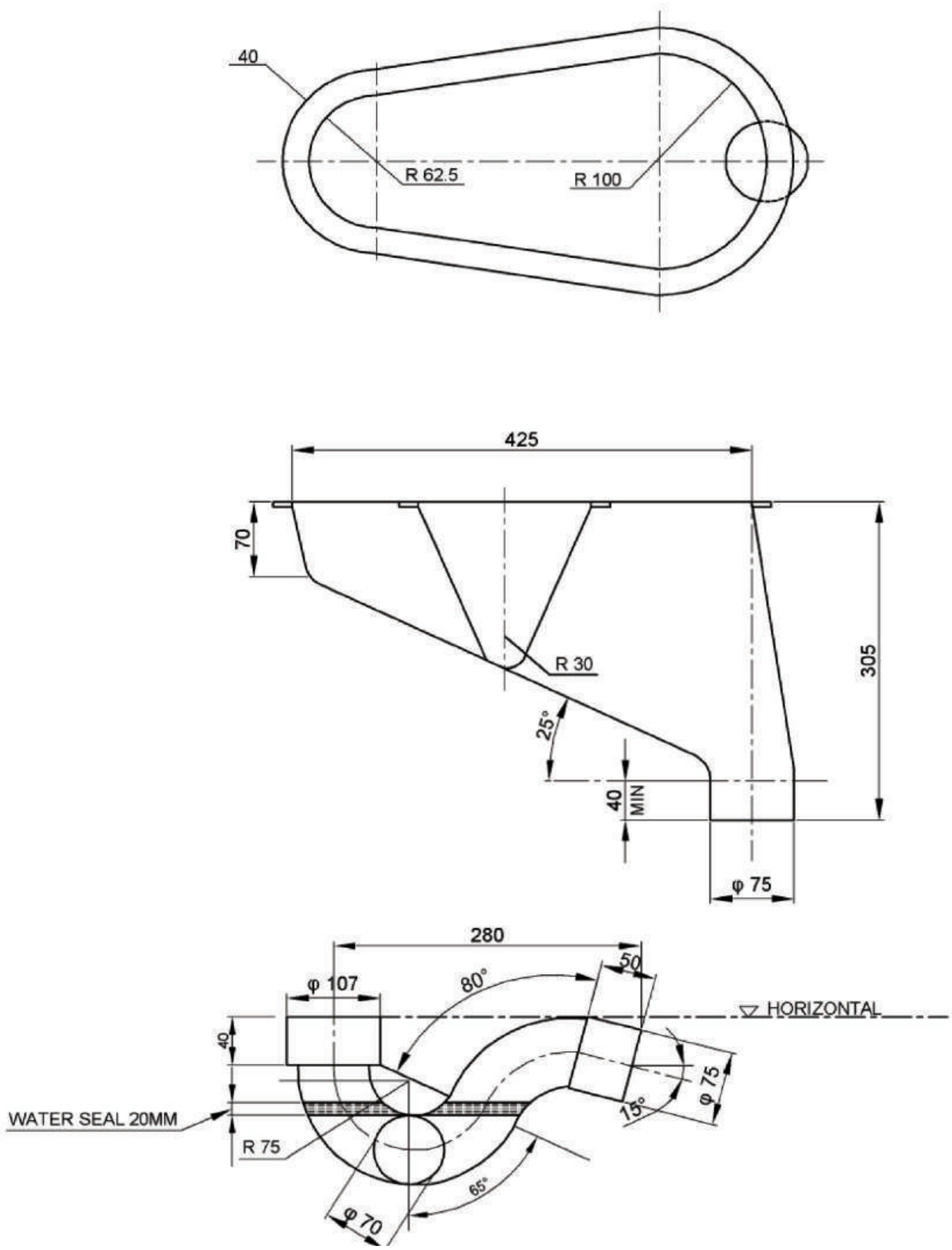
In the late fifties, a modified design of the system was developed. In this system the leach pit is kept away from the seat instead of placing it underneath the pan. In a single pit system, desludging has to be done almost immediately after the pit has been filled up to enable its re-use; this involves handling of fresh and undigested excreta containing pathogens which is a health hazard. Single leach pit is appropriate only if it is desludged mechanically by a vacuum tanker. To overcome this shortcoming, the twin-pit design was introduced and in this case when one pit is full, the excreta is diverted to the second pit. The filled up pit can be conveniently emptied after 1.5 to 2 years, when most of the pathogens die off. The sludge can safely be used as manure. Thus the two pits can be used alternately and perpetually.

With simple care, pour-flush water-seal latrine is a very satisfactory and hygienic sanitation system and hence it can be located inside the house since the water-seal prevents odour and insect nuisance from the pit.

9.3.3.1 Design and Materials

9.3.3.1.1 Squatting Pan, Trap, Footrests, and Connecting Drain

The squatting pan is of special design with steep bottom slope 25 - 28° and a trap having 20 mm water seal set on a cement concrete floor. The hydraulic design of the pan is such that the human excreta can be flushed by pouring only 1.5 to 2 litres of water. The squatting pan and trap design details are shown in Figure 9.3.



Source: CPHEEO, 1993

Figure 9.3 Squatting pan and trap

The squatting pan can be of ceramic or glass reinforced plastic (GRP), High Density Polyethylene (HDPE) or Poly Vinyl Chloride (PVC), Polypropylene (PP), Cement mosaic or even concrete. The squatting pan is connected to the leaching pit through a trap and a pipe or covered drain. The design and material details for latrine units squatting pan, trap, footrest and the connecting drain are summarised below in Table 9.1.

Table 9.1 Material and other details for latrine unit

No.	Squatting Pan	Trap	Footrests	Connecting Drain
1	Horizontal length of pan should be at least 425 mm and longitudinal bottom slope 25 -28°	It should be 70 to 75 mm with 20 mm water seal	It should be 250×125 mm with 15 to 20 mm height	May be non-pressure pipes of PVC minimum 75 mm dia
2	Material: Ceramic, FRP, PP, HDPE, PVC, Cement mosaic or Cement concrete	Fibre Glass, Ceramic, HDPE or CC traps	Ceramic or concrete with mosaic finish brick or stone	Bricks or stone semi-circular bottom
3	Should conform to IS: 2556 (Pt. III), IS: 11246, GRP Sq. Pan	Should conform to IS: 2556 (Pt. XIII)	Should conform to IS: 2556 (Pt. X)	Slope should be 1 in 5 to 1 in 15 as per site conditions
4	(A)			(B)

(A)- Ceramic, FRP, PP are smooth and require less water for flushing. FRP cheaper, lighter and easier to transport than the other

(B)- The inlet pipe should project 100 mm in to the leach pit.A junction chamber of 250×250 mm should be provided in case of pipe

Source: CPHEEO, 1993

9.3.3.1.2 Leach Pits/Twin Pit Latrine

Leach pits serve a dual function of (a) storage and digestion of excreted solids and b) infiltration of the waste liquids and are therefore, to be designed on the basis of the following parameters:

- Sludge accumulation rate
- Long term infiltration rate of the liquid fraction across the pit soil interface
- Hydraulic loading on the pit
- Minimum period required for effective pathogen destruction
- Optimal pit emptying frequency.

9.3.3.1.2.1 Sludge Accumulation Rate

The sludge accumulation rate is a function of a wide range of variables including water table level, pit age, water and excreta loading rates, microbial conditions in the pit, temperature and local soil conditions and the type of material used for anal cleansing.

The leach pit is classified as wet or dry depending on whether the ground water table is above the bottom of pit or below. In dry pits, the pit volume needed is calculated on the basis of solids accumulation rate, but in wet pits though the sludge accumulation rate is lower - the sludge digestion rate is high in the presence of water, yet volume of pit has to be increased to prevent flooding due to surcharge of pits. The sludge accumulation rates given below in Table 9.2 may be used to calculate the pit volume.

Table 9.2 Sludge accumulation rates

Material used for anal cleansing	Effective Volume in m^3 per Capita per Year (A)		
	Pit under dry conditions	Pit under Wet conditions	
		With successive desludging intervals	
		2 years	3 years
Water	0.04	0.095	0.067
Soft Paper	0.053	0.114	0.080

(A) Effective Volume is the volume of the pit below the invert level of pipe or drain.

Source:CPHEEO, 1993

9.3.3.1.2.2 Long Term Infiltration Rate

On account of clogging of soil pores around the leach pits, the long term infiltration capacity (after clogging) of the soil is always less than the natural percolative capacity. The recommended design values of the long term infiltrative capacity can be derived for the typical soil conditions as given below in Table 9.3.

Table 9.3 Long term infiltration rates of different types of soils

No.	Soil type	litres / sqm / day
1	Sand	50
2	Sandy loam, loams	30
3	Porous silty loams, porous silty, silty clay loams	20
4	Compact silty loams, compact silty clay loams, clay	10

Source: CPHEEO, 1993

9.3.3.1.2.3 Hydraulic Loading

The hydraulic loading rate is the total volume of liquids entering the leach pit and is expressed in litres per day although it is often more convenient to consider per capita loadings (litres per capita per day). For computing the pit hydraulic loading, sewage contribution of 9.5 litres per day per person, including water used for ablutions and flushing, urine, excreta, etc., can be taken as the basis.

The outer surface area (perimeter) of the pit from pit bottom to invert level of pipe or drain is to be considered for infiltration. The pit bottom is not taken into account as it gets clogged in course of time. The infiltration area required is the total flow in the pit per day divided by the long term infiltrative rate of the soil where pits will be located. The infiltrative area of leach pits, sized on the basis of sludge accumulation rate should conform to the computed infiltrative area.

9.3.3.1.2.4 Pathogen Destruction

After a period of almost all pathogens viruses, bacteria, protozoa and helminths die off in the leach pit or in the surrounding soil, but not Ascaris Lumbricoides (the large human round-worm) particularly if the leach pit is wet. After about one or one and a half years of storage in the pit, it may not be hazardous to handle the contents of the pit for use as manure.

9.3.3.1.2.5 Optimal Pit Emptying Frequency

The minimum acceptable design interval between successive manual desludging of each twin leach pit could be one-and-a-half-years. However, to provide a reasonable degree of operational flexibility, it is desirable to provide three years storage volume in urban areas and two years in rural areas.

9.3.3.1.2.6 Size of Pits

Sizes of leach pits, [designed as above for different number of users, using water ablution and for different subsoil water levels], with 3 years sludge storage volume, are in Table 9.4.

Table 9.4 Size of leach pits

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

Note: (A) Depth from bottom of pit to invert level of incoming pipe or drain (all dimensions in mm)

Source: CPHEEO, 1993

The surface area of these is adequate for soils with long term infiltrative rate down to 20 l/m^2/day. The above depths should be increased by 300 mm to provide a free board depth of pit from invert level of pipe or drain to bottom of pit cover.

9.3.3.1.2.7 Design of Pits under Different Conditions

A typical pour flush latrine with circular pits is shown in Figure 9.4.

In water logged area: The pit top should be raised by 300 mm above the likely level of water above ground level at the time of water logging. Earth should then be filled well compacted all round the pits up to 1.0 m distance from the pit and up to its top. The raising of the pit will necessitate raising of latrine floor also. A typical pour flush latrine in water logged areas is shown in Figure 9.5.

In high subsoil water level: Where the subsoil water level rises to less than 300 mm below ground level, the top of the pits should be raised by 300 mm above the likely subsoil water level and earth should be filled all round the pits and latrine floor raised as stated above. A typical pour flush latrine with leach pits in high subsoil water level is shown in Figure 9.6

In rocky strata: In rocky strata with soil layer in between, the leach pits can be designed on the same principle as those for low subsoil water level and taking the long term infiltrative capacity as 20 $l/m^2/d$. However, in rocks with fissures, chalk formations, old root channels, pollution can flow to very long distances; hence these conditions demand careful investigation and adoption of pollution safeguards as stated in paragraph below.

In black cotton soil: Pits in black cotton soil should be designed taking infiltrative rate of 10 $l/m^2/d$. However a vertical fill (envelope) 300 mm in width with sand, gravel or ballast of small sizes should be provided all round the pit outside the pit lining.

Where space is a constraint: Where circular pits of standard sizes cannot be constructed due to space constraints, deeper pit with small diameter (not less than 750 mm), or combined oval, square or rectangular pits divided into two equal compartments by a partition wall may be provided. In case of combined pits and the partition wall should not have holes. The partition wall should go 225 mm deeper than the pit lining and plastered on both sides with cement mortar. A typical pour flush latrine with combined pits is shown in Figure 9.7

Design example of leach pit is given in Appendix A.9.1.

9.3.3.2 Construction of Pour Flush Latrine

9.3.3.2.1 Squatting Pan and Trap

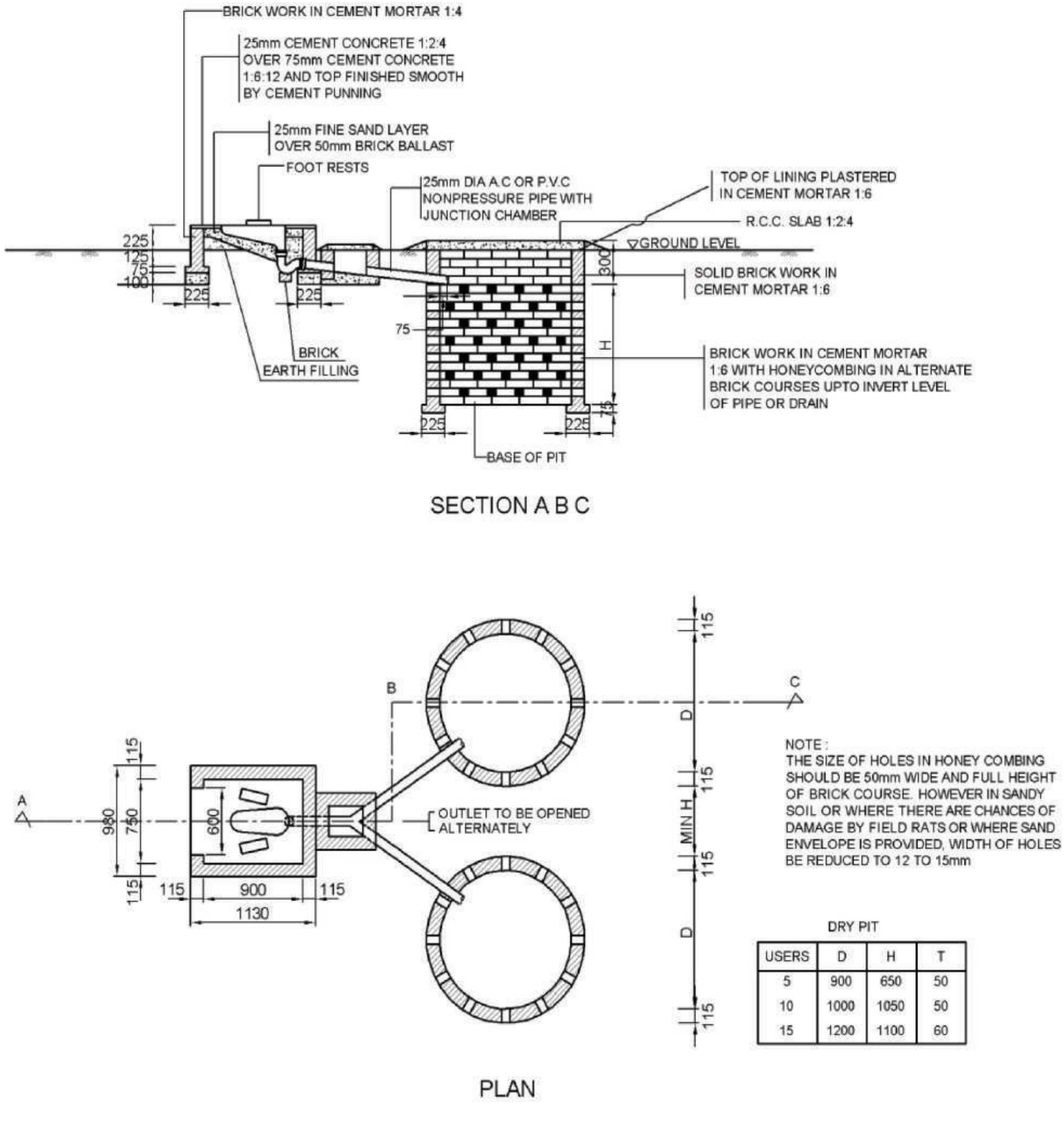
The pan could be ceramic, GRP, PVC, PP, Cement Concrete or Cement Mosaic. Ceramic are the best but costliest. Mosaic or cement concrete pans have the advantage that these can be manufactured locally by trained masons but the surface tends to become rough after long use. Their acceptance is less compared to other types. Traps for ceramic pans are made of the same material but in case of GRP pans, HDPE traps are used. For mosaic pans, traps are of cement concrete.

9.3.3.2.2 Foot Rests

These can be of ceramic, cement concrete, cement mosaics or brick plastered. The top of the footrest should be about 20 mm above the floor level and inclined slightly outwards in the front.

9.3.3.2.3 Pit Lining

The pits should be lined to avoid collapsing. Bricks joined in 1:6 cement mortar are most commonly used for lining. Locally manufactured bricks should be used wherever available. Stones or laterite bricks cement concrete rings could also be used depending upon their availability and cost. However, for ease of construction, use of concrete rings will be advantageous where the subsoil water level is above the pit bottom.

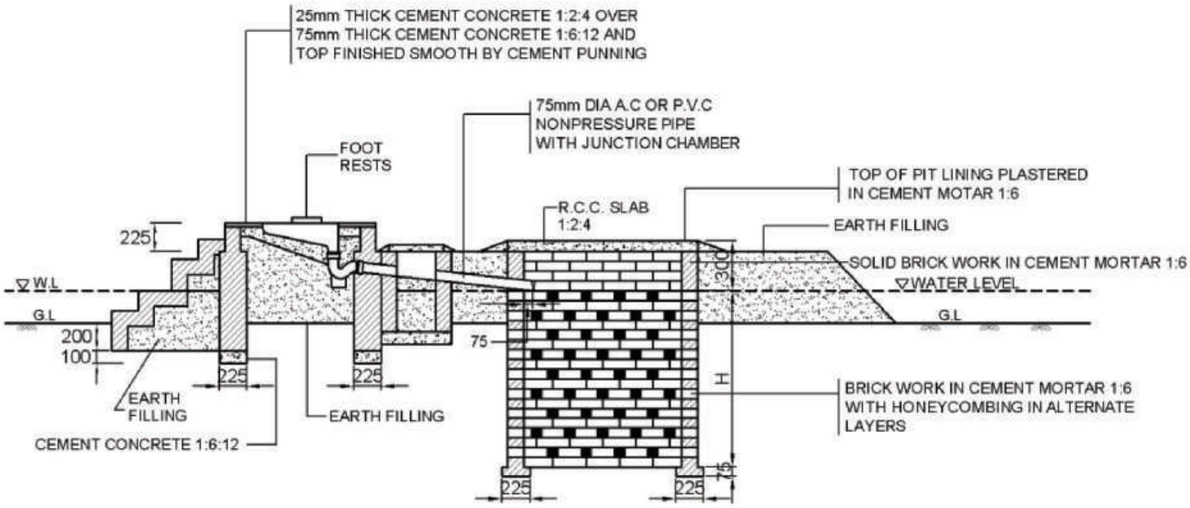


DRY PIT

USERS	D	H	T
5	900	650	50
10	1000	1050	50
15	1200	1100	60

Source: CPHEEO, 1993

Figure 9.4 Pour flush latrine with circular pits



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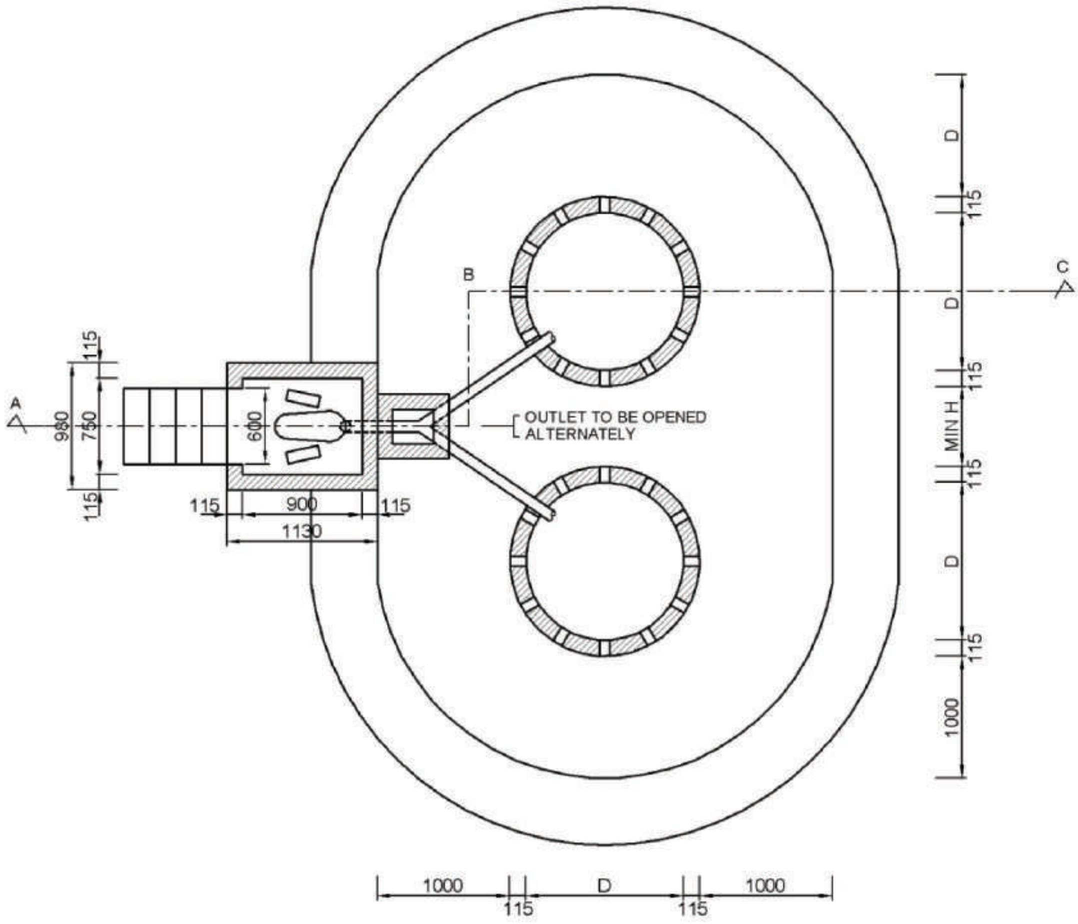
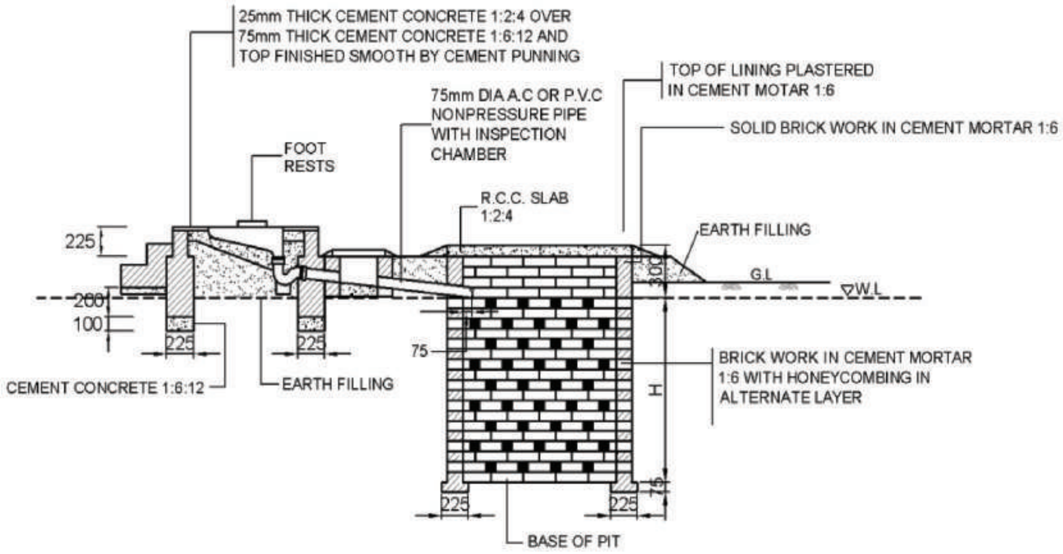


PLAN

Source:CPHEEO, 1993

Figure 9.5 Pour flush latrine in water logged areas



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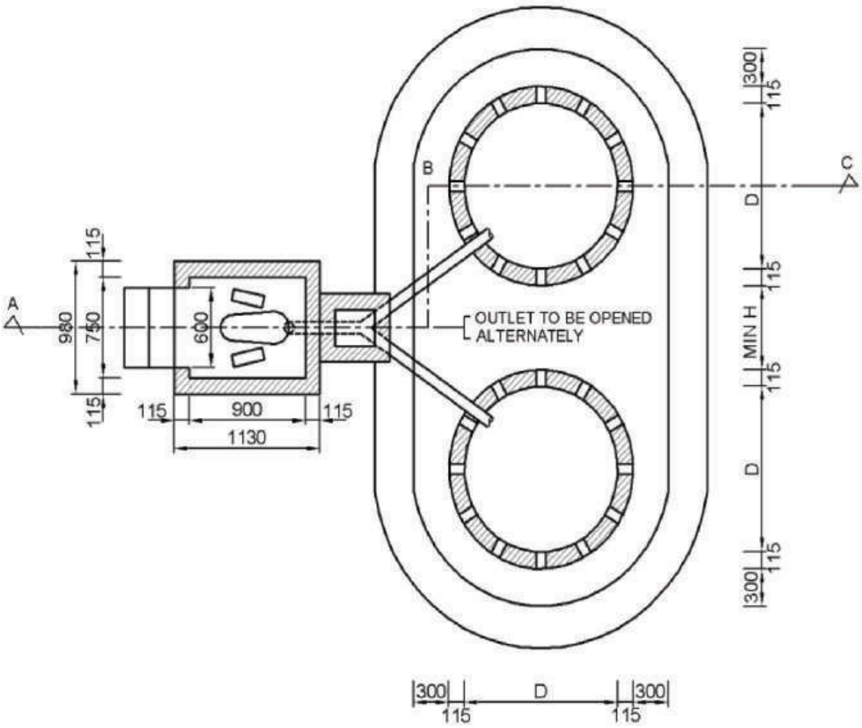
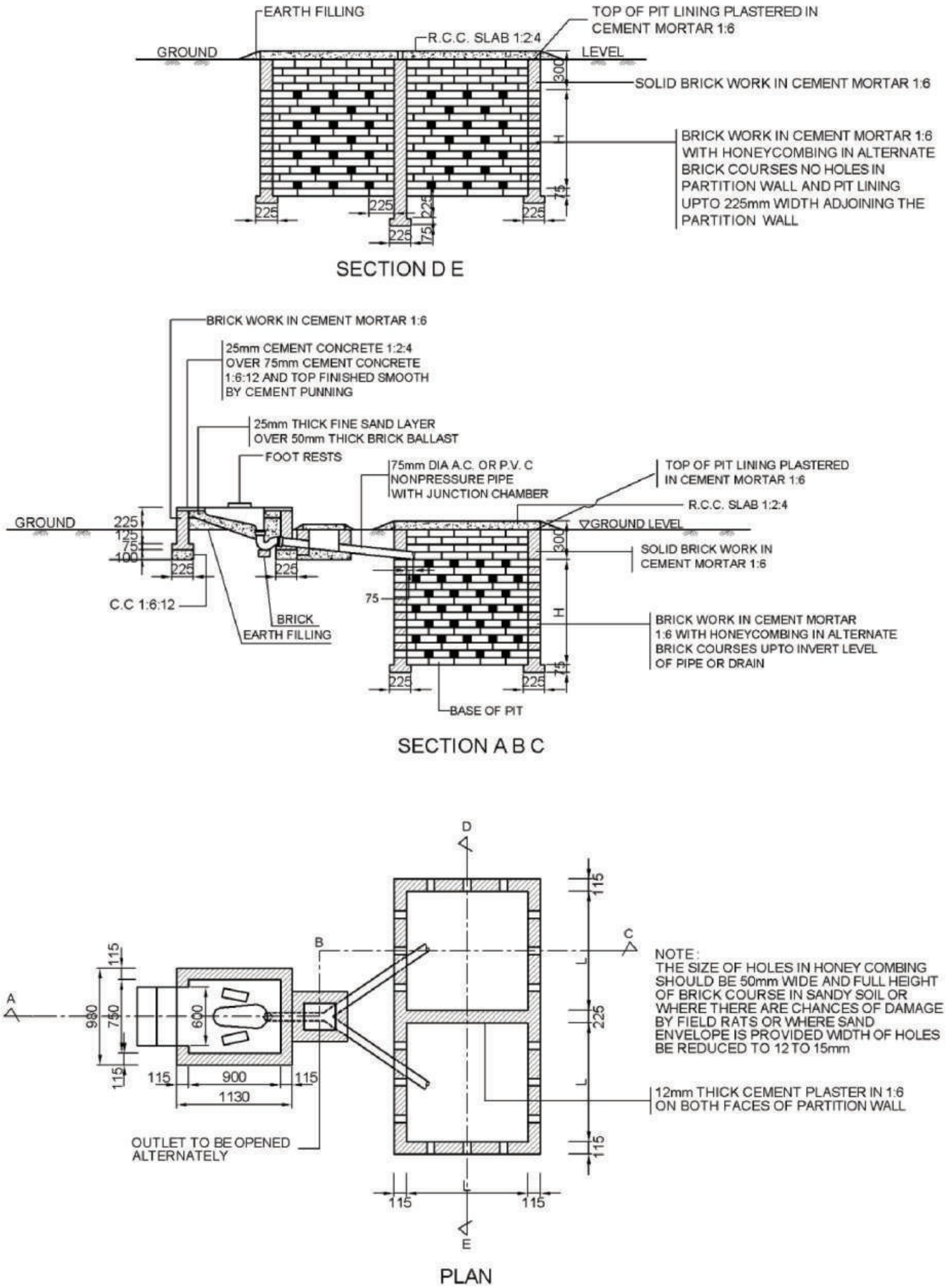


PLAN

Source:CPHEEO, 1993

Figure 9.6 Leach pits in high subsoil water level



Source:CPHEEO, 1993

Figure 9.7 Pour flush latrine with combined pits

The lining in brick work should be 115 mm thick (half brick) with honey combing up to the invert level of incoming pipe or drain; the size of holes should be about 50 mm wide up to the height of the brick course. For ease of construction, holes should be provided in alternate brick courses. In case the soil is sandy and sand envelope is provided, the width of openings should be reduced to 12 to 15 mm. Where foundation of building is close to the pit, no holes should be provided in the portion of lining facing the foundation and in rest of the lining 12 to 15 mm wide holes should be provided. The lining above the invert level of pipe or drain up to the bottom of pit's cover should be in solid brick work, i.e., with no openings.

The concrete rings used for lining should be 50 mm thick, about 450 mm in height and of required diameter in 1:3:6 cement concrete and have 40 mm circular holes staggered about 200 mm apart. The rings are not jointed with mortar, but are put one over the other. The rings above the invert level of pipe or drain should not have holes and are jointed with cement mortar.

9.3.3.2.4 Pit Bottom

Except where precautions are to be taken to prevent pollution of water sources, the pit bottom should be left in natural condition.

9.3.3.2.5 Pit Cover

Usually RCC slabs are used for covering the pits, but depending upon the availability and cost, flag stones can also be used. The RCC Slab may be centrally cast in pieces for convenience of handling.

9.3.3.2.6 Leach Pit Connection

The toilet pan is connected to the pit through a 75 mm brick channel of 'U' shape covered with loosely jointed bricks or 75 mm dia AC or PVC non-pressure pipe laid in 1:15 gradient. In case pipes are used, a chamber of minimum size 225 × 225 mm is provided at the bifurcation point to facilitate cleaning and allowing flow to one pit at a time. In case of drain, 'Y' portion of the drain serves the purpose by taking out the brick cover.

9.3.3.3 Pollution Safeguards

In order to reduce the pollution risk of ground water and water sources, the following safeguards should be taken while locating the pits.

9.3.3.3.1 Safe Distance from Drinking Water Sources

In dry pits or unsaturated soil conditions, i.e. where the height between the bottom of the pit and the maximum ground water level throughout the year is 2 m and more.

a) The pits can be located at a minimum distance of 3 m from the water sources such as tube wells and dug wells if the effective size (ES) of the soil is 0.2 mm or less, and

b. For coarser soils (with ES greater than 0.2 mm) the same distance can be maintained if the bottom of the pit is sealed off by an impervious material such as puddle clay or plastic sheet and 500 mm thick envelope of fine sand of 0.2 mm effective size is provided around the pit.

In wet pit saturated soil conditions, i.e. where the distance between the bottom of the pit and the maximum ground water level during any part of the year is less than 2 m,

a. The pits can be located at a minimum distance of 10 m from the water sources such as tube wells and dug wells if the ES of the soil is 0.2 mm or less, and

b. For coarser soils (with ES more than 0.2 mm), minimum distance of 10 m can be maintained if the pit is sealed off by an impervious material such as puddle clay or plastic sheet with 500 mm thick envelope of fine sand of 0.2 mm, effective size provided all round the pit.

9.3.3.3.2 Safe Distance from Water Supply Mains

Lateral distance between the leach pit and the water mains should be at least 3 m provided the water table does not rise during any part of the year above the pit bottom and the inlet of the pipe or drain to the leach pit is below the level of water main. If the water table rises above the bottom of the pit, then the safe lateral distance should be kept as 8 m. If this cannot be achieved, then the pipes should be completely encased to a length of at least 3 m on either side of the pit.

When the pits are located either under the foot path or under the road, or the water supply main is within a distance of 3 m from the pits, the invert of the inlet pipe should be kept at least 1 m below the ground level. This would ensure that the liquid level in the pits does not reach the level of the water main as the water mains are generally laid at 0.9 m depth.

The water pipe should not cut across the pit, but where this is unavoidable; the water pipe should be completely encased for length of 3 m on either side of the pit including the portion across the pit to prevent infiltration or exfiltration.

A study is reported by National Institute of Technology, Calicut, Kerala in respect of safe distance in laterite type of soils (Biju.et.al.2011)

The study area had houses with either the septic tank-soak pit system or pit latrines, the latter being more common with open wells as the source of water at 1.2 m to 2.4 m below ground in laterite soil. The horizontal distance between well and the soak pit / pit latrines varied from 5 m to 31 m. The MPN of total coliform from nearly 35 wells was studied and it was found that the number of total coliform correlated with the length of a specific parabolic curve connecting the soak pit / pit latrine and the well. This relationship was used to calculate the safe distance between the soak pit / pit latrine and open well so that the total coliform was not exceeding the MoEF classification of class “A” water in the well water and which is “Drinking water source without conventional treatment but after disinfection” at total coliform of not exceeding 50/100 ml. The distance evaluated was 21 m, where the water table rises to the level of soak-pit / pit latrine and the well.

9.3.3.3.3 Location of Pits

The ideal position for locating the pits is that the pits are placed symmetrically at the backside of pan. The pits may be located within the premises, under footpath or narrow lanes or under the road.

The minimum space between two pits should be equivalent to at least the effective depth (distance between the bottom of the pit and invert level of pipe or drain. Spacing can be reduced by providing an impervious barrier like cut off screen or puddle wall.

In many cases, the space available for constructing leach pits may be small and placement of pits near existing structure may be unavoidable. The digging of pits and subsequent seepage may disturb the soil around the pits.

The safe distance of the leach pits from the foundations of existing building depends upon the soil characteristics, depth as well as type of foundation of the structure, depth of the leaching pits etc., and varies from 0.2 to 1.3 m.

However, in cases where the leach pits are quite close to the existing building foundation, the opening in the brick work lining of the leach pit may be reduced to 12 to 15 mm.

Where the bottom of the pit is submerged below the maximum ground water level:

i. The top of the pits should be raised above the ground level, if necessary, so that the pipe into the pit is at least 0.75 m above the maximum ground water level.

ii) The sand envelope is taken up to 0.3 m above the top of the inlet pipe and confined suitably to exclude any surface drainage including rain water directly entering the sand envelope.

iii) In mound type latrines, 1 m high earth filling be provided at least 0.25 m beyond the sand envelope with the edges chamfered to lead away the rain or surface water, and

iv) The honeycomb brick work for the pit lining should be substituted by brick work in cement mortar 1:6 with open vertical joints, i.e. without mortar. Where sand is not available economically, local soil of effective size of 0.2 mm can also be used.

9.3.3.3.4 Subsoil Conditions

In depression and waterlogged areas, location of pits should be avoided, as far as possible, in depression where sewage or rain water is likely to remain collected all round and over the pits. If it cannot be avoided or the pits are to be constructed adjacent to ponds or tanks, then the top of pits should be raised to 0.6 m to 0.8 m above the ground level and earth filling should be done all around the pits up to a distance of 1.5 m right up to the pit top.

The raising of pit may necessitate raising the latrine floor also.

9.3.3.4 Night Soil Digesters

The night soil can be anaerobically digested either alone or in combination with cattle dung. It is rich in nitrogen and phosphorus in comparison to cow dung.

The characteristics of night soil are different from the cow dung and are mentioned in Table 9.5 (overleaf).

Table 9.5 Characteristics of night-soil and cow-dung

No.	Characteristics	Night Soil	Cow Dung
1	Moisture content, %	85 - 90	74 - 82
2	Volatile solids as % of Total Solids	80 - 88	70 - 80
3	Total Nitrogen as N, % on dry basis	3 - 5	1.4 - 1.8
4	Total Phosphorus as P_2O_5, % on dry basis	2.5 - 4.4	1.1 - 2.0
5	Potassium as K_2O, % on dry basis	0.7 - 1.9	0.8 - 1.2

Source: CPHEEO, 1993

9.3.3.4.1 Design Criteria

The design criteria for night soil digester are listed in Table 9.6.

Table 9.6 Design criteria and performance parameters for digester

No.	Item	Magnitude
1	Volumetric Organic loading, kg VS/m^3 d	1.6
2	Hydraulic residence time, d	25-30
3	Solids concentration of slurry fed to digester, %	5
4	Volatile solids destroyed during digestion, %	45-55
5	Gas yield, m^3/kg of VS added in m^3/capita/d	0.5
6	m^3/capita/d	0.034

Source: CPHEEO, 1993

The night soil digesters are constructed in a similar manner as anaerobic digesters and essentially consist of the following components:

i. Inlet tank with a feed pipe leading to digester

ii. Digester tank with fixed or floating dome for gas collection

iii. Outlet pipe from digester discharging digested slurry into a masonry chamber.

9.3.4 Conventional Septic Tank

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

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

9.3.4.1 Design

Several experiments and performance evaluation studies have established that only about 30% of the settled solids are anaerobically digested in a septic tank. In case of frequent desludging, which is necessary for satisfactory effluent quality, still lower digestion rates have been reported. All these studies have proved that when the septic tank is not desludged for a longer period i.e., more than the design period, substantial portion of solids escape with the effluent. Therefore, for the septic tank to be an efficient suspended solids remover, it should be of sufficient capacity with proper inlet and outlet arrangements. It should be designed in such a way that the sludge can settle at the bottom and scum accumulates at the surface, while enough space is left in between, for the sewage to flow through without dislocating either the scum or the settled sludge.

Normally, sufficient capacity is provided to the extent that the accumulated sludge and scum occupy only half or maximum two-thirds the tank capacity, at the end of the design storage period.

Experience has shown that in order to provide sufficiently quiescent conditions for effective sedimentation of the suspended solids, the minimum liquid retention time should be 24 hours. Therefore, considering the volume required for sludge and scum accumulation, the septic tank may be designed for 1 to 2 days of sewage retention.

The septic tanks are normally rectangular in shape and can either be a single tank or a double tank. In case of double tank, the effluent solids concentration is considerably lower and the first compartment is usually twice the size of the second. The liquid depth is 1-2 m and the length to breadth ratio is 2-3 to 1.

Recommended sizes of septic tanks for individual households (up to 20 users) and for housing colonies (up to 300 users) are given below in Table 9.7 and Table 9.8 respectively.

Table 9.7 Recommended size of septic tank up to 20 users

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

Note 1: The capacities are recommended on the assumption that discharge from only WC will be treated in the septic tank

Note 2: A provision of 300 mm should be made for free broad.

Note 3: The sizes of septic tank are based on certain assumption on peak discharges, as estimated in IS: 2470 (part 1) and while choosing the size of septic tank exact calculations shall be made.

Source: CPHEEO, 1993

Table 9.8 Recommended size of septic tank for housing colony upto 300 users

No. of Users	Length (m)	Breadth (m)	Liquid depth (cleaning interval of)	
			2 years	3 years
50	5.0	2.00	1.0	1.24
100	7.5	2.65	1.0	1.24
150	10.0	3.00	1.0	1.24
200	12.0	3.30	1.0	1.24
300	15.0	4.00	1.0	1.24

Note 1: A provision of 300 mm should be made for free board.

Note 2: The sizes of septic tanks are based on certain assumptions on peak discharges, as estimated in IS: 2470 (Part 1) and while choosing the size of septic tank exact calculations shall be made.

Note 3: For population over 100, the tank may be divided into independent parallel chambers of maintenance and cleaning.

Source: CPHEEO, 1993

9.3.4.2 Construction Details

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

Baffled inlet will distribute the flow more evenly along the width of the tank and similarly a baffled outlet pipe will serve better than a tee-pipe.

For larger capacities, a two-compartment tank constructed with the partition wall at a distance of about two-thirds the length from the inlet gives a better performance than a single compartment tank. The two compartments should be interconnected above the sludge storage level by means of pipes or square openings of diameter or side length respectively of not less than 75 mm. Every septic tank should be provided with ventilation pipes, the top being covered with a suitable mosquito proof wire mesh. The height of the pipe should extend at least 2 m above the top of the highest building within a radius of 20 m. Septic tanks may either be constructed in brick work, stone masonry or concrete cast in situ or pre-cast materials. Pre-cast household tank made of materials such as asbestos cement / HDPE could also be used, provided they are watertight and possess adequate strength in handling and installing and bear the static earth and superimposed loads.

All septic tanks shall be provided with watertight covers of adequate strength. Access manholes (minimum two numbers one on opposite ends in the longer direction) of adequate size shall also be provided for purposes of inspection and desludging of tanks.

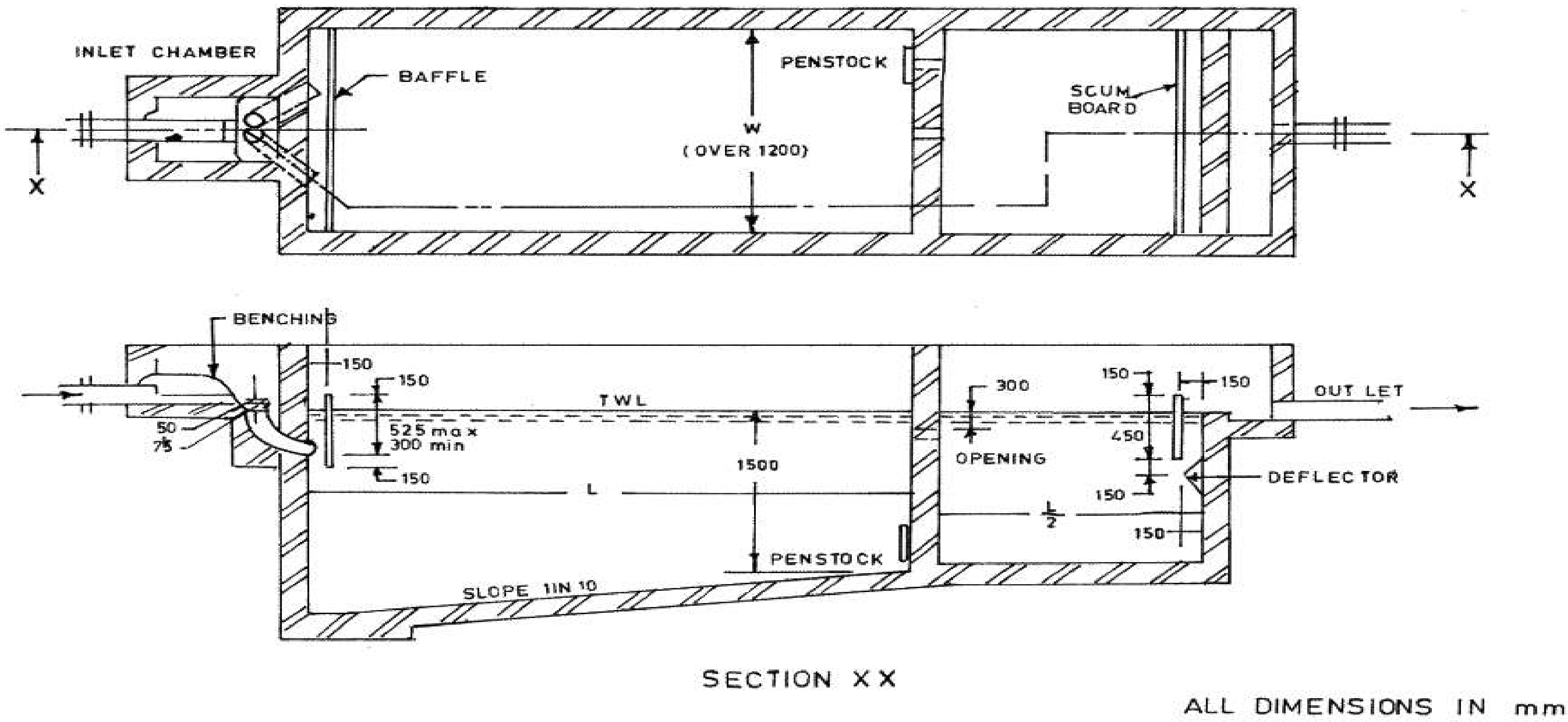
The floor of the tank should be of cement concrete and sloped towards the sludge outlet. Both the floor and side wall shall be plastered with cement mortar to render the surfaces smooth and to make them water tight. A typical two compartment septic tank is shown in Figure 9.8 (overleaf).

9.3.4.3 Sludge Withdrawal and Disposal

When sludge is drawn off from the bottom of the tank, at first the small quantity of sludge in the immediate vicinity of the outlet or suction pipe is withdrawn. This is followed by drawing off sewage, because the sludge, being only slightly heavier, but much more viscous than the sewage, lies away from the point of outlet and the scum remains floating on the surface. With continued draw-off more sewage is removed, until finally only sludge and scum remain in the tank. These come off last, and then only if there is sufficient slope on the floor of the tank, force them to gravitate to the outlet. This is the reason for the slow bleeding-off of sludge from steep bottomed pyramidal sedimentation tanks and for desludging by complete emptying. If septic tanks are desludged by only partial removal of the contents, then they become more and more full with sludge and scum, and the quality of the effluent deteriorates soon.

For certain reasons, desludging of septic tanks under hydrostatic head by means of a sludge pipe collecting of sludge from the lowest point in the tank and discharging at a higher level - should be discouraged. The manual handling of sludge should be avoided.

The mechanical vacuum tankers should be used by the municipal authorities to empty the septic tanks. Alternately, where space is not a constraint, a sludge-pipe with a delivery valve to draw the sludge as and when required, should be installed at the bottom of the tank to empty its contents into a sump, for subsequent disposal on land or sent for further treatment. Spreading of sludge on the ground in the vicinity should not be allowed. Portable pumps may also be used for desludging, in which case there will be no need for sludge pipe or sludge sump.



TYPICAL SKETCH OF TWO COMPARTMENT SEPTIC TANK FOR POPULATIONS OVER 50 (IS : 2470 (PART 1)-1985)

Source: CPHEEO, 1993

Figure 9.8 Structure of a septic tank

Yearly desludging of septic tank is desirable, but if it is not feasible or economical, then septic tanks should be cleaned at least once in two - three years, provided the tank is not overloaded due to use by more than the number of persons for which it is designed.

9.3.4.4 Secondary Treatment and Disposal of Effluent

The septic tank effluent will be malodorous, containing sizable portion of dissolved organic content and pathogenic organisms and hence, need to be treated before its final, safe disposal. Depending upon the situation — the size, treatment objective, resources available etc., the extent and type of secondary treatment facility can vary from the most conventional land disposal methods like soak pits or dispersion trenches to additional secondary biological treatment systems.

Normally, the land disposal methods are designed to achieve subsurface percolation or seepage into the soil. Satisfactory disposal therefore depends, to a great extent, on porosity and percolation characteristics of the soil.

In addition, other factors, such as level of subsoil water table, the climatic conditions, presence of vegetation, aeration of solid and concentration of suspended solids in the effluent also influence the application of these methods. Soak pits or dispersion trenches can be adopted in all porous soils, where soak percolation rate is below 25 minutes per cm and the depth of water table is 2 m or more from the ground level. Method of soil percolation test is described in Appendix A.9.2. Dispersion trenches should be preferred in soils with percolation rates between 12 and 25 minutes/cm, if adequate land is available. In areas with higher water table, dispersion trenches should be located partly or fully above ground level, in a mound.

The subsoil dispersion system shall be at least 20 m away from any source of drinking water. It should also be as far as possible from the nearest dwellings, but not closer than 7 m to avoid any corrosive effect due to tank gases vented into atmosphere. Subsoil dispersion system is not recommended in limestone or crevice rock formations, where there may be solution cavities that may convey the pollution to long distances and pollute water resources. In impervious soils such as dense clays and rocks, where percolation rate exceeds 25 minutes/cm, adoption of up flow or reverse filters, trickling filters, subsurface sand filters or open sand filters followed by chlorination should be considered, particularly for larger installations.

In the absence of information relating to ground water or subsoil, subsurface explorations are necessary. Percolation tests determine the acceptability of the site and serve as the basis of design for liquid absorption. The total subsurface soil area required for soak pits or dispersion trenches is given by the empirical relation:

$$Q = 130\sqrt{t} \tag{9.1}$$

where

Q = Maximum rate of effluent application in $l/d/m^2$ of leaching surface, and

t = Standard percolation rate for the soil in minutes.

In calculating the effective leaching area required, the area of trench bottom in case of dispersion trenches and effective side wall area below the inlet level for soak pits should be considered.

9.3.4.5 Soak Pits

Soak pits are cheap to construct and are extensively used. They need no media when lined or filled with rubble or brick bats. The pits may be of any regular shape, circular or square being more common. When water table is sufficiently below ground level, soak pits should be preferred only when land is limited or when a porous layer underlies an impervious layer at the top, which permits easier vertical downward flow than horizontal spread out as in the case of dispersion trenches.

Minimum horizontal dimension of soak pit should be 1 m, the depth below the invert level or inlet pipe being at 1 m. The pit should be covered and the top raised above the adjacent ground to prevent damage by flooding. It is being recommended that these are to be phased out in due course of time.

9.3.4.6 Dispersion Trenches

Dispersion trenches consist of relatively narrow and shallow trenches about 0.5 to 1 m deep and 0.3 to 1 m wide excavated to a slight gradient of about 0.25%. Open joined earthenware or concrete pipes of 80 to 100 mm size are laid in the trenches over a bed of 15 cm to 25 cm of washed gravel or crushed stone. The top of pipes shall be covered by coarse gravel and crushed stone to a minimum depth of 15 cm and the balance depth of trench filled with excavated earth and finished with a mound above the ground level to prevent direct flooding of trench during rains. The effluent from the septic tank is led into a small distribution box from which several such trenches could radiate out. The total length of trench required shall be calculated from the Eq. (9.1) and the number of trenches worked out on the basis of a maximum length of 30 m for each trench and spaced not closer than 2 m apart. Parallel distribution should be such that a distribution box should be provided for 3 to 4 trenches. It is being recommended that these are to be phased out in due course of time.

9.3.5 Improved Septic Tank

9.3.5.1 Up-Flow Anaerobic Filter

The up-flow filter can be successfully used for secondary treatment of septic tank effluent in areas where dense soil conditions, high water table and limited availability of land preclude soil absorption or the leaching system for effluent disposal. It is a submerged filter with stone media or half broken chamber well burnt bricks by hand and the septic tank effluent is introduced from the bottom.

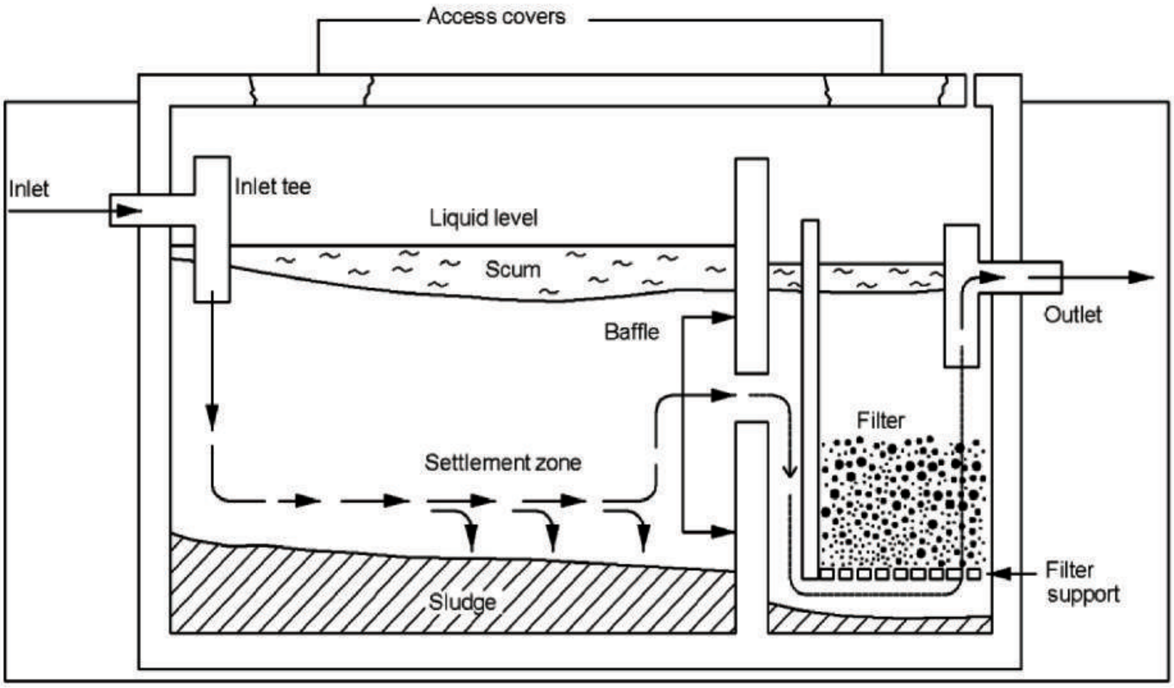
The microbial growth is retained on the stone media, making possible higher loading rates and efficient digestion. The capacity of the unit is 0.04 to 0.05 m3 per capita or 1/3 to 1/2 the liquid capacity of the septic tank it serves. BOD removals of 70% can be expected. The effluent is clear and free from odour. This unit has several advantages viz, (a) high degree of stabilization; (b) little sludge production; (c) low capital and operating cost; and (d) low loss of head in the filter (10 to 15 cm) in normal operation.

The up-flow anaerobic filter can either be a separate unit or constructed as an extended part of septic tanks. An anaerobic filter is a fixed-bed biological reactor.

Dissolved organic matter and non-settleable solids are filtered and anaerobically digested by the bacteria in the biofilm attached to the filter media.

Anaerobic filters are widely used as secondary treatment in household black or grey water systems and to improve the solid removal compared to septic tanks or anaerobic baffled reactors. Since anaerobic filters work by anaerobic digestion, they can be designed as anaerobic digesters allowing recovering the produced biogas.

Multi-chamber septic tank system prevents sludge carryover. The schematic diagrams of anaerobic filter, anaerobic baffled reactor, and multi chamber anaerobic filter is provided in Figure 9.9, Figure 9.10 and Figure 9.11 respectively.



Simple one unit anaerobic Filter integrated in the second chamber of a septic tank.
Gas is evacuated by the venting opening at the upper right.

Source: Tilley et al., 2008

Figure 9.9 Anaerobic filter

A typical septic tank up flow filter for 10 persons is shown in Figure 9.12. A typical septic tank - up flow filter evapotranspiration system is shown in Figure 9.13.

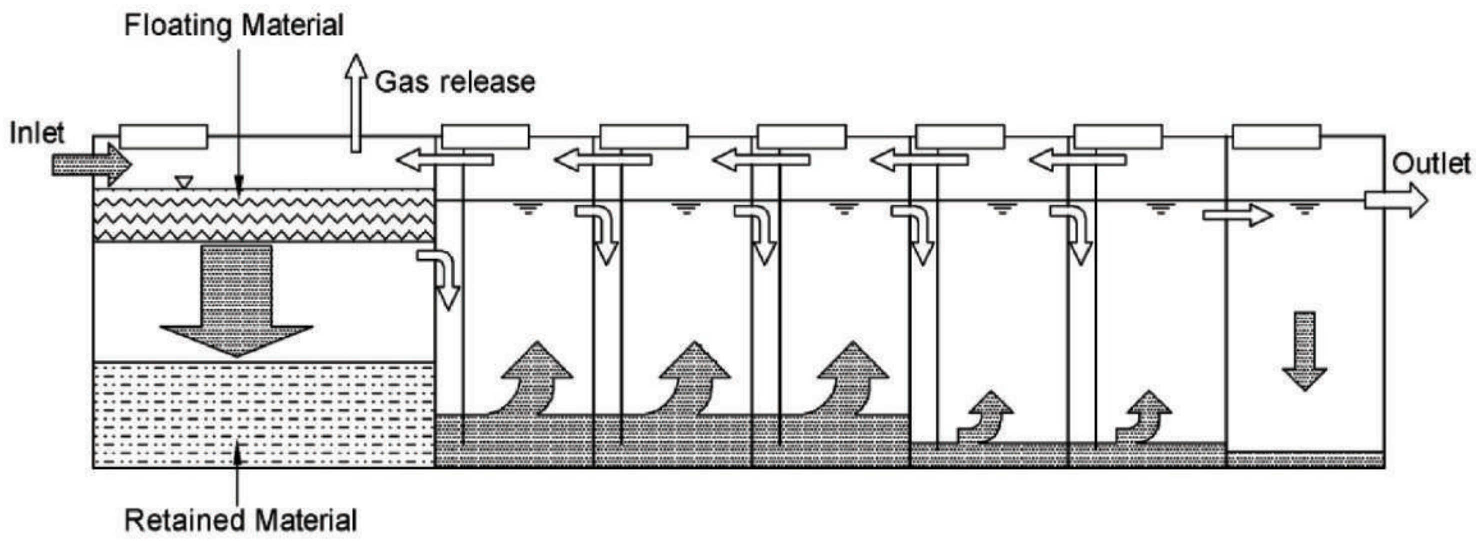


Figure 9.10 Anaerobic baffled reactor

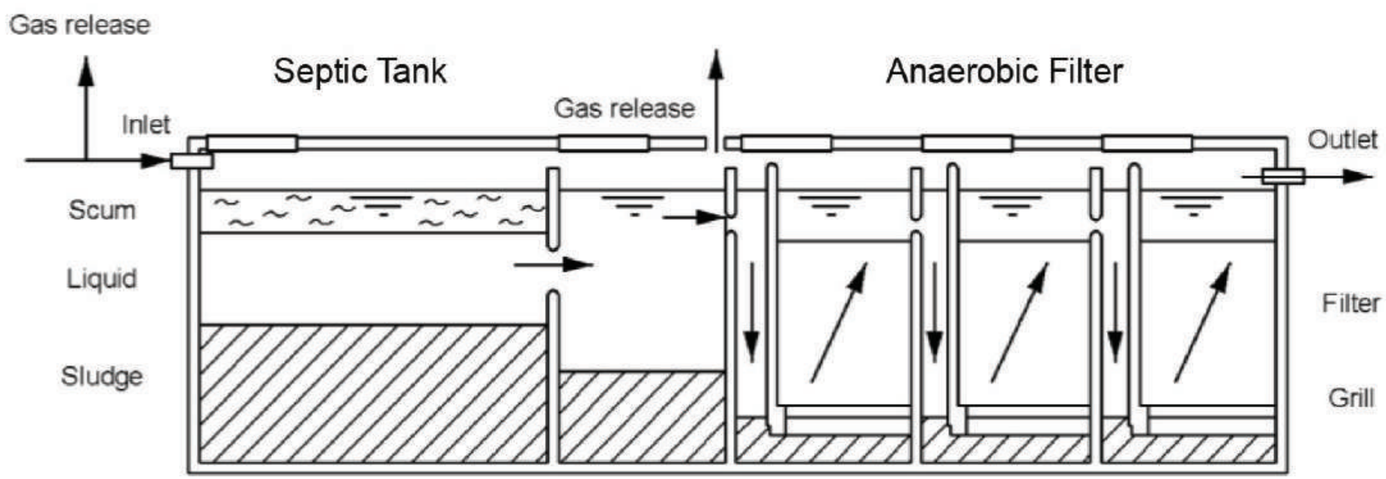


Figure 9.11 Multi chamber anaerobic filter

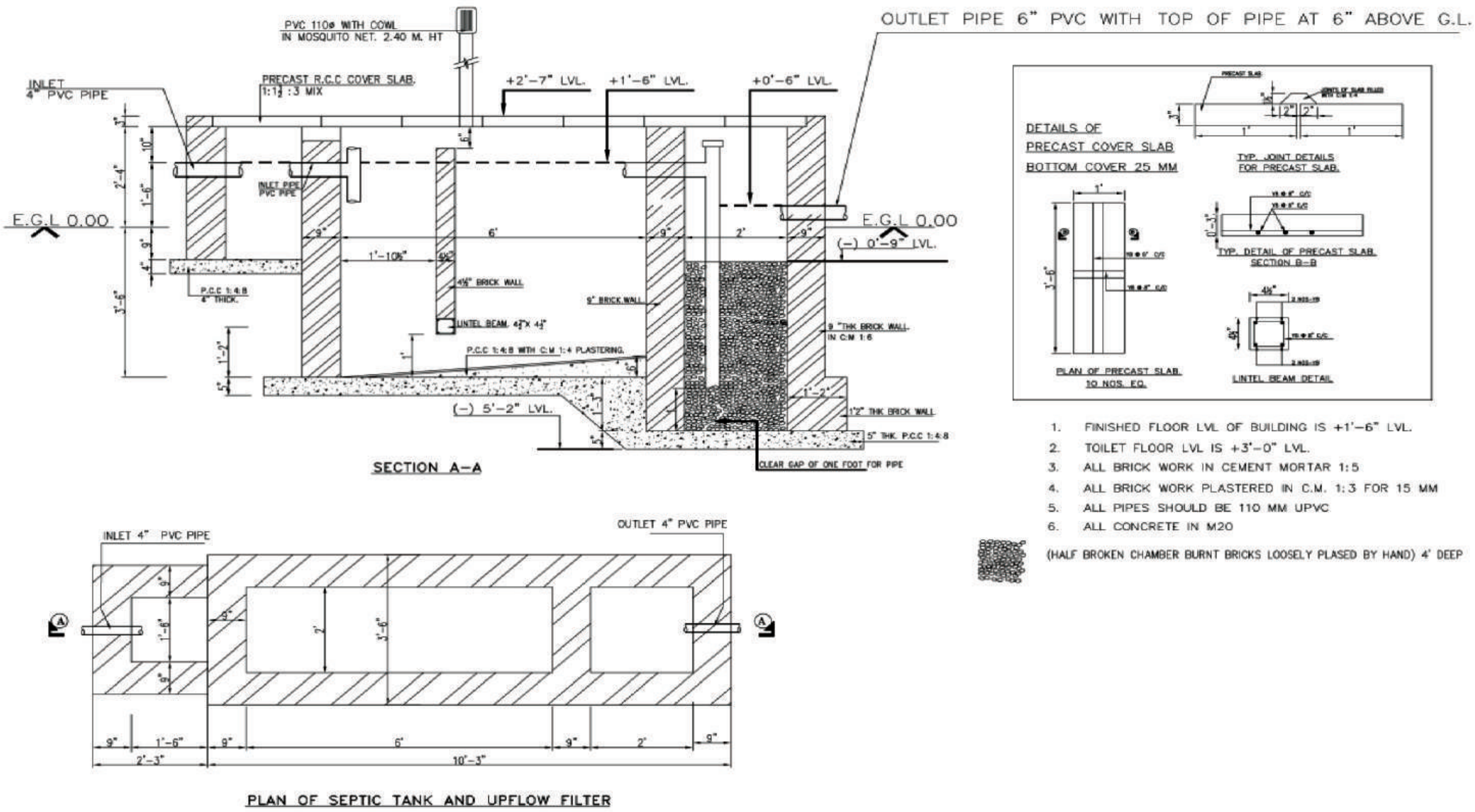
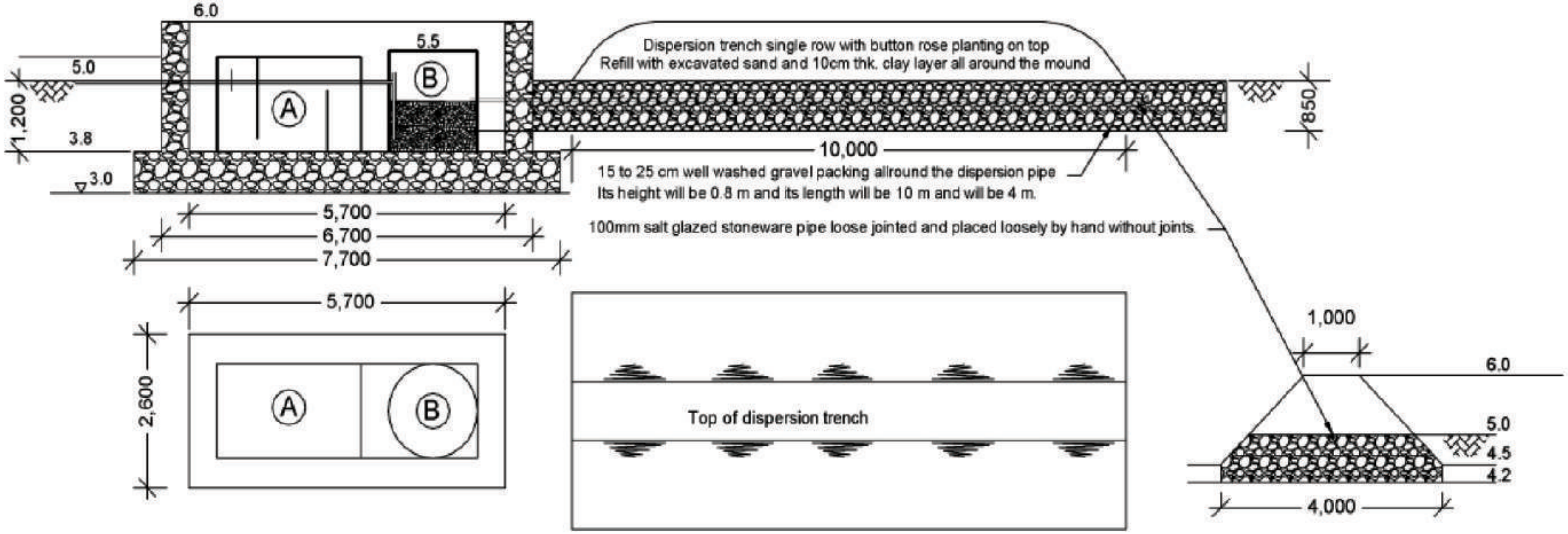


Figure 9.12 Typical septic tank up flow filter for ten persons



Location	Elevation	Location	Elevation
G.L.	5 m	Level of top of upflow filter media	4.7 m
Factory floor	5.3 m	Level of dispersion trench sewer	4.7 m
Seat of European water closet	5.7 m	Bottom level of dispersion trench	4.2 m
Level of sewer outlet	5.2 m	Top of gravel layer in dispersion trench	5.0 m
Level of sewer entering septic tank	5.0 m	Top of dispersion trench	6.0 m
Level of sewer leaving septic tank	5.0 m		

(A) Polyethlene septic tank model 5 of M/S. United sanitation devices, United building, Amala nagar, P.O., Thrissur Dt., Kerala, 680 555. Ph. 0847 - 2307791, 2308792, E-mail unitedseptictanks@gmail.com, enquiry@unitedseptictanks.com

(B) Chemical / acid storage HDPE tank model no. CCV-250-01 of M/S. Sintex of diameter 1508mm & height 1701mm with manhole diameter of 450mm from Sintex Industries Ltd, Plastic Division, 166, Anna Salai, Little Mount, Chennai-600015, Ph.: 22200302, 22200405, Fax: 044-22353225, E-mail: sintex06@dataone.in

Figure 9 .13 Septic tank - Up flow filter evapotranspiration system

The arrangement shown in Figure 9.13 is septic tank followed by up flow filter. The effluent of the up flow filter normally will discharge into nearby drains and will find its way to a public water course. However in some cases even the public drain may not be available and it becomes a challenge to dispose off the up flow filter effluent. In such a case the effluent will stagnate and will lead to propagation of flies, mosquitoes etc. leading to environmental problems. This can be avoided by a raising the elevation of the pan in the toilet so that effluent comes out of the septic tank at higher than the ground level. Further this effluent will go through the up flow filter before it finally comes out as treated effluent and this will involve additional drop of the sewage level. All these have to be considered so that the final effluent from the up flow filter will come out at least 30 to 45 cm above the ground level. At this location an elevated mound of sand can be constructed as a dispersion mound and flowering small plants can be grown for evapotranspiration. This system in Figure 9.13 is one such and meant for a factory with 25 persons working for whom the septic tank volume is 4.7 cum and is met by the above specified septic tank and the volume of up flow filter at one third volume of septic tank is also met with comfortably. The dispersion trench requirement is 13 sqm. The area provided is 28 x 0.8 = 22 sqm. The maximum uplift pressure can be as high as 5 – 3 = 2 m. This is countered by stone masonry floor of 0.8 m thickness which equates to 0.8 x 2.5 = 2 m of water column. On the same lines the top of the stone masonry side walls are increased to 6 m and thus the system is safe. The inter-space between the side wall and the filter and the septic tank will be filled with excavated sand and plastered in a chamber so that rain water flows away and does not get into the structure. The stone masonry itself will be random rubble using boulders available at site with base slab 0.8 m thick and sidewalls 0.5 m thick set in cement mortar 1.5 with only pointing. Later on, when the full-fledged sewerage system becomes functional, this on-site system can be dismantled and the entire stone masonry, septic tank, up flow filter are all reusable in other construction sites to advantage, The dispersion trench functions mainly by evapotranspiration due to the button rose plantation whose roots act like a pump is the capillary action. During times of rainfall, it will be necessary, to provide a temporary cover to prevent direct rainfall over the dispersion trench by simple arrangements like a tarpaulin sheet placed around it and stone boulders kept on the edges at GL.

9.3.6 Package Septic Tank – Anaerobic Filter Type System

The disadvantage of the septic tank is its low treatment efficiency (30-60% BOD and SS removal) and associated cost and space requirements for the construction of soak pit. Many situations such as presence of rocky ground, highly permeable soil and high groundwater table do not allow the construction of soak pits. In such cases, it is often a common practice to discharge effluent directly into an open drain causing surface water pollution. Another disadvantage of septic tank is its incapability to handle hydraulic shock loads, as peak flow disturbs the settling zone and causes high suspended solids in the effluent. One of the recommended solutions is the provision of anaerobic filter type system for the treatment of septic tank effluent (MoUD, 2008). Hence, package type septic tank- anaerobic filter system can be used to enhance the removals

Typically, this type of package on-site treatment system is made up of LLDPE (Linear Low Density Polyethylene) and can be installed easily in a very short time. It consists of two chambers, i.e., settling and anaerobic filter. The first chamber works as a septic tank, where settleable solids are settled down and further degraded anaerobically at the bottom zone.

The second chamber consists of up flow anaerobic filter, where further removal of organic matter takes place and made up of synthetic media with specific surface area of as high as 100 m^2/m^3. This provides additional surfaces for the growth of organisms that purify the sewage further. There are a couple of manufacturers in the country as also many others elsewhere, but published and documented performing data are not available. All the same, the relative performance as compared to mere septic tank alone is expected to be better. Precautions to be taken are the use of media from virgin material, their specific gravity being close to water and the percent volume of packing within the reactor so that the microbes do not overgrow, bridge up and eventually choke the entire filter. However, it should be noted that this effluent would still contain pathogens and nutrients that are capable of causing public health and environmental problems and there remains the ambiguity about the technology, its feasibility and technical robustness. Such systems can be easily modified and applied to India, where localized on-site treatment systems are most desirable. Lab scale testing has been carried out at IIT Roorkee and the test facility dimensions are shown in Figure 9-14.

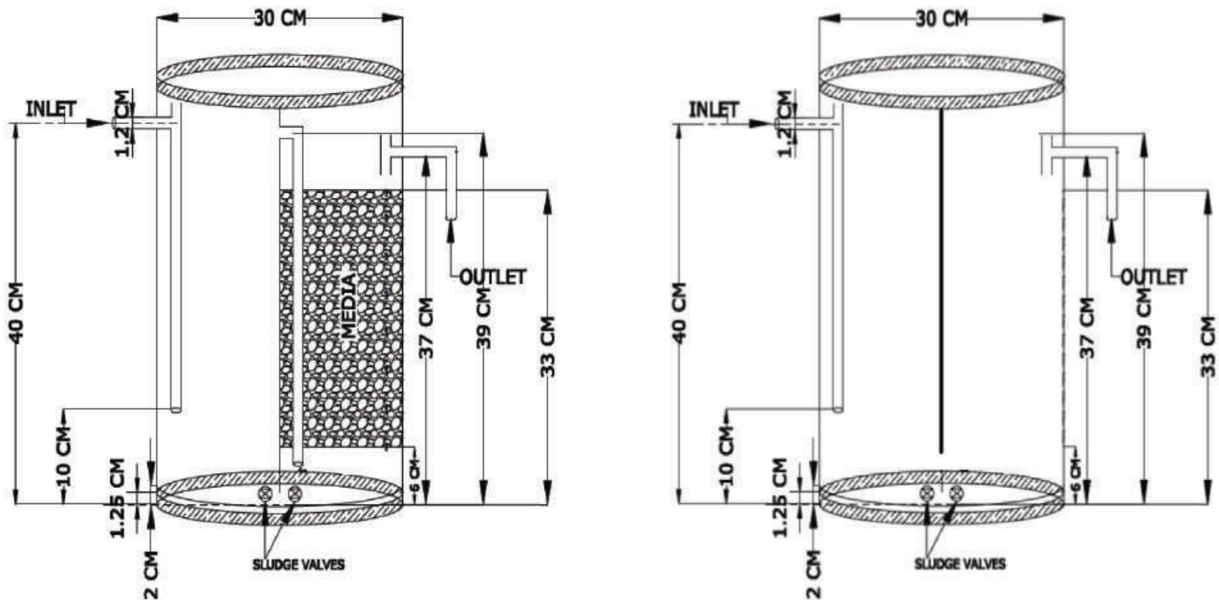


Figure 9.14 Lab Scale Facility Used for Testing the flow pattern and COD removal

The COD was in the range of 472 to 600 in raw sewage, 111 to 154 mg/l in septic tank effluent and 57 to 60 mg/l in the anaerobic filter effluent. Further studies are being pursued for pilot scale testing, followed by actual field units in a school campus and in a household and evaluate the parameters of hydraulic and organic loadings, performance results of removal of BOD, COD and coliforms and engineering modifications to bring out a design and O&M manual.

9.3.7 On-site Package Septic Tank - Contact Aeration Type System

Another improvement of the septic tank is to provide contact aeration tank after the septic tank. Hence, in package type septic tank - contact aeration system is developed in the line of well-established Japanese on-site treatment systems called Johkasou.

This type of package on-site treatment system is made up of LLDPE (Low Linear Density Polyethylene) and can be installed easily in a very short time. It consists of two chambers, i.e., settling and contact aeration with pall ring media.

The first chamber works as a septic tank, where settleable solids are settled down and further degraded anaerobically at the bottom zone. Second stage is high specific surface area (100 m^2/m^3), fixed film plastic media to retain high mass of aerobic microorganism to degrade the organic matter in the sewage aided by continuous diffusion of controlled air supply from a blower. The high specific surface area not only prevents clogging, but also provides intensive contact between the sewage and the fixed film aerobic bacteria for the fast degradation of organic matter. The treatment performance may be possible to be enhanced to 80-95% for BOD and SS removal. A possible section is illustrated in Figure 9.15.

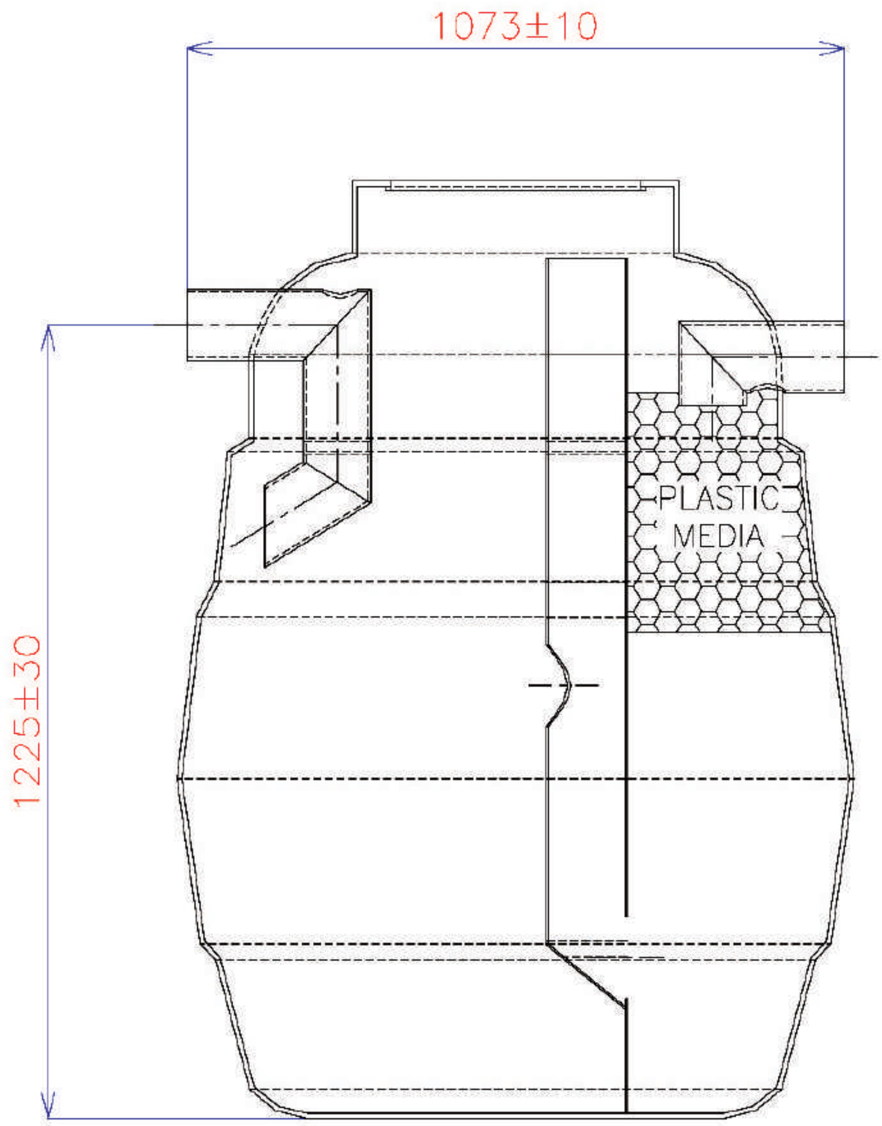


Figure 9.15 Illustrative configuration of an integral septic tank and contact aeration unit

9.3.8 Advanced Anaerobic - Aerobic Type On-site Treatment System (Johkasou)

There are various kinds of packaged treatment technologies. This subsection describes package type treatment plant, taking Japanese Johkasou as an example, and on-site construction type treatment plant.

9.3.8.1 Classification of Treatment Systems

Treatment systems are classified into various types according to capacity and performance.

i. Capacity

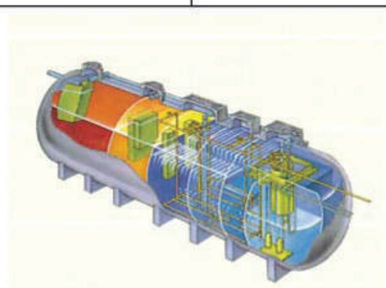
Treatment systems are classified into three types according to capacity: a small-scale unit is for several to more than a dozen people, who live in individual houses, a medium-scale system is for up to hundreds of people, who live in a condominium or small village and a large-scale system is for thousands of people in a large commercial building or factory.

Package-type is applied from small to large-scale systems. When unit is applied to large-scale, multiple tanks are connected. Package-type is made from plastics such as GFRP (Glass fibre reinforced plastics) or steel plates (that depends on the treatment method), so they can be manufactured in a factory.

The on-site construction type is made from RC and constructed on-site, so it looks nearly like a small-scale sewage treatment plant.

The classification according to the treatment capacity is mentioned in Table 9.9

Table 9.9 Classification according to treatment capacity (Example of Japan)

Package-type			On-site construction-type
Small-scale	Medium-scale	Large-scale	Medium/Large-scale
(About 5 to 50 people)	(About 51 to 500 people)	(Approx. 500 to 5,000 people)	(More than 500 people)
			

ii. Performance

Treatment processes are classified into three kinds according to performance:

1. Process that mainly removes BOD-related contaminants,
2. Process that removes BOD-related contaminants and nitrogen, and
3. Process that removes BOD-related contaminants, nitrogen, and phosphorus.

In addition, advanced treatment for better effluent quality is possible by applying membrane separator or flocculation separation or activated carbon adsorption, etc. Some package-types contain membrane separator unit in it. The classification according to the treatment performance is mentioned in Table 9.10.

Table 9.10 Classification according to treatment performance (Example of Japan)

Type	Treatment Method	Treated water quality, mg/L		
		BOD	T-N	T-P
Package type Small scale Medium scale Large-scale	BOD reduction	≤20	—	—
	Nitrogen removal	≤20	≤20	—
	Nitrogen and phosphorus removal	≤20	≤20	≤1
	Membrane separation	≤5	—	—
	Nitrogen and phosphorus removal	≤5	≤10	≤1
On-site construction Type Medium scale Large scale	Contact aeration	≤20	—	—
	Activated sludge			
	Flocculation separation (A)	≤10	—	≤1
	(A) and activated carbon absorption	≤10	—	≤1

9.3.8.2 System Configuration

A treatment system consists mainly of pre-treatment, main treatment, advanced treatment (if necessary), and disinfection processes.

i. Pre-treatment process

This process removes insoluble substances that are difficult to decompose biologically by means of sedimentation, floating, and screening. In the large-scale system, a flow equalizer is planned for stabilizing the biological treatment.

ii. Main treatment process

The main treatment process biologically removes BOD-related contaminants by aerobic treatment and removes nitrogen by combination of anoxic and aerobic treatment. The system employs a sedimentation tank for solid-liquid separation in most cases, but use of a membrane separator in place of the sedimentation tank makes it possible to downsize the system and to improve the quality of treated sewage further.

iii. Advanced treatment process (to be installed if necessary)

This process removes COD-related contaminants and phosphorus from the biologically treated sewage by means of flocculation sedimentation, sand filtration, activated carbon absorption, and dephosphorization.

iv. Disinfection process

This process disinfects E. coli and other bacteria to make effluent water safer.

9.3.8.3 Example Design in Japan

- Treatment flowchart and system configuration

Figure 9.16 shows the flowchart and configuration of a package-type treatment system based on the “anaerobic filter and contact aeration method (for BOD reduction)” as an example. This system consists of anaerobic filter, contact aeration, sedimentation, and disinfection tanks.

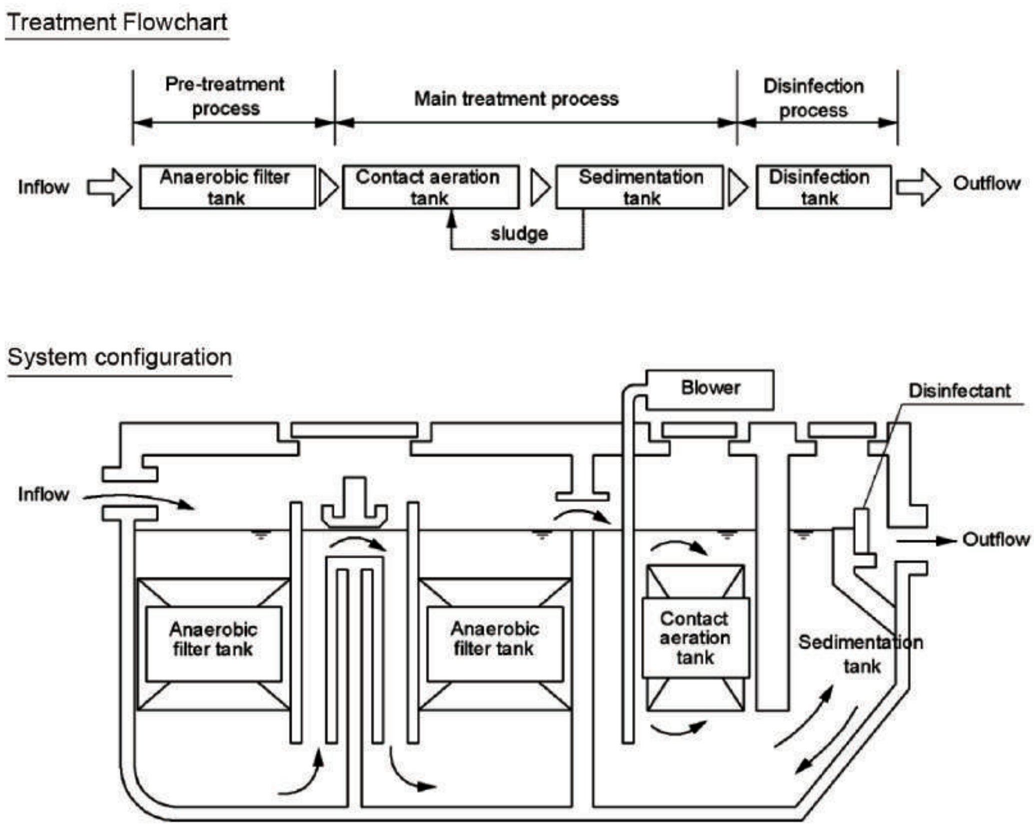


Figure 9.16 Treatment system based on the anaerobic filter and contact aeration method

- Outline of the system components

  - Anaerobic filter tank

    The main purpose of this tank is to remove solid matter that cannot be removed by biological treatment. In addition, anaerobic microorganisms adhering to the surface of the filter media submerged in this tank decompose part of BOD-related contaminants.

  - Contact aeration tank

    In this tank, the aerobic microorganisms are activated by the air supplied by blower and biodegradation takes place. That is, BOD-related contaminants are consumed and decomposed by the microorganisms. The contact media is installed in this tank and microorganisms are adhered on it to improve contact efficiency. Introduction of moving bed bioreactor (MBBR) contributes to reduce size of the package-type.

  - Sedimentation tank

    The purpose of this tank is solid-liquid separation. Supernatant and sludge contained in biologically treated sewage are separated by gravity sedimentation. Supernatant is transferred to subsequent process and the settled and separated sludge returns to the previous tank, resulting in a gradual rise in the sludge concentration of the aeration tank.

  - Disinfection unit

    This process disinfects E. coli and other bacteria contained in the supernatant from sedimentation tank to make effluent water safer. As the disinfectant, solid chlorine is used.

    - Example specifications

Table 9.11 (overleaf) shows a package-type treatment system for 10 persons.

ii. On-site construction-type

- Treatment flowchart and system configuration

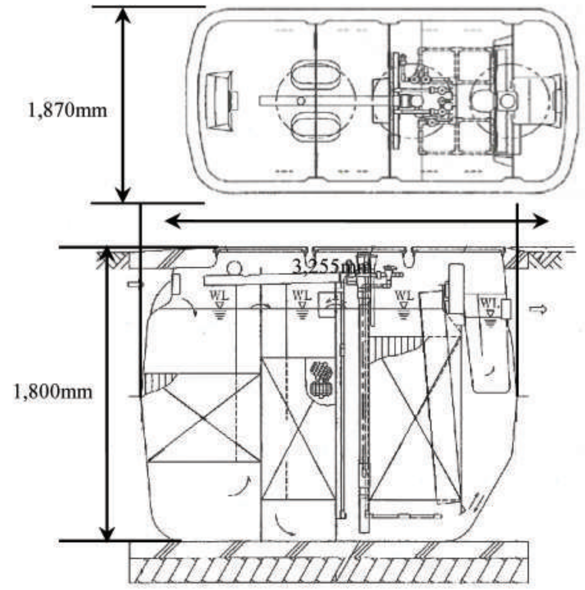
  As an example of on-site construction-type treatment systems based on “the contact aeration method and the flocculation sedimentation method,” Figure 9.17 (overleaf) shows the flowchart and configuration. This system consists of a screen, a flow equalization tank, a contact aeration tank, a flocculation sedimentation tank, a disinfection unit, and a sludge treatment unit.

- Outline of the system components

  - Screen

    The purpose of this screen is to remove foreign matter. The screen is classified into three types according to mesh size: the coarse, fine and micro screens. A combination of them is planned according to the characteristics of sewage.

Table 9.11 Example specifications for a package-type treatment system in Japan

Capacity (A)		
10 Persons (2.0 m^3/day*)		
Weight (equipment only)		
470 kg		
Main body material		
FRP		
Tank volume, Equipment capacity		
Anaerobic filter tank	No. 1: 2.13 cum No. 2: 1.414 cum	
Contact aeration tank	2.037 cum	
Sedimentation tank	0.717 cum	
Blower	120 L/min × 130 W	

(A):The daily amount of sewage per person is 200 L.

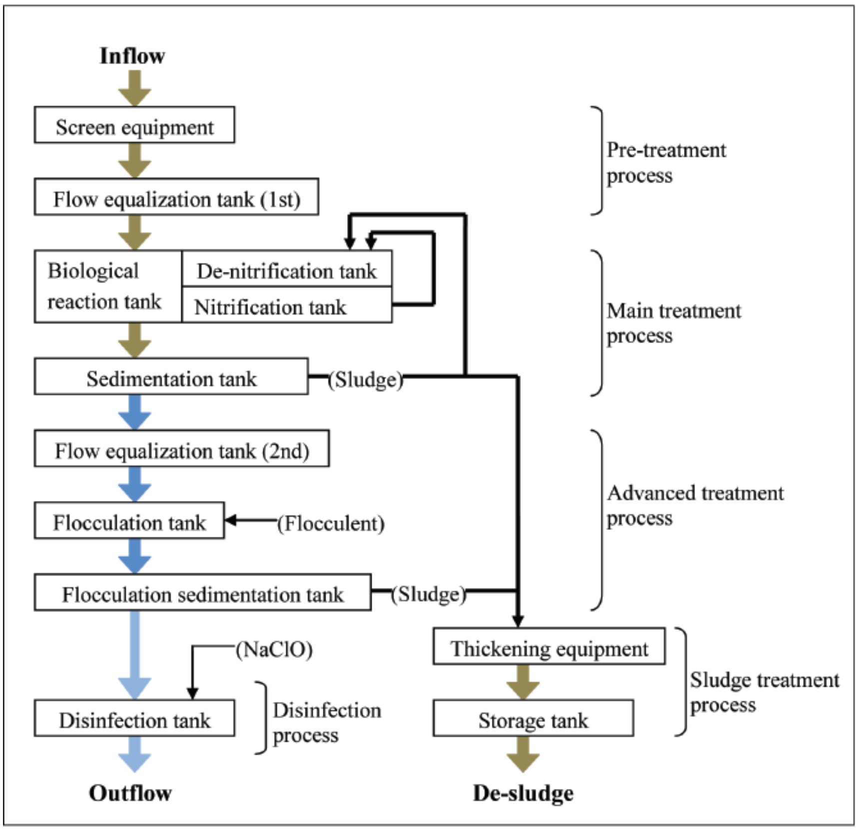


Figure 9.17 Flowchart of the contact aeration method and flocculation sedimentation method

- Flow equalization tank

  In the on-site small-scale treatment system, load changes due to rise or reduction in the flow rate of sewage and have a direct impact on the biological treatment function. This tank is installed before the biological reaction tank to have a stable load on it. The capacity of the flow equalization tank shall be specified according to changes in the flow rate of sewage.

- Contact aeration tank

  This unit consists of contact aeration and sedimentation tanks. The former is filled with a contact media to form and put biological film on the media surface and to biologically treat the sewage by letting it come into contact with the film under aerobic conditions. The contact aeration tank is equipped with an aerator that maintains the aerobic environment, and a back washing machine that removes biota generated excessively from the contact media.

- Flocculation sedimentation tank

  This tank removes COD-related contaminants and phosphorus by adding a flocculent to the sewage. The agent is classified into two types: one is an aluminium coagulant (e.g. aluminium sulphate) and the other is a ferric flocculent (e.g. polyferric sulphate). The unit consists of flow equalization, flocculation and flocculation sedimentation tanks.

- Disinfection unit

  This unit disinfects the treated effluent. Solid or liquid (sodium hypochlorite) chlorine is used as the disinfectant.

- Sludge treatment unit

  This unit receives and stores sludge generated in the biological reaction and flocculation sedimentation tanks. In certain circumstances, a sludge thickening or dehydrating unit may be planned. The stored sludge shall be regularly extracted and delivered to the outside. An example of designing an on-site construction-type sewage treatment system is shown in Appendix A.9.3.

9.3.8.4 Features

i. Advantages

- Since package-type treatment equipment can be fully manufactured in a factory, quality control of the product is easy and the price can be reduced due to a mass production effect.
- A treatment system for home use (5 to 10 persons) requires an area of 3 to 5 m^2; that is to say, it is a compact system. Moreover, when it is installed underground, the space above can be used for several purposes such as a garage.
- This system, being a product manufactured in a factory, does not require complicated work on site during installation, so the installation time is short (about one week). Accordingly, it can improve environmental sanitation quickly.

- The treatment system requires running costs, such as electric charges and chemical expenses, and the treated water is comparable to that of conventional treatment system. In addition, planning advanced treatment can result cleaner effluent and remove nitrogen and phosphorus.

- Where membrane separator is applied, BOD contained in the effluent is reduced to less than 5 mg/l, and the treated effluent can be reused for various purposes.

- The treatment system can be constructed more cost-effectively and faster, because sewer is shorter compared with conventional system, especially in areas with low-medium population density, areas that have not been covered by sewer and individual houses or buildings.

ii. Notes on application

Keeping the performance of a treatment system high requires proper maintenance, which varies depending on the scale and treatment method of the system. Common works to achieve this are listed below. Each work requires expertise, so it is necessary to build up an implementation system, to train inspectors (vendors), and to educate users to increase their awareness of the importance of maintenance. For more information about the maintenance of treatment systems, see Part B Operation and Maintenance.

- Maintenance and inspection

  Inspecting mechanical components including the blower, replenishing tanks with chemicals including disinfectants, etc.

- Water quality check

  Checking the aeration tank for DO testing the quality of the discharged water, etc.

- Cleaning

  Removing foreign matter from the screen and extracting generated sludge.

9.4 DECISION MAKING FOR ON-SITE TREATMENT TECHNOLOGY

9.4.1 General

Employing on-site sewage treatment technology requires an in-depth survey of requirements of the installation site, such as the volume and quality of treated sewage, the selection of a method based on the resulting data and the determination of the scale. After the determination of the basically required performance and scale, the treatment method shall be chosen in consideration of the following requirements:

i) The method shall be as simple as possible.

ii) The maintenance shall be easy.

iii) The construction and maintenance costs shall be low.

iv) The method shall contribute to environmental preservation and water quality improvement.

v) The quality characteristics of incoming sewage shall be understood.

vi) Changes in the quality and rate of incoming sewage shall be taken into consideration.

Any sewage treatment system is required to be made available always and display its function and performance, but the installer may have little knowledge about it. The selection of an appropriate treatment method requires consideration of preserving the water quality environment in receiving water bodies and fund necessary for construction and maintenance.

9.4.2 Problems with Existing On-site System

9.4.2.1 Natural Characteristics

A natural condition requiring caution is weather, such as temperature changes and precipitation. In addition, it is necessary to investigate geographical features and groundwater levels.

The effect of temperature on the sewage treatment function varies depending on the type of treatment facilities, the degree of load, and the kinds of contaminants to be removed. A combination of nitrification and denitrification is susceptible to temperature changes; the reaction rate at 23ºC is 2 to 2.5 times that at 13ºC, the higher the water temperature, the higher the reaction rate. Accordingly, if this technology is applied to cold areas, it is effective to set up BOD and nitrogen loads lower than the design values.

Precipitation is one of the local characteristics. Mixing a large amount of rainwater with sewage reduces the treatment function. Particularly in a housing estate where sewage is collected and treated, it is necessary to employ an advanced construction technology in consideration of the effect of the amount of rainwater.

9.4.2.2 Social Requirements

If the treated sewage receiving water body is a source of drinking water, it is essential to employ a treatment method that can remove nitrogen and phosphorus and faecal coliforms to preserve the water source. In addition, the features of site where a sewage treatment tank is installed shall be taken into consideration. For example, a region with low population density can provide a relatively extensive site, which makes it possible to employ a treatment method featuring easy maintenance, while an urban area is obliged to use a compact treatment method. In addition, the latter case has the risk of troubling the neighbouring people with noise and offensive odour generated by the sewage treatment system.

Accordingly, it is essential to select a treatment method that does not cause such problems or to take measures to mitigate them.

The extent of maintaining a sewage treatment system has an effect on the treatment function and performance. Therefore, a small-scale system shall employ a method featuring as easy maintenance as possible. In addition, it is necessary to select an installation site in consideration of the smooth extraction, transportation, and treatment of sludge.

9.4.3 Elements of Successful Programme

Planning an on-site system and making it successful require the following decision-making processes (Stages 1 to 5).

Stage 1: Outline survey of settlements and services

The objective of the first stage is to gather information about the coverage and quality of existing services to clarify the key problems to be addressed and priority locations for improvement.

This investigation might be done citywide or within areas of the town that have already been earmarked for attention. The information can be obtained from (a) maps and other secondary sources; (b) from a rapid physical inspection on the ground; and (c) from informal discussion with residents.

This preparatory work does not involve systematic user consultation, which follows in Stage 2.The output includes one or more maps that show the existing sanitation infrastructure and services, and highlights areas where sanitation problems are most acute.

Stage 2: The Need for assessment and consultation

Stage 2 entails a more detailed analysis of the current situation to reveal what types of improvements are needed and where they will have the most beneficial impact. It involves further technical investigations in priority areas identified from Stage 1, plus an assessment of existing services from the users' point of view.

This should provide a fuller understanding of why existing services have failed or are otherwise inadequate. This is also an opportunity to find out what type of improvements users want and would be willing to pay for, or at least contribute towards.

Stage 3: Identification of appropriate technologies

The objective of this stage is to eliminate technologies that are unlikely to be viable from a technical perspective and thus, narrow the field of options. The key question for each option at this stage is: 'Can it work?' A variety of additional factors (some of them financial and managerial) affect whether an option would in fact be viable and these are considered in Stage 4.

Stage 4: Development of cost options

Stage 3 identified technology options that are viable from a technical perspective. In order that technology choices can be made, this stage estimates the capital and operating costs associated with each option over its anticipated lifetime, and considers how the new services could be operated and maintained. This should confirm whether the technologies are viable in terms of the human and financial resources available locally.

For those that are viable, cost packages can be presented to the community in Stage 5 and agreement reached on the final choice.

Stage 5: Reaching consensus on preferred options

In the final stage, the options developed in Stage 4 can be presented back to the community. For each package, the technical, managerial and financial implications - including proposed operation and maintenance arrangements - need to be explained clearly. This should enable residents to engage in an informed discussion with municipal representatives resulting, hopefully, in consensus on the way forward.

The following shows preconditions important for a successful on-site system:

- Establish and enforce clear and effective policy frameworks
    - Update and enforce septic tank design codes
    - Mandate scheduled desludging
- Strengthen institutional and implementation capacity
    - Develop comprehensive awareness programmes, especially targeting septic tank users
    - Develop mechanisms for inter-agency coordination and dialogue
    - Develop comprehensive capacity building programmes that engage educational institutions
    - Apply economies of scale in deploying septage services
    - Leverage real estate development to build sewerage infrastructure
    - Engage private service providers
- Increase funding for septage management
    - Strengthen National financial support for septage management
    - Promote creative financing
    - Design innovative sewerage tariff structures
    - Develop progressive fee structures in line with willingness to pay
    - Create opportunities and incentives for commercial activities

9.4.4 Transport and Fate of Sludge

Sludge resulting from on-site treatment shall be treated and disposed of in consideration of its impact on the surrounding environment. The following shows precautions for this work:

- Sludge shall not pollute the environment
- Sludge shall not produce any diseases and pests
- Sludge shall not be disposed off illegally
- Sludge shall be reused as effectively as possible.

In any case, it is recommended to effectively change the septage and sludge to compost for agricultural use or to soil conditioners in its final disposition. The septage shall be disposed as per the advisory note issued by the MoUD, http://urbanindia.nic.in/programme/uwss/Advisory_SMUI.pdf

9.5 DEALING WITH SEPTAGE

The effluent from the septic tank can be collected in a network of drains and/or sewers and treated in a treatment plant designed appropriately on the lines discussed in Chapter 5. The accumulating sludge at the bottom of the septic tank however, has to be also removed and treated once it has reached the designed depth or at the end of the designed desludging period whichever occurs earlier. Such a removal is possible only by trucks. While sucking out the sludge, the liquid in the septic tank will also be sucked out. Such a mixture is referred to as septage. Obviously, the removal of septage from a household septic tank will occur approximately once in two or three years only.

9.5.1 Characterisation of Septage

9.5.1.1 Septic Tanks used only for Water Closets

In general, the septic tank is intended to be used only for the water closet and hence, the night soil alone is the causative factor for the organic load. Thus, as far as the BOD is concerned, the per capita contribution of night soil and the volume of ablution water and its frequency per day are relevant. The urine is the factor for the nitrogen content. The septic tank system reported in the twin drain system has recorded a range of characteristics of BOD, COD and SS as in Table 9.12 and in Table 8.1.

Table 9.12 Range values of BOD, COD and SS at inlet to septic tank in India

No.	Indicator	BOD, mg/L	COD, mg/L	SS, mg/L
1	Mean	1,290	2,570	4,140
2	Standard Deviation	143	290	542
3	Range	970 to 1,550	1,920 to 3,050	2,550 to 4,860

The average amount of ablution water used at this location was about 6 litres per use. The BOD from defecation is about 8 grams/day. This corresponds to the BOD value in the above table. This value of BOD can however vary drastically based on the volume of ablution water and the number of times per day though the usage rarely exceeds one usage per day. It stands to reason to infer that the BOD of septage is relatable to the liquid portion and the suspended matter and the rates at which these have undergone some degradation by anaerobiasis in the tank and the accumulation especially in the sludge zone. All these are highly variable and as such a theoretical basis for arriving at the characteristics of septage is fraught with uncertainty. In respect of the literature values reported from advanced countries in the west, the personal habits of ablution water vs. toilet paper is a crucial influencing factor defying the flat out adoption of the characteristics reported from those locations.

9.5.1.2 Septic Tanks used for all Domestic Sewage

The per capita BOD being 36 g per day and a water usage at about 100 lpcd will imply a BOD of 360 mg/l though it will be higher if the lpcd goes down.

9.5.1.3 Septic Tanks used for Sewage from Water Closets and Bathing

The US EPA "Handbook on Septage Treatment and Disposal - 62568409" identifies Septage as arising from water closets and bath tubs. This is understandably off the mark for the average Indian conditions where the bath tub is first of all a non-entity in the household except in high profile urban living, where incidentally the conventional sewage prima facie eliminates the septage issue.

9.5.1.4 Values Reported from Elsewhere

Given the above understanding of the overall scenario, it stands to reason not to be guided by the characterization data from western countries in the bath tub usage category. A value reported is "BOD concentrations between 2,000 and 20,000 mg/l and TSS values in excess of 50,000 mg/l, where septic tank effluent has values averaging 200 mg/l BOD and 300 mg/l TSS" (Septage Management Guide for Local Governments-David M Robbins). The US EPA in "Handbook on Septage Treatment and Disposal - 62568409" has reported the organic and heavy metals in septage as in Table 9-13 and Table 9-14 (overleaf). The characteristics of Septage reported from the city of Surabaya, Indonesia are BOD of 8,250 mg/l, COD of 17,250 mg/l, and TSS of 2,000 mg/l.

9.5.1.5 Values to be considered for Indian Conditions

Given the above wide variations in literature values and the various influencing factors, it becomes risky to hazard a guess on advocating a set of characteristics for septage in Indian conditions. However, in order to bring about an example of treatment of septage, the values in Table 9-15 (overleaf) are proposed to be advocated purely for illustration and it should be mandatory to carry out local sampling and analysis before designing the treatment and disposal system.

9.6 LOGISTICS OF SEPTAGE COLLECTION

Basically the septage collected should be treated as it cannot be let into the environment directly because of the characteristics in Table 9-15. Because of this, a treatment facility shall be set up or the septage added to an existing septage treatment facility. This implies a near uniform loading all the year round instead of peaking the discharge at certain days alone. This in turn demands the planned septage collection logistics round the year by the septage trucks. Hence the establishment of a septage collection unit becomes an adjunct to the decentralized sewerage system where septic tanks are the primary treatment at households.

9.7 SEPTAGE TREATMENT FACILITY

Sludge generated in an on-site treatment facility is regularly extracted and hygienically treated. The sludge treatment method includes (1) delivery to a sewage treatment facility and treatment with sludge generated in the sewage treatment process, (2) treatment in a special sludge treatment facility, (3) solar drying on a floor, and (4) treatment by a mobile dehydrating truck. This section describes the first and second method.

9.8 TREATMENT OF SEPTAGE IN EXISTING STP

This can be brought about in (a) existing STPs depending on the concentrations of BOD, flows and spare capacity available in them and (b) separate dedicated treatment facility for septage.

Table 9.13 Septage characteristics as per US EPA

Parameter	United States				Europe/Canada				EPA Mean	Suggested Design Value
	Average	Minimum	Maximum	Variance	Average	Minimum	Maximum	Variance		
TS	34,106	1,132	130,475	115	33,800	200	123,860	619	38,800	40,000
TVS	23,100	353	71,402	202	31,600	160	67,570	422	25,260	25,000
TSS	12,862	310	93,378	301	45,000	5,000	70,920	14	13,000	15,000
VSS	9,027	95	51,500	542	29,900	4,000	52,370	13	8,720	10,000
BOD_5	6,480	440	78,600	179	8,343	700	25,000	36	5,000	7,000
COD	31,900	1,500	703,000	469	28,975	1,300	114,870	88	42,850	15,000
TKN	588	66	1,060	16	1,067	150	2,570	17	677	700
NH_3-N	97	3	116	39	-	-	-	-	157	150
Total P	210	20	760	38	155	20	636	32	253	250
Alkalinity	970	522	4,190	8	-	-	-	-	-	1,000
Grease	5,600	208	23,368	112	-	-	-	-	9,090	8,000
pH	-	1.5	12.6	8	-	5.2	9.0		6.9	6.0
LAS	-	110	200	2	-	-	-		157	150

Note:

i) Values expressed as mg/L, except for pH.

ii) The data presented in this Table were compiled from many sources. The inconsistency of individual data sets results in some skewing of the data and discrepancies when individual parameters are compared. This is taken into account in offering suggested design values.

Source: USEPA

Table 9.14 Heavy metals in septage as per US EPA

Parameter	United States			Europe/Canada			Typical US Domestic Sludge Ranges	EPA Mean	Suggested Design Value for Septage
	Average	Minimum	Maximum	Average	Minimum	Maximum			
Al	48.00	2.00	200.0	-	-	-	-	48.00	50.00
As	0.16	0.03	0.5	-	-	-	0-0.7	0.16	0.20
Cd	0.27	0.03	10.8	0.05	-	0.35	0.1-44	0.71	0.70
Cr	0.92	0.60	2.2	0.63	-	5.00	0.9-1,200	1.10	1.00
Cu	8.27	0.30	34.0	4.65	1.25	15.00	3.4-416	6.40	8.00
Fe	191.00	3.00	750.0	-	-	-	-	200.00	200.00
Hg	0.23	0.0002	4.0	-	0.15	0.20	0-2.2	0.28	0.25
Mn	3.97	0.20	32.0	-	-	-	-	5.00	5.00
Ni	0.75	0.20	37.0	0.58	-	2.50	0.5-112	0.90	1.00
Pb	5.20	2.00	8.4	3.88	-	21.25	3.2-1,040	8.40	10.00
Se	0.076	0.02	0.3	-	-	-	-	0.10	0.10
Zn	27.4	2.90	153.0	38.85	1.25	90.00	79-655	49.00	40.00

Note:

i) Values expressed as mg/L.

ii) Values converted from µg/g assuming TS=40,000 mg/L.

Source: USEPA

Table 9.15 Illustrative characteristics of septage for Indian Conditions

No.	Source	Type A	Type B
		Public toilet or bucket latrine sludge	Septage
	Characteristics	Highly concentrated, mostly fresh Faecal Sludge; stored for days or weeks only	Faecal Sludge of low concentration; usually stored for several years; more stabilized than Type "A"
1	COD (mg/L)	20-50,000	<15,000
2	COD/BOD	5:1 to 10:1	5:1 to 10:1
3	NH_4-N (mg/l)	2-5,000	<1,000
4	TS (%)	≥ 3.5 %	< 3 %
5	SS (mg/l)	≥30,000	7,000 (approx.)
6	Helminth Eggs	20-60,000	4,000 (approx.)

9.8.1 Pre-Treatment of Septage

This is needed to (a) ensure a flow equalization tank for the septage flow so that it can be loaded onto the STP at as much uniform flow as possible through the 24 hours, (b) a degritting facility to segregate the grit content and prevent it from getting into aeration units and pumps etc. and (c) separate the liquid stream and sludge stream.

The equalization tank may be a relatively deeper tank equipped with sub surface mixers to maintain the contents in suspension. The surface aerators and diffused aeration will create odour problems.

The degritting facility is best designed as a vortex separator similar to the one described in Chapter 5. The sludge-liquid separation facility can be a filter press or belt press or screw press or centrifuges depending on the feed solids concentration being within the capacity of these equipment. Their designs will be the same as in Chapters 5 and 6.

The pumps however, can be submersible pump sets with open impellers. A typical receiving station facility is shown in Figure 9.18 (overleaf)

9.8.1.1 Co-treatment in Existing STPs-Liquid Stream

The basic consideration is the spare capacity at the existing STP. Normally, the septage volumes are not unduly significant in relation to the full-fledged STP volumes and would seldom exceed about say 5% and this way, even if the STP is functioning at design capacity, volume wise, it will not be a problem to add even up to 5% of flows. But it is the BOD load that comes in the way.

Considering a typical STP with about 300 mg/l of raw BOD and a septage volume of about 3% with a BOD of say 4,000 mg/l, this would result in a situation mentioned overleaf.

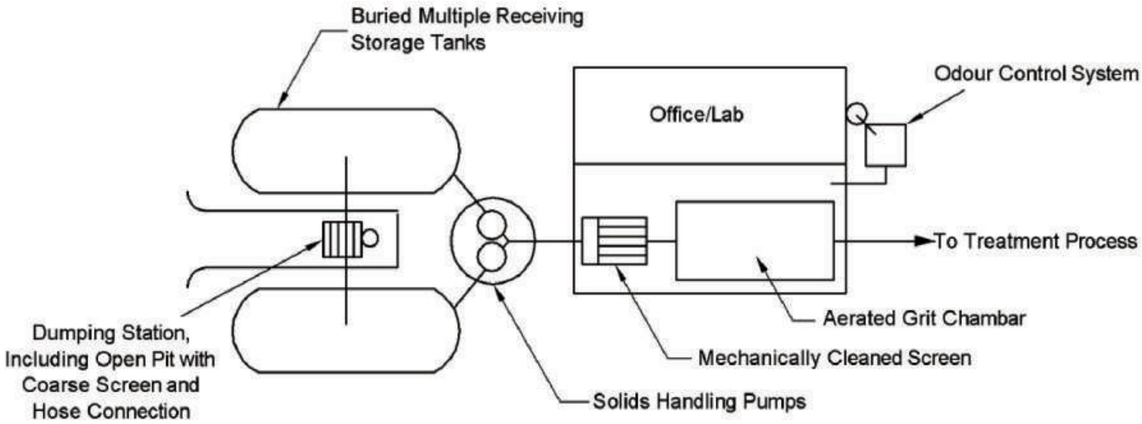


Figure 9.18 Typical septage receiving facility

Design capacity of the STP	= 1 mld
Actual operating capacity	= 0.65 mld
BOD load in to the STP	= 0.65 mld × 300 mg/l = 195 kg/day
BOD load from septage	= 0.03 mld × 4,000 mg/l = 120 kg/day
Total resulting BOD load	= 195 + 120 = 315 kg/day
Designed ability of the STP for BOD load	= 1 × 300 = 300 kg/day

Thus, it may be possible to accommodate the septage as long as the actual flow to STP does not increase. But then, over a period of time both the sewage volume and septage will increase and hence, it is not easy to use this option as a permanent measure. At the same time, if the spare capacity is available, then it is wiser to opt for this instead of rushing into a dedicated septage treatment facility. Yet another option will be to augment or upgrade the STP capacity, which is by far simpler and so far as the liquid stream is concerned.

9.8.1.2 Co-treatment in Existing STPs-Sludge Stream

The computations similar to that in respect of liquid stream shall be evaluated to verify whether the sludge treatment facilities of the existing STP can handle the extra sludge from the septage. Most often, this may be possible. In case it is not possible, add on sludge treatment standalone facilities shall be designed and constructed instead of trying to invasive augmentations of existing facilities.

9.8.1.3 Points of Addition of the Liquid and Sludge Streams

The points of addition of liquid and sludge streams provided spare capacities are available are suggested in Figure 9.19 (overleaf)

9.9 TREATMENT OF SEPTAGE AT INDEPENDENT SeTP

When the distance or the capacity of the plant becomes a limiting factor, it is not a feasible option to transport and treat the septage to the sewage treatment facilities.

In this case treatment plants specially meant for septage treatment becomes an attractive option. Independent septage treatment plants are designed specifically for septage treatment and usually have separate unit processes to handle both the liquid and solid portions of septage.

These facilities include mechanical dewatering, sludge drying beds, Waste stabilization ponds, etc. The benefit of using these treatment plants is that they provide a regional solution to septage management. Many septage treatment plants use lime to provide both conditioning and stabilization before the septage is dewatered. Dewatered sludge can be used as organic fertilizer after drying and composting. The remaining effluent/filtrate/supernatant can be released to another treatment process such as WSP, Anaerobic baffled reactor, constructed wetland or combination of these of extended aeration activated sludge where it can undergo further treatment and then finally can be safely discharged.

Choosing an appropriate septage management method relies not only on technical aspect but also on regulatory requirements. The management option selected should be in conformity with local, State and Central regulations. Some of the factors that determine the process of selection include: land availability and site conditions, buffer zone requirements, hauling distance, fuel costs, labour costs, disposal costs and other legal and regulatory requirements.

The technical options could be as follows:

Case 1: Land Area is not limited but Funds are Limited

Option - 1

Pretreatment - Anaerobic Digesters - Dewatered and Dried Sludge - Composting - Reuse as Organic Fertilizer; Filtrate of Sludge Drying Bed and Digester supernatant - Pumping - Reed beds (or) Constructed wetlands - Electricity generation from digester gas. Totally nature based system with mechanical equipment as needed.

Constructed wetlands are essentially on-site technologies involving sequential treatment of sewage on-site, in selective filter media and finally greenbelt development and have been developed by IIT Powai and called Soil Bio Technology and also NEERI and called as Phytorid.

A septage treatment facility handling nearly 51 MLD at Nonthaburi in Thailand is widely reported in literature. The treatment process is shown in Figure 9.20.

It is reported that the treatment is anaerobic digestion and the digested sludge is sent to drying beds. The filtrate is dewatered in sand beds and is sent to ponds and the pond effluent is used on public parks. The use of constructed wetlands has also been reported with solids loading rate of 250 kg/m^2/year, once a week application and percolate impounding for 6 days and harvesting twice a year with COD removal efficiency of 80 to 90%, and solids accumulation at 12 cm/year in the impoundment.

A photo view is presented in Figure 9.21.

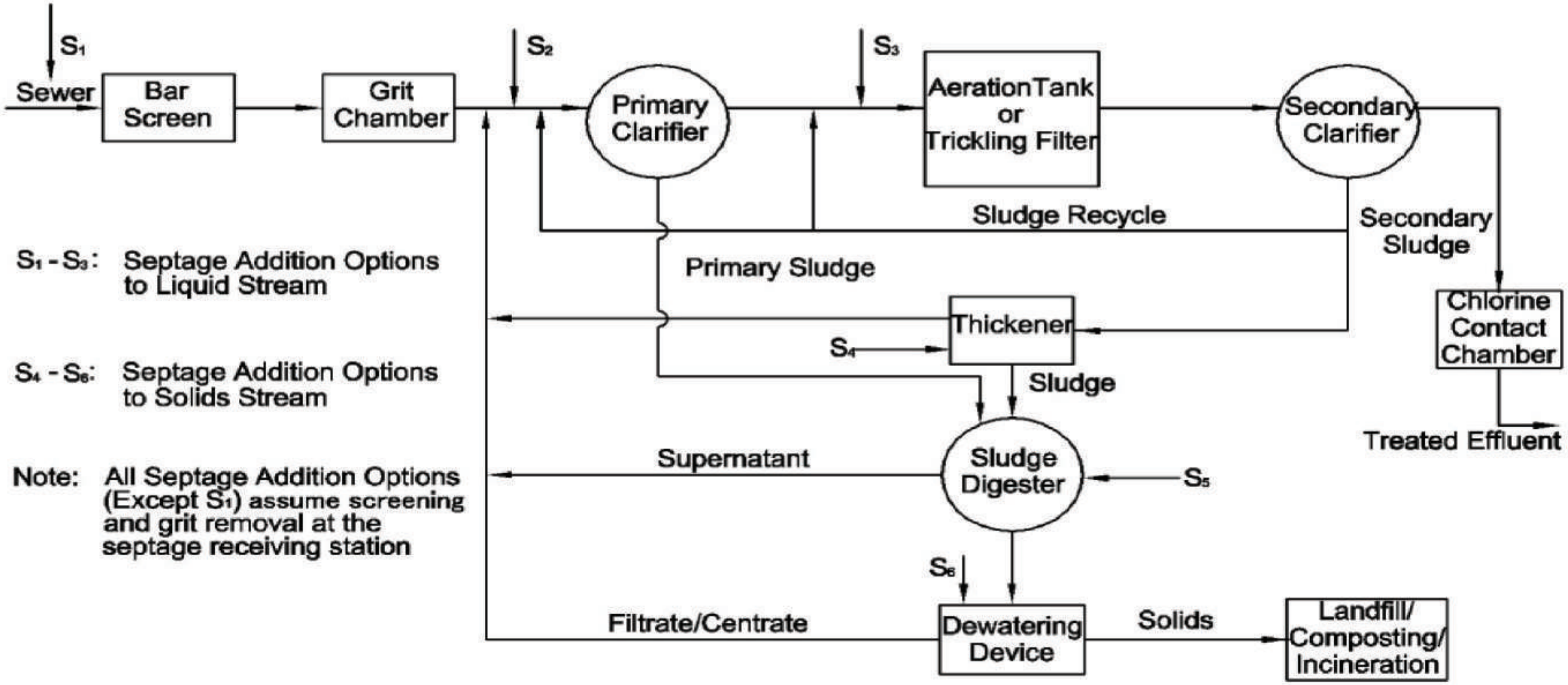
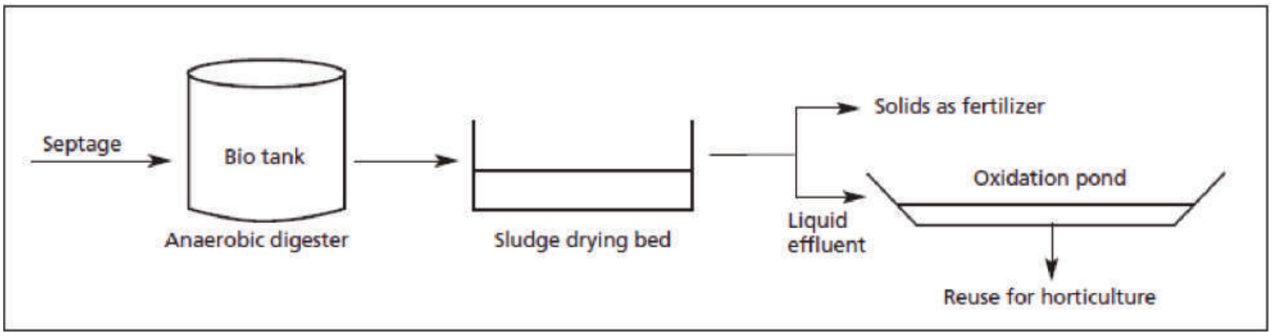


Figure 9.19 Points of likely addition of liquid and solids from septage on to existing STPs



Source:USAID, 2010

Figure 9.20 Septage treatment process at Nonthaburi, Thailand

The Nonthaburi Municipality's septage treatment facility has 30 anaerobic digestion tanks and is one of the best run facilities of its kind in Thailand. As part of a pilot project to improve septage treatment in Lampang, the Asian Institute of Technology partnered with Lampang Municipality to build a treatment facility that uses a grid of reed beds to treat septage leachate to secondary levels.

Source:USAID, 2010

Figure 9.21 A photo view of septage treatment process at Nonthaburi in Thailand

Option - 2

Pretreatment - lime stabilization (optional) - Pumping - Sludge Drying beds (FRP covered in regions of high rainfall) - Dewatered & Dried Sludge - Composting - Reuse as Organic Fertilizer; Filtrate of Sludge Drying Bed - Pumping - Anaerobic Baffled Reactor / Covered Anaerobic Ponds - Facultative - Aerobic / Maturation Ponds - chlorination - discharge'

Case 2: Land Area is Limited and Funds are also Limited.

Option - 1

Pretreatment - lime stabilization (optional) - Pumping - Mechanical Sludge dewatering system - Dewatered sludge - Solar drying or/and Composting - Reuse as Organic Fertilizer; Filtrate of Mechanical Dewatering Machine - Pumping - Anaerobic Baffled Reactor / Covered Anaerobic Ponds - Facultative - Aerobic / Maturation Ponds - chlorination - discharge. There should be 25% additional capacity of sludge drying beds in case of maintenance of dewatering machine and or unavailability of polyelectrolyte.

Option - 2

Pre-treatment - lime stabilization (optional) - Pumping - Sludge drying beds (FRP covered in regions of high rainfall) - Dewatered & Dried Sludge - Composting - Reuse as Organic Fertilizer; Filtrate of Sludge / septage Drying Bed - Pumping - Extended Aeration - Activated Sludge Process (Continuous or Batch) - chlorination - discharge

Case 3. Land Area is Limited and Funds are not limited

Pretreatment - lime stabilization (optional) - Pumping - Mechanical Sludge dewatering system - Dewatered sludge - Solar drying or/and Composting - Reuse as Organic Fertilizer; Filtrate of Mechanical dewatering machines - Pumping - Extended Aeration Activated Sludge Process (Continuous or Batch) - chlorination - discharge. There should be 25% addition capacity of sludge drying beds in case of maintenance of dewatering machine and or unavailability of polyelectrolyte.

9.9.1 Pre-Treatment of Septage

The pre-treatment facilities discussed earlier are the same in this case also (Figure 9-18).

In addition, if possible there should be lime stabilization facility to control odour, vector and pathogen destruction. Lime stabilization involves adding and thoroughly mixing lime (alkali) with each load of septage to ensure that the pH is raised to at least 12 for at least 30 minutes.

Lime addition could be done at any of these three points:

i) To the hauler truck before the septage is pumped,

ii) To the hauler truck while the septage is being pumped, or

iii) To a septage storage tank where septage is discharged from a pumper truck is shown in Figure 9.22 (overleaf)

9.9.2 Septage Dewatering

The septage after lime dosing is pumped to screw press or any other mechanical dewatering machine. Polyelectrolyte is added to increase the dewatering efficiency of the machine.

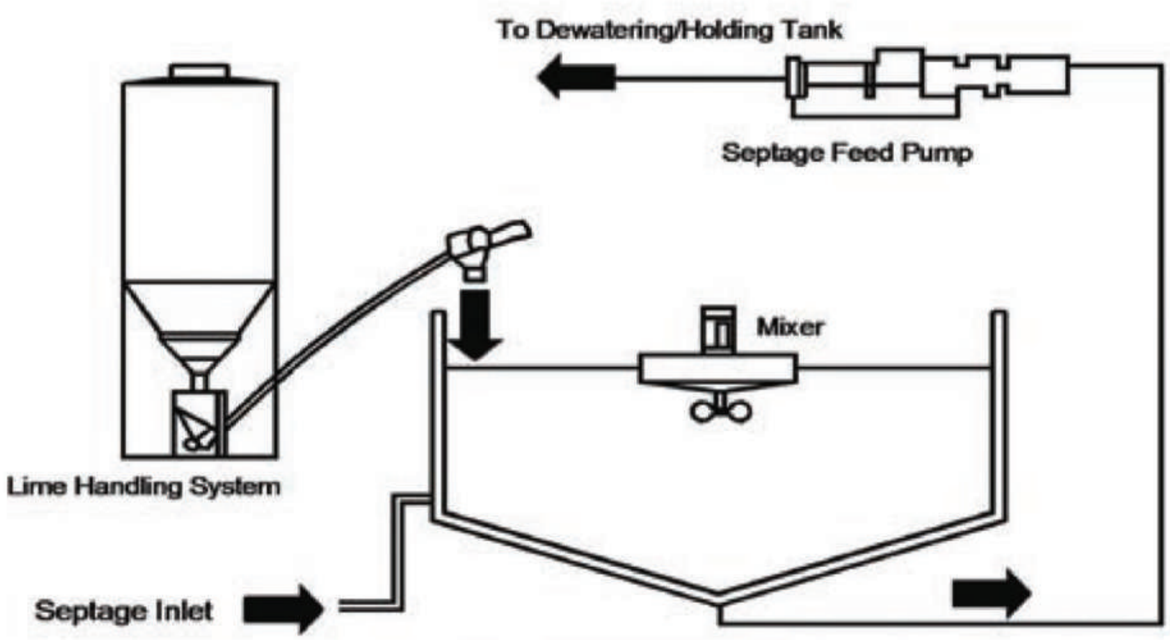
The liquid residual / pressate / filtrate / supernatant from dewatering machine can be discharged for further biological treatment. The dewatered sludge can be send for further drying or composting prior to reuse as organic fertilizer. The typical mechanical septage dewatering system is shown in Figure 9.23 (overleaf)

Instead of Screw Press the options can be:

i) Centrifuge

ii) Belt Press

iii) Filter Press



Supernatant to pH neutralization and dedicated STP

Underflow to mechanical dewatering with polyelectrolyte

Figure 9.22 Lime stabilization of septage

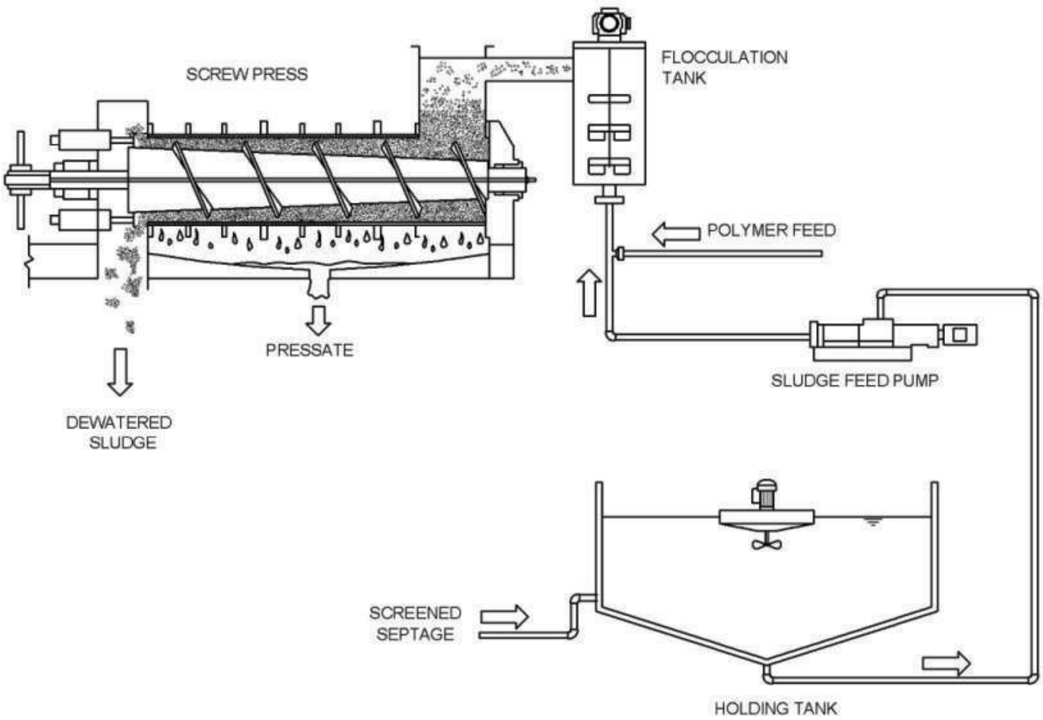


Figure 9.23 Typical Mechanical Septage Dewatering System

9.10 ADVANTAGES AND DISADVANTAGES OF THE SYSTEMS

Advantages and disadvantages of septage treatment at STPs and at independent septage treatment facility are given in Table 9.16 and Table 9.17, respectively.

Table 9-16 Advantages and disadvantages of septage treatment at sewage treatment plant

Method	Description	Advantages	Disadvantages
Treatment at STPs or Independent septage treatment facility in the vicinity of STPs	Septage is added to the pumping station, upstream manhole or sludge treatment process for co-treatment with sewage sludge. Septage volumes that can be accommodated depend on plant capacity and types of unit processes employed.	Most STPs in India are underutilized and are capable to handle some septage. As skilled personnel and laboratory facilities are available in STPs, easy to operate and maintain.	Potential for STP upset if plants are running at full capacity. Increased sludge treatment cost.

Table 9.17 Advantages and disadvantages of independent septage treatment facility

Method	Description	Advantages	Disadvantages
Treatment at independent septage treatment plants	A facility is constructed solely for the treatment of septage. Treatment generates residuals, i.e., dewatered sludge and filtrate which must be dried composted (dewatered sludge) and properly treated (filtrate) prior to being disposed off.	Provides regional solutions to the septage management.	High capital and operation and maintenance cost. Requires high skills of operation in case of mechanical dewatering.

9.11 COMPOSTING OF DEWATERED SEPTAGE OR SLUDGE

Another feasible option is composting where bulking agents are easily available. The humus is produced after composting that can be used as a soil conditioner. Composting is the stabilization of organic waste through aerobic biological decomposition. As described in more detail in Chapter 6, the process can be accomplished in various configurations. The different types of composting include two open-area methods: windrow and static pile composting and in-vessel mechanical composting. Operational parameters for septage composting are presented in Table 9-18 (overleaf) Compost products can be sold or given away.

Table 9.18 Operational parameters for dewatered septage composting

Parameter	Optimum range	Control mechanisms
Moisture content of compost mixture	40-60%	Dewatering of septage to 10 to 20% solids followed by addition of bulking material (amendments such as sawdust and woodchips), 3:1 by volume amendment: dewatered septage.
Oxygen	5-15%	Periodic turning (windrow), forced aeration (static pile), mechanical agitation with compressed air (mechanical).
Temperature (compost must reach)	55-65ºC	Natural result of biological activity in piles. Too much aeration will reduce temperature.
pH	5-8	Septage is generally within this pH range, adjustments not normally necessary.
Carbon/nitrogen ratio	20:1 to 30:1	Addition of bulking material.

9.12 DEWATERED SEPTAGE SLUDGE REUSE

For dewatered septage/sludge agriculture application, it should satisfy the following criteria of Class A Biosolids of US EPA either by lime stabilization, solar drying and or composting.

- A faecal coliform density of less than 1,000 MPN/g total dry solids
- Salmonella sp. density of less than 3 MPN per 4 g of total dry solids (3 MPN/4 g TS)

Properly treated sludge can be reused to reclaim parched land by application as soil conditioner, and as a fertilizer in agriculture. Deteriorated land areas, which cannot support the plant vegetation due to lack of nutrients, soil organic matter, low pH and low water holding capacity, can be reclaimed and improved by the application of sludge.

Septage sludge has a pH buffering capacity resulting from lime addition that is beneficial in the reclamation of acidic sites, like acid mine spoils, and acidic coal refuse materials.

Sludge with a solid content of 30% or more handled with conventional end-loading equipment, and applied with agricultural manure spreaders. Liquid sludge, typically with solid content less than 6% managed and handled by normal hydraulic equipment.

Agricultural use of sludge matches best with priorities in waste management. Sewage sludge contains nutrients in considerable amounts, which can be used as discussed in Chapter 6 of the part A manual.

CHAPTER 10: PREPARATION OF CITY SANITATION PLAN

10.1 THE PLANNING PROCESS

Planning is a thinking process. In sewerage and sewage treatment, it aims at identifying how best the required infrastructure can be conceived in mind and given shape within the restrictions of available funds and satisfying the public as far as possible. For example, a twin pit latrine is a boon in remote hilly area, but totally unfit in a city. Thus, planning has to be above all “relevant to situation on hand”. The planning process is a systematic method of:

1. Understanding the existing needs
2. Identifying the limitations and restrictions of funds
3. Collecting and analyzing available records of these
4. Identifying the options of potential remedies
5. Suggesting a set of actions, which may change the situation and step-by-step eliminate the problems
6. Evolve a suitable strategy for implementation with respect to a time frame
7. Go through a consultative process with the stakeholders to evolve a complete acceptance of physical, financial and managerial aspects
8. Evaluation of the actions taken for their success or failure and documentation for posterity
9. Thus, planning is a continual process and not a one-time process adopting principles and technology which are environment friendly, economically viable and sustainable
10. It also includes the reuse of the reclaimed water from treated sewage and conditioned sludge for feasible purposes that are hygienically safe
11. It needs close collaboration with other planning agencies at local, state and national levels to ensure co-ordination in allocation of priorities and resources
12. All these must be aimed to be reached in a step-by-step manner so that the lessons of the earlier step will improve the efforts in the next step

10.2 THE CITY SANITATION PLAN (CSP)

A city sanitation plan (CSP) is a living document as a result of the planning process.

Every ULB should have a city sanitation plan and undertake to implement it for all its citizens in an economic, environmentally friendly and sustainable manner.

10.3 DESIGN PERIOD

The following design period could be considered:

i) Short-term plan up to 5 years from base year
ii) Medium-term plan up to 15 years
iii) Long-term plan 30 years

The base year for short term will start when the completed infrastructure is put to use. The years of medium term and long term will start from the year of planning

The planning process involves close collaboration with other planning agencies at local, state and national levels to ensure better coordination in allocation of priorities and resources. The collection, transportation, treatment and disposal aspects, facilities, augmentation and replacement of the equipment and sites, allocation of priorities and resources should invariably be decided keeping in view the design period of the CSP.

10.4 POPULATION FORECAST

The design population will have to be estimated considering the decadal growth pattern and factors impacting growth such as economy, social, etc. Special factors causing sudden emigration or influx of population should also be foreseen to the extent possible. Worked out examples for estimation of the future population are given in Appendix A.2.2.

10.5 BASIC PLANNING MODEL

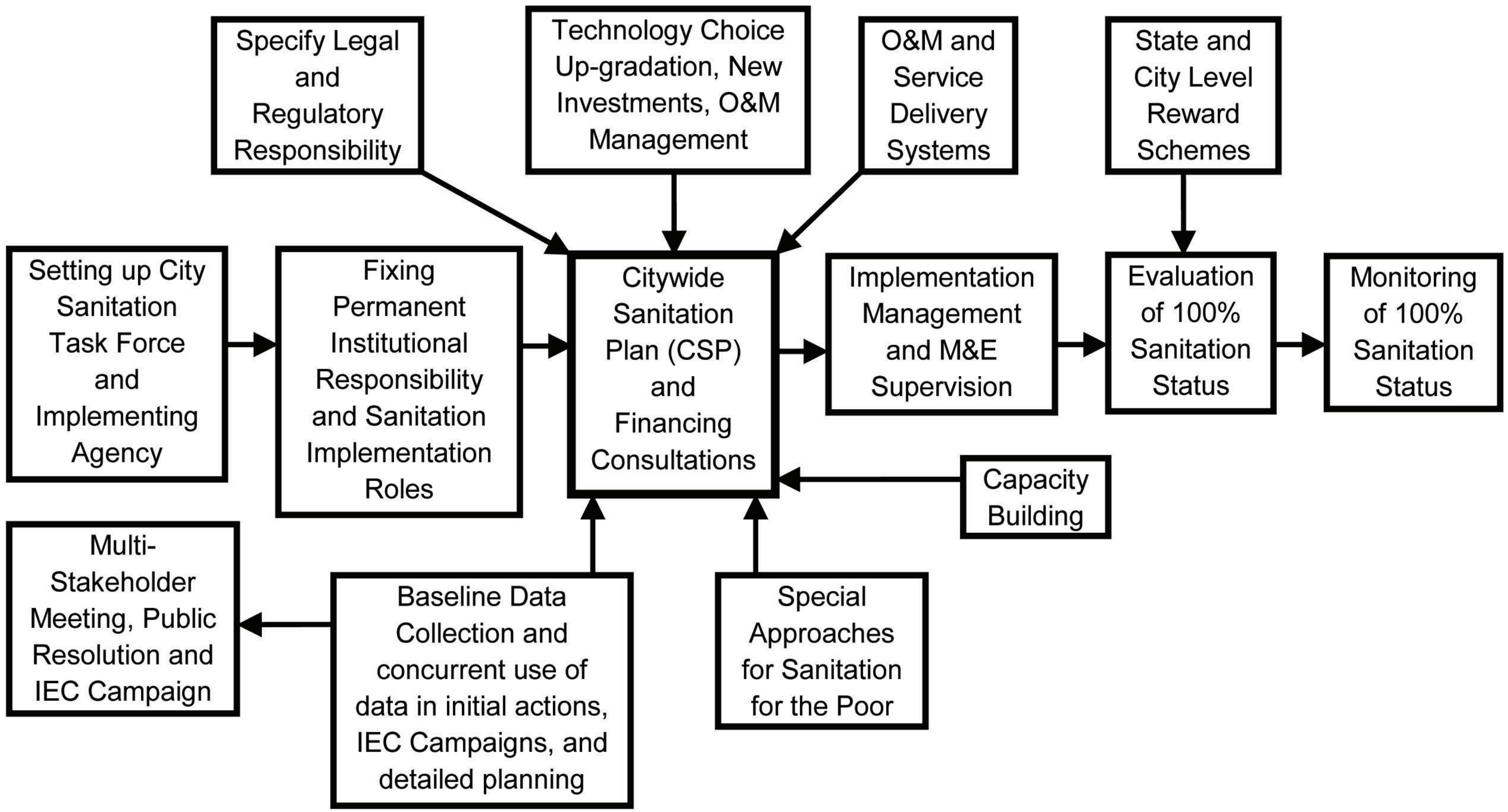
10.5.1 Draft Framework for a CSP under NUSP

10.5.1.1 Generic Elements of Planning

This shall be in accordance with the chart as contained in the National Urban Sanitation Policy (NUSP) and reproduced here as Figure 10.1 overleaf.

10.5.1.2 Purpose

The purpose of this framework is to assist ULBs, NGOs, community based organizations, citizens and private sector agencies through a series of steps towards the development of a plan for achieving the goal of 100% sanitation in their cities. The focus is the approach and “how to go about” the process to develop a comprehensive, wholesome citywide sanitation plan. Since each city will make choices based on demand and need, local context, availability of financial and human resources, and the opportunity for innovations, this chapter does not prescribe the options to choose. The framework may be adapted to suit the state’s urban sanitation strategy and used for its cities. To assist in thinking through the challenge, some core building blocks are outlined in Figure 10.1. Though apparently linear, the process needs to be iterative.



Source: MoUD, 2008

Figure 10.1 Generic elements of planning, implementation and monitoring and evaluation of citywide sanitation

The states will need to determine time-frames and deadlines to achieve the goals mentioned in the NUSP and will need to spell out a detailed road map, including the incremental targets for achievement of goals. For example, to achieve the goal of open defecation free (ODF) by the year 2013, a detailed plan for extending access will need to be formulated and implemented in a time-bound manner. The steps towards achieving universal access through individual, community or public toilets, the capital and operation and maintenance costs and the management arrangements needs to be detailed and made operational under the CSP. While some of the activities in the sanitation plan may be possible to complete with little financial resources e.g., better utilization of existing facilities, improved management systems for septage cleaning, awareness generation, etc.; others e.g. reconditioning or laying new sewers, may be more resource-intensive. The CSP will need to be prepared keeping in view the city's current sanitation arrangement and their technical and financial capability. It will be prudent to improve the effectiveness of existing facilities before embarking on new projects. Further, comprehensive and citywide solutions, and not just some piecemeal solution, will be necessary to achieve the goals in a comprehensive and systematic manner.

10.5.2 Steps for Achieving 100% Sanitation

10.5.2.1 Key Principles

The NUSP identified the following core principles that need to be addressed. These must be used as a guide by the cities:

- Institutional roles and responsibilities
- Awareness generation for changing mind-sets
- Citywide Approach
- Technology choice
- Reaching the un-served and poor
- Client focus and generation of demand
- Sustained improvements

10.5.2.2 Preparatory Actions

10.5.2.2.1 City Sanitation Task Force

Mobilize Stakeholders: The first step in making the cities 100% sanitized is to create awareness on the need to improve sanitation in the mind of municipal agencies, civil society and most importantly, amongst the people of the city. These can be done by the following approaches.

a) Constitute a multi-stakeholder City Sanitation Task Force comprising representatives from

- Agencies directly responsible for sanitation including on-site sanitation, sewerage, water supply, solid waste, drainage, etc., including the different divisions and departments of the Urban Local Bodies (ULB), Public Health Engineering Department (PHED), etc.,

- Agencies indirectly involved in or impacted by sanitation conditions including representatives from the civil society, colonies, slum areas, apartment buildings, etc.,
- Eminent persons and practitioners in civic affairs, health, urban poverty,
- Representatives from shops and establishments,
- Representatives of other large institutions in the city (e.g. Cantonment Boards, Government of India or State Government. Enterprise campuses, etc.),
- NGOs working on water and sanitation, urban development and slums, health and environment,
- Representatives of unions of safai karamcharis, sewerage sanitary workers, recycling agents / kabaris, etc.,
- Representatives from private firms/contractors formally or informally working in the sanitation sector (e.g. garbage collectors, septic tank desludging firms, technology providers for sewage and sludge treatment, etc.),
- Representatives from educational and cultural institutions,
- Elected members from the State Assembly and City Councils,
- Any other significant or interested stakeholders.

The Task Force should be headed by the Mayor with the executive head (e.g., Municipal Commissioner) as the Convener. Cities can also choose to appoint, as a part of the Task Force, City Sanitation Ambassadors chosen from eminent people, who enjoy outstanding credibility and influence amongst the city's leadership and population. Political leadership from all political parties and persuasions must be involved in the planning process so that the sanitation campaign has their full support and no opposition from any group.

One of the things to be considered by the Task Force is to organize a multi-stakeholder, multi-party meeting in the preparatory stage, and take a formal resolution to make the city 100% sanitized, and publicize the same and disclosing with all signatories.

b) The City Sanitation Task Force will be responsible for:

- Launching the City 100% Sanitation Campaign
- Generating awareness amongst the city's citizens and stakeholders
- Approving materials and progress reports provided by the implementing agency, other public agencies, as well as NGOs and private parties contracted by the Implementing Agency, for different aspects of implementation
- Approving the CSP for the city prepared by the Sanitation Implementation Agency after consultations with citizens
- Undertaking field visits from time to time to supervise progress

- Issue briefings to the press/media and state government about progress
- Providing overall guidance to the Implementation Agency
- Recommend to the ULB fixing of responsibilities for citywide sanitation on a permanent basis

The Task Force should meet formally frequently (at least once in two months) in the initial stages to monitor and guide the process of planning and implementation. At a later stage, meetings and field visits can be on an as-needed basis. In some cities, the City Sanitation Task Force may divide up roles and responsibilities amongst smaller sub-committees to focus on different aspects closely while keeping the overall character of the Task Force intact.

c) The Task Force should appoint one of the key agencies, preferably the ULB, as the Implementing Agency, which will be responsible for the implementation of the CSP for the city.

This agency will be responsible for day-to-day coordination, management and implementation of the sanitation programmes on a citywide basis. The agency will coordinate with and agree on joint actions with other public agencies, and contract in and supervise the services of NGOs (through Memorandum of Understanding) and private parties (through contracts) for preparing and disseminating materials for Information, Education and Communication (IEC), conducting baseline surveys and stakeholder consultations, maintaining a comprehensive GIS-based database, implementing physical works, letting out and supervising O&M management contracts, etc.

The ULB should formally notify and publicize the appointment of the City Sanitation Task Force and Implementing Agency.

d) Assign Institutional Responsibilities:

One of the key gaps in urban sanitation is lack of clear and complementary institutional responsibilities. This comprises two aspects: a) roles and responsibilities institutionalized on a permanent basis; and b) roles and responsibilities for the immediate campaign, planning and implementation of the City's Sanitation Plan - based on which the former can be outlined, experimented with, and finally institutionalized.

The Sanitation Task Force will recommend the assigning of permanent responsibilities for citywide sanitation to the ULB or other agencies including the following aspects:

- The ULB to have final overall responsibility for citywide sanitation, including devolving power, functions, functionaries and funds to them
- Planning and Financing including State Government and Government of India schemes
- Asset creation including improvement and augmentation
- Operations and Management (O&M) arrangements for all networks, on-site, community and public sanitation facilities and systems (including transportation up to final treatment and disposal of wastes)

- Fixing tariffs and revenue collections in order to make O&M sustainable
- Improving access and instituting special O&M arrangements for the urban poor and un-served populations in slum areas and in mixed areas
- Adopting standards for:
  - Environment Outcomes (e.g. State Pollution Control Board standards on effluent parameters),
  - Public Health Outcomes (e.g. State Health Departments),
  - Processes (e.g. safe disposal of on-site septage) and
  - Infrastructure (e.g. design standards) (PHEDs/Parastatals), and
  - Service Delivery standards (e.g. by Urban Development Departments)
- Adoption of Regulatory roles including environmental standards (e.g. State Pollution Control Boards), health outcomes (e.g. Health Departments).
- Measures in case specific stakeholders do not discharge their responsibilities properly
- Training and Capacity Building of implementing agency and related personnel
- Monitoring of 100% Sanitation involving multiple stakeholders

While the responsibilities for each of the above roles may temporarily be vested in one or the other stakeholders, for reasons of efficiency and effectiveness during the campaign period, the Task Force will recognize that these roles must be permanently institutionalized in the ULB and amongst other stakeholders. Therefore, the recommendation of later permanent roles may be different from those in the Campaign Period.

In many cases, Acts, rules and regulations exist, but these are not enforced. This may be a good entry point to start on roles and responsibilities. The roles and responsibilities for the Sanitation Plan implementation are outlined in the next section - this will also be the task of the City Sanitation Task Force.

10.5.2.3 Baseline Data Collection for Database / GIS

In parallel with the preparatory steps, the ULB / implementing Agency will collate the information on the current sanitation situation that exists in the city. This will include demographic, institutional, technical, social and financial information. In addition, it will commission a private agency or an NGO or both to carry out primary data collection on the missing items – the surveys will use a mix of structured and participatory techniques. All the data collected must be amenable to linking to an existing or proposed Geographic Information Systems (GIS) for the city. (If this does not exist, it is recommended that a GIS for water, sanitation and solid waste management be set up at the earliest). The baseline will be overlaid on plans for development of new areas and colonization, based on the Master Plan of the City. If a Master Plan does not exist, appropriate projections will be made after consulting real estate development public authorities as well as private agencies.

The combined database from the above exercise will form the basis for planning and implementing the campaign. Since such data collection can be time-consuming, ULBs must start very early on this activity and start using data as and when it starts becoming available.

One of the methods to make data collation and database preparation process efficient and adaptive to planning and implementation actions, is to break it down into simplified components like:

Stage I Data: use for initial preparatory actions

- ULB, and utility/service provider data on institutional parameters (organizational structure, investments and assets, personnel, O&M systems and finances),
- Census 2011 data on households, JnNURM / Urban infrastructure development scheme for small and medium towns (UIDSSMT) or other scheme's data compiled for poor households
- ULB and utility/service provider data on public sanitation and available crude data on conveyance and treatment.

Stage II Data: use for IEC Campaign and planning to achieve universal access to sanitation on a citywide basis.

- Refined secondary data on existing conditions of disposal and conveyance (sewers, on-site pits, availability and use of suction machines, etc.) and treatment systems (landfill sites, recycling, etc.)
- Baseline primary data on household arrangements for sanitation and waste disposal, and hygiene behaviour and perceptions about service providers
- Baseline primary data on citizen's demands and perceptions about sanitation arrangements, outcomes, health and environmental linkages

Stage III Data: Use for planning and implementing institutional changes, social mobilization and upgradation, improvements and new investments in assets and systems of O&M, monitoring and evaluation, etc.

- Primary data based on sample condition assessment surveys (see parameters above) of arrangements, disposal and treatment systems.
- Institutional Assessment detailed information on existing and required skills and capacities, systems and procedures, financial position
- Social – personal hygiene and public health behaviour and practices
- Economic – Surveys on willingness to pay for different options
- Financial – Costs of O&M, Revenue and tariffs, systems of community management of community and neighbourhood level systems

Usually, a baseline study needs to be completed in about three to four months (Class II and above), depending on the size of the city and complexities involved. About two months is adequate to complete baseline in cities of Class III and below. Combining participatory approaches with institutional and other stakeholders, with observation and community and household interactions using checklists, schedules, etc., makes the data collection efficient and economical. It may be noted that the baseline is not a census of all properties and households/units. It is rather an assessment, usually using sampling to cover all representative types of situations prevailing in the city, in order that progress can be measured at later points comparing with the baseline. Most immediately, baseline studies are required for planning the citywide sanitation plan. It is advisable to cover all aspects during the baseline: technical, institutional, social, economic, financial, urban poor, etc., and be cautious that none of the aspects are left out. Even if the baseline studies are completed in a short period – this is necessary so that planning processes are not kept on hold for long – further data collection and updating of records must continue later on too, and become a part of the ULB/ Implementation Agency's implementation management system.

10.5.2.4 Awareness Generation and Launch of 100% Sanitation Campaign

After a reasonable amount of data has been collated from secondary and primary sources, and the Task Force is in place, the first task will be launching a citywide 100% Sanitation Campaign. This will be ideally timed with GOI national media campaign, and a state wide campaign that the state government may choose to launch. If required, a professional media agency to work closely with the Task Force and Implementing Agency to package the messages and direct them effectively to different stakeholder groups in the city. NGOs may be commissioned to do group messaging and door-to-door campaigns with special stakeholders like slum-dwellers etc. Schools and Colleges can play a special role in propagating the messages in their institutions as well as in their families.

At the city level, it will be advisable to launch the campaign as a time-bound programme that all stakeholders need to work towards. Appropriate media like Newspapers, TV and city and ward/ neighbourhood level programmes (sweeping streets, health camps, tree-planting, etc.) may be engaged. There should be an intensive first round followed by successive rounds that may be focused on specific aspects and/or special type of stakeholders, or neighbourhoods. One of the methods that some cities or neighbourhoods may try out is to declare Clean City Week every year or half-year. The Task Force should enlist the participation of leaders and eminent persons to lead the campaigns. The messages and media/campaign strategy for each of the successive rounds must be planned carefully. There are a number of other programmes (e.g. health, education, HIV/AIDS, etc.) that have media campaigns. The 100% Sanitation campaign should be coordinated with such agencies so that maximum multipliers can be gained by collaborative and calibrated working of these initiatives. Wherever possible, messages should be put in other campaigns to reinforce the impact.

10.5.2.5 Specifying Legal and Regulatory Institutional Responsibilities

Even though there are municipal laws with regard to sanitation responsibilities of households and ULB, etc., these are neither clearly laid out nor comprehensive. The Implementing Agency will examine the law and rules in this regard and make recommendations regarding:

- Safe sanitary arrangements at unit level (household, establishment)
- Designs and systems for safe collection
- Norms for transport/conveyance
- Treatment and final disposal

The recommended standards and guidelines are available from the CPHEEO and the Environment Acts. These will need to be formally adopted including laying down the monitoring and regulatory responsibilities, and incentives and disincentives for doing so. This must include the system of user charges/fees, fines and community pressure mechanisms to help people move to desirable public health behaviour. Actions to be taken in case of institutional failure will also be specified clearly.

All the above recommendations will be considered by the Task Force and recommended to the ULB for appropriate action. Executive changes may be implemented immediately, whereas legal matters may be referred to the State Government if not within the ambit of the ULB. Expert advisors on the Sanitation Task Force will be the resources to utilize for this task – matters may be discussed with national or state level agencies if standards are not clear, or need to be further detailed. Interim and working standards may suffice in many cases to immediately adopt and implement, whereas the codification and detailing may be undertaken in parallel. In all cases, the Task Force will strive to make standards based on the goals of 100% Sanitation, as much as possible, simple and easy for ULBs and public to understand and adhere to.

10.5.2.6 Planning and Financing

The task of planning and finding sources of funding will be under the oversight of the Task Force, but carried out by the Implementing Agency. The Agency will take assistance from consultants, etc., to help prepare plans for the city for different aspects including institutional, social, technical, financial, etc. At all stages, the plans must be comprehensive and cover the whole of the city, and not just one part or aspect. Therefore, a number of innovative measures may have to be used.

The Government of India's Jawaharlal Nehru National Urban Renewal Mission (JNNURM), Basic Services to Urban Poor (BSUP), and Thirteenth Finance Commission (TFC) are the key programmes to source funding (others being special programmes for the North-East and satellite towns schemes, etc.), apart from State Government's own resources. Planning should be aligned to the above funding sources (as well as what customers are willing to pay by way of connection fees, user charges, etc.), and seek to derive maximum benefits from these sources for achieving 100% sanitation. The City and States will also need to explore other sources of finance to fund their sanitation plans since Government of India scheme resources may not be enough to fulfill all requirements. In this context, it may also be noted that investments will need to be financially sustainable and hence, cities may lay down options (different levels of infrastructure and service levels) depending on what they can afford in the medium term, and what will prevent them from getting trapped in high loan repayment liabilities, or O&M management expenditure bubble at a later point in time. The CSP must be prepared and presented by the Implementing Agency and presented to the Task Force for approval. While the exact contents of the CSP may vary depending on the local situation, the aspects mentioned overleaf must be covered:

- Plan for Development of Institutions/Organizations responsible for sanitation, and their roles and responsibilities
- Plan for ensuring 100% Sanitation Access to different socio-economic groups, and related O&M systems (including improving existing systems, supplementary facilities, O&M Management contracts using PPP and community management, etc.)
- Costs and tariffs for service provision'
- The issue of collection of dues needs to be emphasized as a means of ensuring accountability as well as financial sustainability.
- Investments and O&M systems for new development areas/market and public places, and residential and other habitations
- Plan for safe collection, conveyance and treatment of household wastes
- Plan for Monitoring and Evaluation of implementation, and of achieving and sustaining 100% Sanitation (including use of community monitoring, etc.)
- Issues such as diminishing water resources, impact of climate change, use of low energy intensive on-site/decentralized sewage treatment technologies, distributed utilities, etc.
- Manpower issues such as adequate remuneration, hazardous nature of work, employment on transparent terms and conditions, use of modern and safe technology, provision of adequate safety equipment such as gloves, boots, masks, regular health check-ups, medical and accident insurance cover, etc.
- Plans for other locally significant aspects.

Some of the bigger cities may choose to prepare the plans on a regional/district or ward-wise basis. This may be a good way to mobilize stakeholders of the respective wards/regions and generate competition. However, at all times, it must be emphasized that such divisions are only limited to convenience in execution and monitoring, and sanitation must be a citywide achievement. Hence, the Task Force will have a special role in ensuring the integration of all the regional or functional components of the CSP as outlined above.

In order to promote wide ownership reflecting the collective and collaborative spirit of the sanitation endeavour, the CSP should be presented to the public for feedback at different stages of its development. Notwithstanding the inclusive and representative character of the City Sanitation Task Force, it is to the city's benefit if all or significant number of city stakeholders is able to contribute to the Plan. Holding of at least one, preferably two (draft and final stages) public meetings, needs to be considered by the Task Force.

10.5.2.7 Technical Options

Technology choice poses a major problem in Indian cities not only because of lack of information on what exists at present, but also because of the constraints of land, tenure, and low budgetary priority accorded to sanitation historically.

This leads to estimations of investments using conventional technologies that are mind-boggling and paralyze any incremental action.

The key issues about the technical options are:

- Technologies come with attendant capital and O&M costs, and management systems that may or may not be appropriate to a city's situation at a given time. Very often we can fall into the trap of planning systems that are difficult to finance, institutions are not ready and geared to operate and maintain them, and people are not ready or willing to adopt these and pay for service provision. Also, technology is linked to a whole set of environmental, behavioural and cultural parameters that need be taken into account. A holistic approach is required for technology choice.
- Approach to difficult existing situations (e.g. dense on-site systems draining into nallahs) is to think about upgradation and retrofitting options to make the systems sanitary and safe and also perform to their existing capacity.
- Technologies need to be incremental – for instance, even if sewers are ideal for dense settlements, they may not be feasible to immediately execute. In such cases, interim (e.g. on-site, or community septic tanks, improved septic tanks, Japanese Johkasou, or latrines if space is a constraint) systems may be planned with a view to later upgrade these to more sophisticated system (e.g. sewerage). Refer to Chapter 9 On-site Sanitation for details.
- Technologies and attendant systems for new development areas can be planned in advance. This results in early investments leading to cheaper and more sustainable systems in future.
- Technologies are only a means and not an end. They are to enable sanitary and safe confinement and disposal and hence, the approach to design must be keeping these ends in view.
- Technologies that promote recycle and reuse of treated sewage should be encouraged.

There is considerable information available on existing options as also the experience with some new systems and processes. These need to be reviewed by the Implementing Agency and where needed, specialist advice sought from state and national level agencies, and the private and community sectors. Exposure visits and training programmes will be required to take an informed decision. Finally, customers are at the heart of such systems – households and establishments must be consulted on expressing their preference after being made aware of the pros and cons of each of the systems under consideration. Technology choice again should address the citywide nature of the challenge – a mix of options must add up to addressing the issue completely, not just in bits.

Finally, technologies need to be planned for the full cycle of arrangements at the unit level, conveyance/transport, and final treatment and disposal into the environment. Any combination of systems that does not lead to the output of 100% safe collection, conveyance, treatment, and disposal will not serve the purpose of achieving 100% sanitation for the city.

Situation Analysis: Studies show that the bulk of decision-making and unit level investments are made by households and establishments – with more focus on sanitation arrangements, and less attention to collection, treatment and disposal. Public agencies are concerned with collection, treatment and disposal, but boundaries of roles and responsibilities are not clear.

In many if not most of the cases, public agencies are also unable to accord much attention to the public infrastructure and systems for collection, treatment, and disposal (e.g. sewerage systems, sewage treatment plants), or leave it for the households to resolve their problems (e.g. cleaning of septage). Thus, issues of O&M and sustainability need to be kept in view when planning for technology options.

10.5.2.8 Reaching the Un-served Populations and Urban Poor

Experiences from many Indian cities show that a differentiated approach is necessary to extend good quality sanitation services to the poor – the group that suffers the most in terms of adverse impacts on health and lost earnings.

Participatory approaches are needed to consult the poor settlements and involve them in the process of planning and management of sanitation arrangements. Many settlements may have the necessary conditions to support the provision of individual on-site sanitation arrangements (e.g. as tried out in some pockets in Ahmedabad, etc.) that are ideal, in many others, tenure and legal issues prevent provision of individual toilets and hence, community toilets (CTs) are the only way for immediate succour and access (e.g., as is the case with Mumbai, Pune, etc.). In some places, conventional and shallow sewers have also been tried out as alternative to on-site solutions in dense settlements. Examination of legal/tenurial, space and affordability issues in close consultation with communities becomes a key step in planning innovative means that are owned by users and will be sustainably managed by them.

NGOs can play an important role in mobilizing slum communities. Further, when community groups themselves take over the O&M of community facilities, then sustainable services become possible. This is also a way of reducing costs (compared to say, pay and use public toilets) and making services affordable to the poorest of families.

Another segment of population normally without sanitation is those who live in dispersed urban locations not being slums or in groups of houses that have legally not been notified as slums. Innovative approaches are required to extend services to these population groups too. It may be noted that public sanitation is for general public or floating populations, whereas CTs are those, where an identifiable core group of users exist, even if floating population may occasionally use these facilities.

The Implementing Agency will need to take stock of the legal and non-notified settlements in the city, and in partnership with NGOs and Community Based Organizations (CBOs), initiate a process of collaborative planning and delivery of services. Sanitation services also serve as an entry point for improved water supply, drainage improvements and community managed solid waste disposal systems – these areas should also be targeted while planning for sanitation is being undertaken.

At least 20% of the funds under the sanitation sector should be earmarked for the urban poor.

The issues of cross subsidization of the urban poor and their involvement in the collection of O&M charges should be addressed.

Finally and not least of all the obstacles, is the mind set of officers of ULBs and other citizens: bias and myths often hinder proper service provision to poor settlements. There must be a concerted effort to raise awareness amongst all stakeholders about the huge health and environmental costs that all have to bear if services are not comprehensively provided to all citizens.

Two steps are necessary to achieve this change in mind-sets: a) orientation programmes must be conducted for ULB functionaries; and b) setting up permanent systems in ULBs, complemented with agreements with NGOs and CBOs, to deliver services and monitor outcomes on an urgent basis to all poor households, as well as others, who are either un-served or have insanitary arrangements for defecation, collection or disposal.

10.5.2.9 O&M and Service Delivery Systems

Institutional systems for O&M are at the heart of any successful set of systems and procedures to achieve and sustain 100% sanitation. As outlined above, responsibilities for institutions are weakly defined and even if stipulated hardly followed properly.

Therefore, existing systems must be examined with the question: which agency or institution is responsible for operating and maintaining the system or a part thereof? If they do not discharge their responsibilities, what corrective action or recourse exists and who is responsible for this? For new investments similar questions need to be asked so that assets and services do not suffer from lack of proper O&M. A citywide perspective is necessary since O&M is required for all parts of the sanitation systems, whether it is excreta removal, or drainage or solid waste management. Assigning institutional responsibility also must go hand in hand with technology selection, design and implementation/creation of assets.

While sewerage systems have limited responsibility of households (from own property to nearest street connection), institutions responsible for the rest of the conveyance systems are faced with a number of personnel, finance and incentives related constraints. These need to be mapped and clearly addressed – even with little resources; innovations need to be made in the organization responsible (relevant ULB department or service provider unit) to seek immediate remedies while a more systematic planned set of steps to improve O&M may be implemented during the plan.

In most on-site systems, households are left to fend for themselves – often, there is no check on unhealthy and illegal practices such as draining wastes in to nallahs and drains. These also need to be brought under the remit of the respective public agency and properly dealt with. Septage clearance services are another area where quick action can be initiated and the necessary fees charged from households. In drainage and solid waste too, a number of steps can be initiated (some of these have been successfully tried out in solid waste management in many Indian cities) to ensure proper O&M and service delivery, in which consumer households also have a stake and roles built in.

Preparing O&M Protocol for each of the sanitation facilities in the city is a good step in this direction, and their adherence needs to be monitored by senior officers, elected representatives and community members.

O&M systems often suffer because customers do not recognize this as a service, and do not pay for the poor service levels. O&M is closely related to the financial sustainability of service provision, and hence, the Implementing Agency must take full stock of the financial implications of improving current and future service levels. These should lead to proposals to the City Task Force, as a part of the CSP, on how to recover or fund the costs of O&M.

Customer complaints and redressal systems is another major area needing attention. One of the important changes that need to be effective amongst the ULB, or service providing agency is to treat citizens as customers of services. Accordingly, complaints, redressal and feedback systems can be instituted for sustained improvements. Preparing proper customer records and taking structured feedback are ways already tried out in other sectors with satisfactory results in improving public services. Providing orientation and training programmes, implementing customer relationship systems, and linking O&M performance to personnel performance are ways to examine improved service delivery systems.

Finally, in many cases, households and communities may be in a better position to carry out O&M tasks or monitor performance thereof. This approach works specially when communities have incentives to work together and/or there are considerable externalities of a particular behaviour (individual actions affecting others easily).

Maintenance management of CTs, maintaining cleanliness in neighbourhoods, keeping drains and nallahs clean, street sweeping, etc., are examples where community groups can easily monitor the performance of service providers. In case of poorer neighbourhoods and slums, some of these tasks may be formally entrusted to local groups too.

10.5.2.10 Capacity Building and Training

The role of capacity building and training is crucial in achieving and sustaining 100% sanitation. Because of the historical neglect, the know-how of sanitation is limited to a minuscule group of personnel in ULBs/service providing agencies – even these skills run down over time due to little scope for application and sometimes the narrow nature of the specific job. Therefore, two broad kinds of interventions are necessary:

a) Orientation, building of skills and aptitude for carrying out different types of activities in respect of total sanitation

b) Designing and implementing working systems in ULBs or service providing agencies to provide the right kind of structures, linkages and organizational systems and environments that utilize the skills and perspectives imparted above.

The task of building capacities is huge – this is compounded by the generally low levels of synthesis and dissemination of existing knowledge and experiences of working with different kind of technologies, management regimes, organizational systems and processes and institutional relationships. Therefore, there is a dual agenda of consolidating and applying existing and new knowledge in a learning-by-doing framework, and building capacities thereon in an adaptive manner that is able to accommodate a range of personnel with different kind of backgrounds.

The National and State level Resource Organizations including NGOs, need to be brought in by the City Task Forces, to assist in this huge agenda that needs to be woven closely with the sanitation campaign, planning, implementation, and monitoring and evaluation. Similarly, experts need to be deployed early with assistance of the Union and State Governments, so that the knowledge development on technologies and management regimes is quickly made available for the city to adapt. The role of NGOs will be valuable in training and capacity building for participatory methods and consultation techniques to be used with the urban poor and un-served households.

Two strategies are worth considering in the capacity building agenda: a) bulk training for a range of municipal, NGO/CBO, private sector personnel – right from the start of the campaign in the city; b) Differentiated and specialized training on a demand-basis to personnel in and outside the government over the period of the Sanitation Plan implementation.

One of the common failures of training and capacity building is the lack of incentives and organizational environment to practice the learnt perspectives and skills. This highlights the need for the Task Force and implementing organizations to plan the training of their personnel in such a manner that their skills can be put to productive use.

Agencies from the private sector, public and NGO training and capacity building institutions must be involved in the campaign process to carry out the necessary assessments and help the Task Force plan and devise a strategy for Human Resource Development and capacity development through the implementation cycle, and institute appropriate practices within the institutional framework of the ULB and other stakeholders for the future.

10.5.2.11 Implementation, Management, Monitoring and Evaluation

10.5.2.11.1 Implementation Management

The task of implementation management can prove to be onerous if the planning stages are done in a hurry or are inadequate in taking account of ground reality (including current assets, finances, capacities and availability of suppliers and vendors, and other environmental conditions). While the Implementation Agency will be responsible for overall implementation, it is useful to think about plan implementation and delivery mechanisms for each of the components of the Plan.

The typical components indicate that there need to be either in-house resources deployed for these tasks (e.g. as in bigger ULBs) or private and NGO service providers need to be contracted or commissioned to carry out the implementation. The following types of skills and competencies are required in these implementation agents:

- Institutions/Organizations Development, and financial (capital and O&M costs, tariffs, ULB finances, etc.)
- Socio-economic and community management
- Urban planning
- Health and environmental linkages to sanitation

- Technical capacities to implement new assets and facilities and set up O&M systems for new development areas
- Monitoring and Evaluation (M&E)
- Capacities to address plans for other local aspects

Expert institutions, Consultants, NGOs, etc. who were involved in planning, may be considered for participating in and providing project management support to the Implementation Agency. In some of the larger cities, this may be an effective way to achieve efficient implementation of a large-scale sanitation plan for which the city may not have all expertise and management competencies within the ULB, or where many parallel activities are to be implemented leading to shortage of personnel during peak activities.

Contracts and their management are crucial in making sure that the implementation is without delays and adheres to appropriate quality standards. Two broad kinds of services are required: hardware related capacities that have to do with implementing physical works and software/process related capacities, e.g., social mobilization, institutional development, training, etc. Since the ULB may not have requisite capacities and systems to effectively deal with the challenges of contracting and supervision of contracts, innovations are needed: these include taking assistance from State level agencies in selection and procurement; appointing contractors and consultants on a cost-plus basis; lump-sum or unit-price contracts for other components and so on. Memoranda of Understanding (MoU) (e.g. with NGOs) to arrive at a common shared understanding of responsibilities and deliverables are another tool to address some of the components. Finally, training in contract management may be an area that core members of the Implementing Agency need to go through if, requisite capacities are deemed to be wanting.

The presence and guidance of the City Sanitation Task Force will be an assurance of quality procedures, fairness, and focus on deliverables. Supervision and M&E of implementation will provide other methods of mid-course correction.

10.5.2.11.2 Monitoring, Evaluation and Supervision of Progress

The City Sanitation Task Force and the Implementing Agency need to think about M&E of the implementation as an integral part of the CSP. The mechanisms to be used in monitoring implementation include:

- Administrative data from Implementing Agency Reports and from the implementing consultants, contractors
- Task Force field visits to different parts of the city
- NGOs working in different parts of the city, e.g. an NGO working in certain slum pockets may be able to monitor changes in the relevant settlements since they work there, visit and interact with people regularly. A Memorandum of Understanding or undertaking to provide additional expenses may be required from the ULB, whereas some NGOs, especially those working on health, may be collecting some of this data as a part of their own work;

- Community groups asked to provide structured feedback to the implementing agency and the task force on progress of implementation and the condition in their respective neighbourhoods
- Independent third party assessments
- Concurrent evaluations by a survey agency.

An important aspect of monitoring and evaluation is to make the findings and reports available to the public so that feedback and suggestions can be received from other stakeholders. Sharing key features in monthly task force meetings and press briefings are also another way of mobilizing city stakeholders and eliciting their cooperation.

10.5.3 Evaluation of 100% Sanitation Status

The mechanisms and systems used for M&E often determine the quality of assessments of results as well as to a large extent the responses of different stakeholders. The Ministry of Urban Development Rating of Cities lists M&E indicators in terms of output, process and outcome related parameters.

While the Task Force and Implementing Agency may use a combination of mechanisms suggested above for implementation, for evaluation of 100% Sanitation Milestone achievements, a number of tools can be considered:

- A mix of self-assessment by the city sanitation task force – based on implementation agency data, citizens' groups feedback, and primary field visits
- Independent report cards and evaluation missions commissioned by the City Task Force and/or mounted by the State Government
- Cross-city monitoring with participation of State level and other-city stakeholders
- Government of India rating of cities, service level benchmarks, monitoring missions and independent agencies

Experiences from other sectors shows that multi-stakeholder M&E systems, using simplified formats to assess objective indicators are likely to build a shared ownership, and economically produce reliable results. Therefore, the City Sanitation Task Force may consider publicizing, as a part of the initial awareness generation campaign, the key indicators that all stakeholders should monitor, and devise a simplified mechanism to collect data and report on.

Introduction of competitive reward schemes within cities are another way to improve the quality of monitoring and evaluation of 100% sanitation achievements.

10.5.4 Monitoring of 100% Sanitation Status

In order to ensure that after the city or parts thereof do not slip back after the achievement of the milestone, there need to be systems instituted to ensure that this is not a one-time achievement, rather a permanent change in behaviour, systems and practices.

Again, multiple stakeholders need to be involved in this process, while the ULB or the Task Force may take the lead in doing so. The mechanisms to institute sustenance of change include:

- ULB Roles in monitoring processes, outputs and outcomes: the ULB will need to assume leadership and institutionalize the means of monitoring the 100% sanitation status. This will be closely tied to new investments and O&M roles and responsibilities within the ULB divisions, but it is recommended that a unit separate from the above units is made responsible for the overall outcomes of the city's achievements and their sustenance. The ULB will also be able to do this more effectively if it involves other government agencies (Environment, Health related within and outside its own organization) NGOs, CBOs, the urban poor, etc.

- The role of Citizens' Groups in monitoring on a day-to-day basis is invaluable and should be mobilized especially for the protection of neighbourhoods, incremental improvements, as well as immediate reporting of any deviance that needs solutions. At the overall city level of course, the erstwhile monitoring of implementation will transform into adding the responsibilities related to sustained change at the ground level.

- The best method of sustaining change is to regularly collect formal data and informal information and feedback, and make it public so that there is pressure created equally on the public agencies, private service providers, as well as households and communities, to keep to sustained practices. Rewards again serve as triggers for sustenance and in many cases, also to make improvements that will earn credit to the city. As outlined in Section 10.5.5 below, there are a number of other indirect benefits that accrue to cities becoming 100% sanitized and making constant improvements.

10.5.5 City Reward Schemes

Cities can institute their own reward schemes to incentivise local stakeholders to participate in the process of improvements for reaching 100% sanitation. Rewards could be given following the national guidelines on an area basis. For example, the following could be units for rewards:

a) Municipal Wards
b) Colonies or Residents' Associations
c) Schools, colleges and other educational institutions
d) Market and Bazaar Committees
e) City-based institutions or localities, e.g., Railway stations, Bus Depot, Office Bhawans, etc.
f) Other locations and institutions that may be in the city.

The reward may contain a nominal amount of money for further upkeep and maintenance of sanitary systems, improvements in infrastructure targeted to better health and environment, as also special purposes like holding environment fairs, health camps, etc. A scroll of honour, public function to accord recognition, and rating of wards may also be considered as a part of rewards. While such rewards are being instituted, it must be emphasized that the responsibility of any group or locality is not over by just its own achievements. It must be a citywide enterprise and no one will be safe and benefit from a healthy life and environment unless everyone in the city and its surroundings adopts improved personal and community practices of 100% sanitation.

The leadership of municipal ward elected representatives, local community leaders, citizens' groups and community based organizations, will be crucial in achieving and sustaining 100% sanitized wards or localities. They must be mobilized to compete in a healthy manner in achieving sanitation. Therefore, the reward scheme should become important in local community civic affairs, politics, and valorize the local economy too.

10.5.6 Cities with Special Institutions and Characteristics

i) There may be cities that have special institutional arrangements: cities where ULBs are not in place or have responsibilities only for a part of the city (other parts coming under a cantonment or a development authority). In such cities, a multi-agency Task Force will need to be created that can plan, guide and monitor the 100% sanitation campaign. It will be crucial that no part of the city is left out and as convenient and efficient, the authorities implement similar measures in their respective jurisdictions.

ii) Cities where ULBs are only partially responsible for sanitation, other responsibilities are vested in parastatal agencies like PHED/PWD, Water Boards, etc. The City Sanitation Task Force must involve representatives from all agencies involved in sanitation. This will include all agencies responsible for household/unit level sanitation, sewerage, water supply, health and environment.

iii) Some cities have unique topographical, environmental features (e.g., hilly or coastal regions), and therefore may be vulnerable to natural phenomena like floods, landslides, earthquakes, etc. Specialist advice may be sought by such cities from relevant national and state level agencies, and private firms. Such specialists may be invited to become members in the City Sanitation Task Force, and contribute their specialist knowledge and advice to the process. In cities vulnerable to natural disasters, special measures for sanitation must be explicitly incorporated in their Disaster Preparedness and Mitigation Plan.

If such a plan does not exist, the Task Force must layout the steps to be taken for the city to cope with such disasters including:

a) Institutional roles and responsibilities for disaster preparedness

b) Incorporation of disaster preparedness in the design and O&M of sanitation arrangements and systems (at household/unit level, in transport and conveyance, and in sewage treatment / disposal)

c) Emergency measures and rehabilitation measures in the event of disasters

d) Building key points from above in public awareness generation campaigns.

10.6 COORDINATION BETWEEN CMP AND CSP

The essence of planning is coordination. Planning requires resolution of conflicting interests, allocation of available funds and other resources, inter and intra central and state government departmental cooperation, and establishment of priorities.

The City Master Plan (CMP) describes the vision for the city's future.

A comprehensive CMP guides development, conservation and capital improvement projects to improve the quality of life in the community. The plan must comply with the State's regulatory requirements, one of which is in review every 10 years.

Topics addressed in the CMP include the City's goals and objectives, land use plan, urban design, housing, infrastructure, parks, open space, transportation, economic development and preservation of historical monuments.

The CMP is constantly under revision as the needs of the community change and state or ULB requirements are incorporated into the document. Residents are welcome to share input on the CMP and are encouraged to get involved keeping in view of environmental and physical status of the city.

The planning period of CMP is a function of various developmental plans as stated above and should be fairly of a longer period for sustainability of other development plans.

In order to have sustainable CMP and other developmental plans, there is a need for inter and intra departmental coordination of central and state departments including parastatal agencies.

From the standpoint of the direction and overall needs of National Government, a CSP is one among several functional plans, such as those dealing with highways, natural resources, education, health, etc. CSP, therefore, should relate to, and not conflict with, other plans of the city.

It is essential that the city sanitation planning be included in the overall plan of the jurisdiction that will ultimately implement it. In this way, the agency responsible for sanitation services will be able to compete effectively for funds, personnel, and other resources and facilities.

10.7 CITY SANITATION PLAN OUTLINE

The basic planning model can be translated into an outline for reporting the established plan. Such a format communicates the logic inherent in the planning procedure. Planning initiative and innovation are desirable.

However, each civic body is expected to formulate its own systematic outline and report, taking into account its particular needs as indicated in the sample format, described later in this chapter, for the preparation of the CSP.

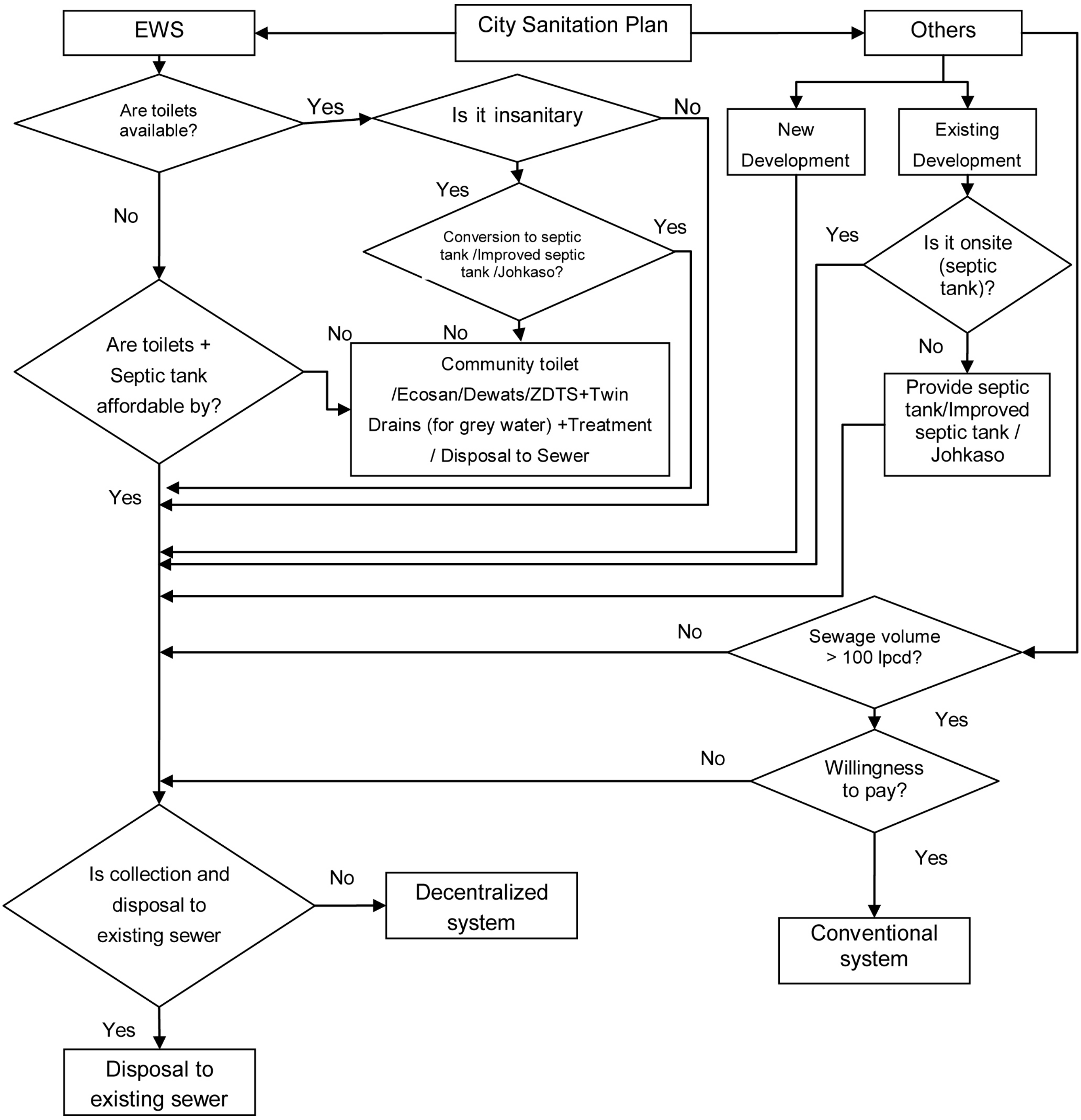
10.8 ALGORITHM FOR DECISION MAKING ON SEWERAGE OPTIONS

The algorithm is presented in Figure 10.2 overleaf.

10.9 REPORTING

The report shall be simple, easy to read as a running text including all calculations, charts and tabular columns in the Annexure for easy understanding of readers. This will help in a quick grasp for the management decisions.

The contents can be on the following sequence.



EWS: Economically Weaker Section

Bahao toilets are the toilets directly connected to stormwater drain

Non Conventional sewers: simplified sewers, settled sewers and twin drains

Figure 10.2 Decision Tree: Selecting the technical option (On-site, Decentralized or Conventional)

1) Introduction and Need – not to exceed one page
2) Executive summary – not to exceed one page
3) Physical setting of the study area
4) Existing sanitation arrangements
5) Socio-economic setting of the study area
6) Health statistics of the study area
7) Financial position of the local authority
8) Human resources of the local body
9) Recommended sanitation Plan
10) Ways and means to strengthen the resources of the local body
11) Optional models for project delivery mechanisms.

The sample format for preparing the city sanitation plan is mentioned in Table 10.1 (overleaf).

Table 10.1 Sample format for preparing City Sanitation Plan

Elements of the Report
Section I Introduction
Purposes of the plan.
Section II Executive Summary
(Note: This section should be written last and may come at the beginning of the report)
Section III Background of the Planning Area
1. Jurisdictions a. National b. State c. City/Town (Civic Authorities) d. Location Map e. Population (size and densities) f. Housing (types and locations) g. Land uses (residential, commercial, industrial, agricultural, extractive, recreational, and other relevant land uses) h. Transportation corridors
Section IV Existing Sanitation Conditions
1. Arrange data according to specific needs of the planning agency. As far as possible all the information related to sanitation has to be collected.
2. Describe and analyse all existing conditions affecting management of sanitation. a. Storage and collection of sewage b. Quantities of sewage generated, collected, treated, reused and disposed of c. Reuse and disposal practices d. General management practices (e.g., utilization of manpower and equipment) e. Public awareness and knowledge about sanitation problems and willingness to pay for better services f. Expenditures for sanitation management
Section V Future Conditions and Problem Definition
1. Relevancy for the future (from the analysis of the data of existing conditions accumulated in sections III and IV, determine which conditions will have a bearing on the future).

Continued

Elements of the Report
2. Future problems defined a. Types b. Locations c. Extent d. Persistence e. Others 3. All existing conditions and problems bearing upon the future should be forecast at this stage. **Section VI Objectives** Objectives should be clearly stated and based upon need to solve problems defined earlier. Civic authority might specify any of the following objectives to solve its sanitation problems: 1. Acceptable methods for storage 2. Acceptable methods for collection of sewage and septage 3. Acceptable sewage treatment practices 4. Acceptable sludge treatment practices 5. Acceptable method of recycle and reuse 6. Acceptable methods of disposal 7. Development of sanitation management organizational structure 8. Development of better trained personnel (operating and management levels) 9. Better informed public regarding sanitation problems and service requirements 10. Provision of sufficient financial support for sanitation 11. Others **Section VII Recommendations for Solution (The Plan)** 1. This section should specify what the civic authority intends to accomplish in order to solve its sanitation problems. It should include designation of the following: a. System improvement b. Timing and priorities of intended action (consider short and long-term objectives) c. Who should act (i.e. agency, department) d. Estimated costs e. Problems that will be solved f. Others 2. It is suggested that the following aspects should be considered in the intended action plan. Proposals for this action should be accompanied by procedures for accomplishment and a schedule of initiation of this action. a. Establishment of sanitation operating departments and identifying its jurisdictions b. Recruitment, selection and hiring of operating personnel c. Human resources development programme

Continued

Elements of the Report
d. Technical assistance to operating units e. Provisions for inspection and enforcement f. Licensing of facilities g. Framing legislation, amendments to rules and regulations h. Development of budgeting procedures, financing, cost-effectiveness, special charge features and other operating management features i. Public information, education and communication programme/system j. Others
Section VIII Implementation (occurs outside the plan document but is guided by it)
Appendices This section of the report should include supporting materials and information used to develop the analyses, objectives, and plan. Content of this section might include: a. Charts b. Additional tables c. References d. Legislation and regulations e. Definition of terms f. Methodologies of research and analyses g. Others
Section IX Monitoring and Performance Evaluation of the Programme This section of the report should include monitoring of various activities of sanitation services and also evaluation of the performance of all the related activities with reference to the objectives/targets envisaged, once the programme is implemented.

Source: MoUD, 2008

The text of the CSP for a city should explain in detail all the above elements that are to be contained in the plan report and conforming to the above outline.

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Government of India

Ministry of Urban Development

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http://moud.gov.in

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