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Sanitation in India

Recommendations for Optimal Practices

GRBMP: Ganga River Basin Management Plan

by

Indian Institutes of Technology

IIT Bombay | IIT Delhi | IIT Guwahati | IIT Kanpur | IIT Kharagpur | IIT Madras | IIT Roorkee

Preface

In exercise of the powers conferred by sub-sections (1) and (3) of Section 3 of the Environment (Protection) Act, 1986 (29 of 1986), the Central Government has constituted National Ganga River Basin Authority (NGRBA) as a planning, financing, monitoring and coordinating authority for strengthening the collective efforts of the Central and State Government for effective abatement of pollution and conservation of the river Ganga. One of the important functions of the NGRBA is to prepare and implement a Ganga River Basin Management Plan (GRBMP).

A Consortium of 7 Indian Institute of Technology (IIT) has been given the responsibility of preparing Ganga River Basin Management Plan (GRBMP) by the Ministry of Environment and Forests (MoEF), GOI, New Delhi. Memorandum of Agreement (MoA) has been signed between 7 IITs (Bombay, Delhi, Guwahati, Kanpur, Kharagpur, Madras and Roorkee) and MoEF for this purpose on July 6, 2010.

This report is one of the many reports prepared by IITs to describe the strategy, information, methodology, analysis and suggestions and recommendations in developing Ganga River Basin Management Plan (GRBMP). The overall Frame Work for documentation of GRBMP and Indexing of Reports is presented on the inside cover page.

There are two aspects to the development of GRBMP. Dedicated people spent hours discussing concerns, issues and potential solutions to problems. This dedication leads to the preparation of reports that hope to articulate the outcome of the dialog in a way that is useful. Many people contributed to the preparation of this report directly or indirectly. This report is therefore truly a collective effort that reflects the cooperation of many, particularly those who are members of the IIT Team. A list of persons who have contributed directly and names of those who have taken lead in preparing this report is given on the reverse side.

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Summary

There is considerable awareness about community water supply needs, but the problems of excreta and sewage disposal, i.e., sanitation, has received less attention in India. The effects of poor sanitation seep into every aspect of human life be it health, welfare, economy, dignity, empowerment or environment.

To meet the country's sanitation challenge there is an urgent need to focus on proper collection and treatment of excreta and sewage and to build and maintain appropriate toilets for all. Government has spent and is still spending a lot of money to improve the state of sanitation, but majority of systems have failed due to various reasons.

Through assessment and analysis of prevalent sanitation issues in various types of human settlements in the country, this report recommends workable sanitation models for various situations. For this purpose, urban sanitation and rural sanitation issues are analyzed separately. Areas of concern are identified and problems faced are discussed, followed by formulation of the recommendations.

Sanitation models suggested in this report for various situations have certain common characteristics. They allow people to defecate with dignity and a minimum amount physical comfort. Further, these proposed models also incorporate methods for the safe disposal of the resultant excreta and sewage. In short, they provide both acceptable "front-end" and safe "back-end" solutions. These models completely discard the prevalent objectionable practices in the sanitation sector, i.e., manual scavenging, open defecation, conventional dry latrines, open drains, direct defecation into water bodies (cesspools) and soak pits in areas with high ground water table or rocky strata.

Finally, cost analysis of various sanitation models show that the cost of defecation and safe disposal of the resultant excreta and sewage ranges between Rs. 3.50 and Rs 5.50 /person/day, irrespective of the model adopted. Our country must be aware of this cost and willing to pay for it for a systemic solution to the sanitation problem.

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1. Introduction

Sanitation is the most neglected sector in India. The general tendency is to just transport the waste out of sight; nobody is concerned about the fate of that waste, believing that that nature will automatically take care. But unfortunately that's not true; the effects of poor sanitation seep into every aspect of human life.

In India only 30% of urban households have access to sewer lines, while this percentage is almost zero in rural areas. Growing volumes of untreated sewage contaminate ground water and surface water. Rivers and drainage channels are carrying raw sewage. A large portion of the population has no access to toilets. These people cannot defecate in privacy and are forced to go out to defecate in open fields, near rivers or on railway tracks. To meet the country's sanitation challenge there is an urgent need to focus on building appropriate toilets, ensuring their maintenance and further treat the waste from these toilets properly before disposal.

In the last few years, substantial funds have been spent by both central and state governments on building of the sanitation infrastructure in the country. However due to a variety of reasons including inappropriate sanitation solutions adopted, the results from such initiatives have been less than heartening, Even now, an unacceptably large percentage of Indian population have no access to toilets and hence practice open defecation.

There is an obvious need for good sanitation systems, which are complete in themselves, i.e. these systems should not compromise in any aspect. Therefore such systems must have certain important properties,

- **Disease prevention:** A sanitation system must be capable of destroying or isolating pathogens.
- **Environment protection:** A sanitation system must prevent pollution and conserve valuable water resources.
- **Nutrient recycling:** A sanitation system should return nutrients to the soil.
- **Affordability:** A sanitation system must be accessible to the poorest people.
- **Acceptability:** A sanitation system must be aesthetically inoffensive and consistent with cultural and social values.
- **Simplicity:** A sanitation system must be robust enough to be easily maintained with the limitations of the local technical capacity, institutional framework and economic resources.

A critical assessment of traditional sanitation practices and present sanitation conditions in India leads to following observations,

1. Open defecation cannot be recommended under any circumstances. This practice does not allow defecation with dignity and privacy and may be unhygienic if done improperly.
2. Toilets that need daily manual cleaning are not recommended under any circumstances since they offendbasic human dignity and contravene the Manual Scavenging Act.
3. Hanging toilets, i.e., toilet constructed directly over water bodies or cesspools cannot be recommended under any circumstances. Such toilets create extremely unhygienic conditions.
4. Indian practice of using anal cleansing water renders the use of pit latrines difficult. The pits cannot be maintained dry and this leads to odor and fly problems. Defecation under such conditions becomes unhygienic and uncomfortable, and people soon abandon pit latrines and revert to open defecation.
5. Use of Urine Diversion and Dehydration Toilets (UDDT) is difficult, since the present models require following a certain discipline during defecation. An improved version of UDDT, specially attuned to Indian conditions is required.
6. Flush and pour-flush latrines connected to open drains are problematic. Since the open drains follow the contours of the ground, in flat areas slopes cannot be maintained for flow of sewage at self-cleansing velocities. This leads to the deposition of sewage solids in the drain and subsequent choking and overflowing of the drains, creating unhygienic conditions.
7. Flush and pour-flush latrines connected directly to soak pits or connected to septic tanks followed by soak pits is problematic in congested areas, especially when water table is high. The chances of groundwater pollution are very high under such conditions.
8. Shared or communal toilet facilities must be given due importance. Such facilities, which are conceptually different from public toilets, may be the only workable solutions under certain conditions.

This report,at first, developsbenchmarks for the minimum requirements of an acceptable sanitation solution in Indian context and then proposes acceptable sanitation solutions for all categories of human settlements, both in urban and rural areas. It also tries to determine the cost of implementation of these solutions.

2. Benchmark for an Acceptable Sanitation Solution

Minimum requirements for an acceptable solution in Indian context can be identified as:

1. The acceptable system must allow defecation in privacy and with dignity and a minimum amount of comfort. In other words, the system must provide a good “front end” solution.
2. The effluents from the sanitation system should not be a threat to general aesthetics of the area, i.e., seen flowing or accumulating in open view or create odor problems.

Such effluents should not become a threat to public health, either by allowing proliferation of flies and other disease vectors or by pollution of groundwater.

3. The effluent from the sanitation system must be treated to render it harmless before disposal. In other words, the system must have a good "back end" solution.
4. It is also desirable that the effluent from the sanitation system is treated such that nutrients present in feces and urine can be recycled for land application.

No sanitation solution that contravenes the first three points above is acceptable. Solutions which allow adherence to all four of the above conditions should be generally preferred.

3. Recommendations for Urban Sanitation

Urban areas in India are defined using the criteria mentioned below,

a. All statutory places with a municipality, corporation, cantonment board or notified town area committee, etc.
b. A place satisfying the following three criteria simultaneously:
    i. a minimum population of 5,000
    ii. at least 75 per cent of male working population engaged in non- agricultural pursuits
    iii. a density of population of at least 400 per sq. km. (1,000 per sq. mile)

An urban area can be classified as metro cities or class 1, class 2 and class 3 towns. The sanitation issues in all urban areas are of similar nature and can be classified as shown in Fig.3.1.

In urban areas with existing sewer lines, the issues are relatively simple. In such areas, care must be taken to ensure that all households and establishments in the area are connected to the sewer lines. In urban areas without sewer lines, the general policy should be to install sewer lines in all areas, except in, a) very congested areas with narrow road width, b) in slum areas and, c) in newly developed or developing colonies and apartment complexes. Further, all sewage collected must be necessarily conveyed to a sewage treatment plant (STP) for treatment. Ideally the STPs must be decentralized, such that the sewage conveyance and pumping costs can be minimized, however this may be impossible in some already developed areas due to space constraints and other local opposition.

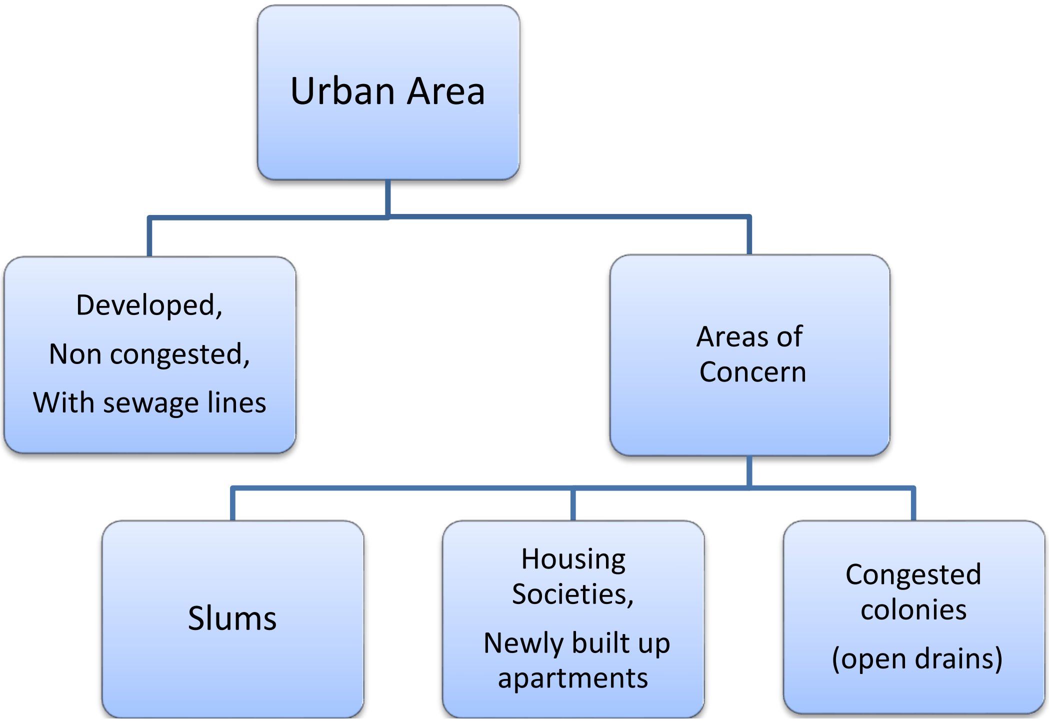

Figure 3.1: **Classification of Urban Area, with respect to areas of concern in view of sanitation**

The proposed sanitation solutions in those parts of urban areas where conventional sewers lines are impossible or are not recommended are given in subsequent sections.

3.1 Congested Colonies

Congested colonies with narrow lanes are quite common in urban areas. In many Indian urban landscapes, such congested colonies constitute the major form of human settlement. Most houses in such colonies have either flush or pour-flush toilets. The sewage from such toilets flows in open drains and then on to some low lying area or water body in the vicinity of the colony. Alternatively, some houses in the colony may have septic tanks, which are connected to soak pits or to open drains.

Neither open drains nor soak-pits constitute an adequate solution to the "back end" sanitation problems in congested urban colonies. A viable solution to the "back-end" sanitation problems in such cases is a small-bore sewer network, which may be constructed inside the open drain network existing in such colonies. In a small bore system, the sewage must pass through an interceptor before being released into small bore closed pipes. Such interceptor tanks, which are similar to septic tank, may be constructed in suitable locations inside the colony. If possible, an interceptor tank may receive sewage from several households. The sewage flowing through the small-bore system may be released into existing sewer lines outside the colony. Alternatively, the sewage from the small-bore system may be treated in a decentralized STP before disposal.

Compared to conventional sewer systems, small bore sewers can be significantly less costly to construct, and yet provide a similar level of service. Such systems are in successful operation in many countries. Blockages in such small bore systems can be largely eliminated through proper designing of the interceptor tanks. The provision of interceptor tanks also result in flow equalization, considerably reducing peak flows in the network. The sustainability of the system however depends on the regular evacuation of the interceptor tanks and systems for this must be put in place. The sludge from such tanks must be further treated before disposal.

Since the solids load is considerably reduced in the effluent from the interceptor tanks, small bore sewers need not be designed for self-cleansing. Pipe gradients can be reduced and sections depressed below the hydraulic grade line. This reduces the sewer depth requirements and such sewers may also run along existing open drains. Also, manholes are not necessary in such networks. Provision of hydraulic flushing must however be available to remove any blockages.

Since such networks have not been installed in India, cost analysis of this system was done by studying a pilot project proposed for a small congested colony near Delhi. This colony has 1200 households and a population of around 6000. Water consumption is around 100 lpcd, hence sewage generated is around 80 lpcd. If the effluent from the proposed small-bore system is discharged in the nearest sewer line, then the amortized capital and O&M cost of the system is Rs. 4.51 /cap/d. In case the amortized capital and O&M cost of an STP is included, the cost rises to Rs. 5.13 /cap/d. The relevant calculations are presented in the Appendix (see Table A1**).**

3.2 Slums

Slums in urban areas are distinguished by the fact that individual households in such areas generally do not have toilets. The inhabitants in such areas either practice open defecation or use other toilet facilities like hanging latrines over cesspools, public latrines provided by municipalities, etc.

It is not practical to have separate toilets for each household in slum areas. Therefore a community toilet system is the best possible solution. The proposed alternatives for slum areas include the following,

- Community latrines based on Zero Discharge Toilet (ZDT) technology as developed at IIT Kanpur.
- Community pour-flush latrines connected to a small bore system and discharging to sewer line outside the slum
- Community pour-flush latrine discharging directly to sewer line outside the slum

Alternatives such as pit latrines, latrines connected to septic tanks and then soak pits etc. were considered inappropriate considering the possibility of groundwater contamination. Composting toilets are generally inappropriate in Indian conditions due to the practice of using water for anal cleaning. Presence of excess water makes composting difficult. Alternatives such as UDDT are also considered inappropriate since the discipline required for using such toilets is difficult to maintain in communal/shared toilets. Calculations show that the amortized capital and O&M cost of a ZDT system for 750 persons is approximately Rs. 4.90/cap/d. The relevant calculations are presented in the appendix (see Table A2).

Community toilet systems are common in India. An organization devoted to the setting up such toilets is Sulabh International, which has evolved a business model for the operation and maintenance of such toilets. Assessment of the model adopted by Sulabh International shows that their model has a good "front end", i.e., users can defecate in privacy and with a minimum physical comfort. However, the 'back end" of their system is not so efficient. The most commonly adopted "back end" solution for such systems is a septic tank followed by a soak pit, which is clearly unacceptable in congested slums. However, the Sulabh Model can readily be improved by connection of toilets to sewers, either directly, or through a small-bore system. Calculations show that the amortized capital and O&M cost of a pour-flush community toilet system for 750 persons is approximately Rs. 4.71/cap/d, when proper "back end' solution is incorporated. The relevant calculations are presented in the appendix (see Table A3).

3.3 New Townships/ Housing Society/ High Rise Building Complexes

The guiding principle regarding sanitation in such units is the fulfilment of the zero discharge criteria, at least in the dry season. All sewage produced in such units must be treated on site and re-used for a) horticulture purposes, b) cooling purposes, c) for flushing purposes, d) fire-fighting demand, and d) to maintain surface water bodies within the premises. Such a policy will have dual benefits, the fresh water demands from such units will be considerably reduced and there will be no additional demand on the urban sewage network.

The entire cost for this should be borne by the township/society concerned. A market survey was done to understand the costing of a decentralized STP of a housing society. For a typical society in the NCR region, the operation and maintenance cost of a 500 kld plant was found around Rs. 25.6/ kL (refer appendix, Table A4). Assuming that a household of 5 generates 800 L sewage per day, the amortized cost of treatment is about Rs. 5.24 /cap/d including the capital cost of STP. However, in cases where an existing STP is already available, the amortized cost is Rs. 4.09 /cap/d (refer appendix, Table A5). Analysis of the costs in a society in the NCR region with a functioning STP showed that the cost of running the STP contributed only around 4.50 % of the total user charges paid by households to the society (refer appendix, Table A6).

4. Recommendations for Rural Sanitation

In India, human settlements with population less than 5000 are generally known as rural areas. Many households in rural areas do not have toilets and practice open defecation. Most toilets in rural households are of the pit latrine type. In rare cases, households have flush or pour flush latrines. Such latrines are sometimes connected to soak pits, either with or without a septic tank. Communal toilets are mostly absent in rural areas.

Based on the description of the current scenario concerning rural sanitation in India, it is clear that most of the practices followed are unacceptable as per the minimum sanitation benchmarks identified. Current government policy recommends the construction of pit latrines in rural areas to prevent open defecation. However, due to the Indian practice of anal cleaning with water after defecation, pit latrines are never dry and hence do not satisfy the minimum comfort criteria (smell, flies etc.) that is expected from a latrine. Hence many pit latrines constructed in rural areas have been abandoned and people have reverted to open defecation. Furthermore, pit latrines and soak pits are unsuitable in areas with high water table, rocky strata etc. and may be the cause of groundwater contamination or general decline in public hygiene due to overflowing.

4.1 Sanitation in Rural Areas with Population less than 1000

In small villages with well drained soil and relatively low water table, the acceptable sanitation solutions are the following,

- A pour flush latrine for individual households, with a septic tank followed by a soak pit. A group of 4-5 households can have one septic tank installed with the septage discharged into the ground through a soak pit. Construction of a double pit system is recommended to enhance system reliability and so that the soak pits can be used in turns and cleaned when not in use. Regular evacuation and maintenance of septic tank is also required. The amortized cost of the above system is Rs. 4.19 /cap/d, which includes the cost of the toilet. Calculations are shown in a tabular form in the Appendix (see Table A7). The existing toilets in households may be converted to the above system relatively easily.
- A community toilet system for each cluster of household with an attached septic tank and a soak pit can be a good option in settlements where majority of households lack toilets. A community toilet could be a pour-flush latrine similar to that described previously, or a ZDT system (similar to that developed by IIT Kanpur).

In small villages with high water table, periodic flooding or with rocky strata, soak pits are not recommended. Acceptable sanitation solutions in such situations are the following,

- For individual households, an improved version of the UDDT system with provisions keeping the feces separate from urine and anal cleaning water. Such systems suitable for Indian conditions are currently not available and development of such systems should be encouraged.

- A community toilet system for each cluster of household based on ZDT technology similar to that developed by IIT Kanpur.

4.2 Sanitation in Rural Areas with Population between 1000 and 5000

In large villages, provision of a soak pit is not recommended even when the topography is favourable. Provision of a soak pit enhances the threat of water borne diseases in the area and hence must be avoided even in areas with moderate population density. The proposed sanitation solutions in large villages include,

- Pour flush toilets in individual households connected to small-bore system transporting the effluent to a lined constructed wetland for further treatment. 4-5 households can have a common interceptor tank. The amortized cost of such a system, including the wetland, but not including the toilet is approximately Rs. 4.18 /capita/d. Detailed cost calculations are provided in the Appendix (see Table A8).
- Community toilet system of the pour-flush type connected to small-bore system transporting the effluent to a lined constructed wetland for further treatment before discharge.
- Community toilet system employing ZDT technology similar to the system developed by IIT Kanpur

4.3 Sanitation in Rural Areas with Population greater than 5000

There may be some settlements with population more than 5000 but still designated as rural area due to predominantly agricultural occupation of the people and/or low population density. The sanitation solutions in such areas are similar to villages with population between 1000 – 5000. However, other types of STPs, i.e., pond systems and aerobic lagoons may be considered in such areas in lieu of wetland systems.

5. Concluding Remarks

The overall sorry state of sanitation facilities in India arises only partly from the fact that a large segment of our population is poor and lack access to toilets. There are considerable doubts regarding which sanitation technologies are suitable for Indian conditions. In recent years, both central and state governments in India have spent enormous resources to provide “improved” sanitation facilities as elucidated in the “Millennium Development Goal” targets. Large numbers of pit latrines were constructed to prevent open defecation. However, many of these pit latrines became defunct and people returned to open defecation.

Through analysis presented in this report, the sanitation practices that are undesirable in Indian conditions have been identified. Further the desirable aspects of any sanitation solution in India have been highlighted. Subsequently, sanitation solutions have been proposed for various kinds of human settlements prevalent in India, in both urban and rural areas. The approximate cost for adopting these technologies has also been worked out. These results are summarized in tabular form in Tables6.1 and 6.2.

From Tables6.1 and 6.2 it can be concluded that amortized cost of sanitation facilities are in the range of Rs. 4.00 to Rs. 6.00 /capita/day. Further all proposed sanitation solutions require provisions for regular operation and maintenance, including deputation of skilled/unskilled workforce for this purpose. Our country not only needs to adopt the correct technological solutions, but must also be willing to arrange and plan for the funds required to provide sanitation for all.

Table 6.1: Summary of Urban Sanitation

Urban Sanitation									
					Components covered in costing				
S.No.	Category	Proposed Solution		Cost (Rs.) /head/day	Front end	Conveyance cost	Capital investment in treatment	Operation and Management cost	Remarks
1	High rise buildings/ Townships/ Housing Societies	a	New Buildings with an in house STPs installed	4.1		√		√	The treated water is used for purposes like flushing, horticulture etc., which further reduces the demand of fresh water of the society
		b	An in-house STP proposed if not already installed, as it would reduce a lot of load from municipal sewer lines	5.24		√	√	√	This cost includes the cost of STP, this is the best possible solution as recycling of wastewater is a necessity nowadays
2	Congested Colonies	a	Small bore sewer system connected to a STP	5.13		√	√	√	Considering 80 L of wastewater generated per head per day
3	Slums	a	Zero Discharge Toilet system: a mobile community toilet system	4.9	√	√	√	√	ZDTS is a complete solution but would need extra land for composting. Cost of toilet included as nobody has a personal toilet in slums
		b	Community toilet (SulabhShauchalya type) connected to STP	3.88	√			√	Wastewater is supposed to be dumped in nearest sewer line, only cost of treatment considered. 40 L wastewater assumed per head per day

Table 6.2: Summary of Rural Sanitation

Rural Sanitation										
S. No.	Population	Proposed Solution			Cost (Rs.) /capita./day	Components covered in costing				Remarks
						Front end	Conveyance cost	Capital investment in treatment	Operation and Management cost	
1	Less than 1000	a	Septic tank with soak pit		4.19		√	√	√	For households already having toilets, only if topography allows
		b.	Community toilet	Pour flush toilet attached to septic tank and soak pit	4.71	√		√	√	To cater households without toilets, a community toilet is a must
				Zero Discharge Toilet System	4.9	√	√	√	√	ZDTS is a complete solution, would need extra land for composting
2	More than 1000 but less than 5000	a	SBS connected to a wetland		4.18		√	√	√	Considering 80 L of wastewater generated per head per day
		b	Community toilet	Pour Flush toiletconnected to wetland via SBS	4.71	√			√	Capital cost of wetland not considered in case of community toilet, 40 L wastewater assumed per head per day
				Zero Discharge Toilet System	4.9	√	√	√	√	ZDTS is a complete solution, would need extra land for composting though

Table 6.2: Summary of Rural Sanitation (continued)

Rural Sanitation										
S. No.	Population	Proposed Solution			Cost (Rs.) /capita./day	Components covered in costing				Remarks
						Front end	Conveyance cost	Capital investment in treatment	Operation and Management cost	
3	More than 5000	a	SBS connected to a STP		5.13		√	√	√	Considering 80 L of wastewater generated per head per household, including cost of STP
		b	Community toilet	Community toilet (SulabhShauchalya) connected to STP via sbs	4.71	√			√	Capital cost of STP not considered, as the wastewater is supposed to be dumped in nearest sewer line, only cost of treatment considered. 40 L wastewater assumed per head per day
				Zero Discharge Toilet System	4.9	√	√	√	√	ZDTS is a complete solution, would need extra land for composting though

Appendix

Table A1: Costing of a Small Bore Sewer System installed in a congested colony

Small bore system for a congested colony (population: 6000)

S.No.	Particulars	One time Cost	Per month
1	Pipe laying cost	7,756,801	
2	Cost of Manholes	0	
3	System Access Points	2,300,256	
4	Clarigester (Septic Tank)	10,160,000	
5	Surface Reinstatement	1,372,800	
6	Low pressure and cctv testing after commissioning	2,215,300	
7	Clarigester internal components	20,888,400	
8	Intermediate Pumping Station	0	
	Total	**44,693,557**	**431365.00**
9	O & M of the conveyance system in 20 years		20850
	Total Monthly expenditure		452215.00
Per head per day cost of safe disposal of waste water to a nearby sewer line			2.51
Per head per day cost of including conveyance in sewer line and treatment			**4.51**
Per head per day cost of conveyance and treatment including cost of onsite STP			**5.13**

Assumptions and considerations

1	Total capital cost amortised on monthly basis assuming rate of interest as 10 % for a period of 20 years
2	Detailed costing has been taken from a proposed pilot project by EIL
3	Assuming 80 liters of wastewater generated per head per day

Table A2: Costing of Zero Discharge Community Toilet System

ZDTS for Slum (Population: 750)				
S.No.	**Particulars**	**One time (Rs.)**	**Monthly (Rs.)**	**Annual(Rs.)**
1	Toilet Structure (30 toilets) + Mixer + Mini Evacuation Trolley + Composting Yard	3240000	42817	513804.00
2	Chemicals and other toiletries		5000	60000.00
3	Diesel + Electricity etc.			54750.00
4	Supervisor / Local Representative incentive @10000 per month			120000.00
5	Sweeper/Operator (6 Nos.) @6000 per month		36000	432000.00
6	Contingency/Repairs/Servicing/Standby			162000.00
	Total			1342554.00

	Cost of treatment per day	3678.23
	No. of Users	750.00
	Cost per user per day	**4.90**

Assumptions and considerations	
1	Total capital cost amortised on monthly basis assuming rate of interest as 10 % for a period of 10 years
2	Cost of chemicals and toiletries taken from market survey
3	Assuming Rs. 150 expenditure on fuel and electricity per day
4	Considering contingencies to be 5 % of the total capital investment, annually
5	Considering 25 users per toilet system per day

Table A3: Costing of Sulabh Shauchalya with proper treatment of wastewater

Sulabh Shauchalya in Slum (Population:750)				
S.No.	**Particulars**	**One time (Rs.)**	**Monthly (Rs.)**	**Annual(Rs.)**
1	Toilet Structure (3 units of 10 toilets each)	3000000	39645	475740.00
2	Toiletries and Electricity charges			54750.00
4	Supervisor / Local Representative incentive @10000 per month			120000.00
5	Sweeper/operator(3 Nos.) @ 6000 per month		18000	216000.00
6	Contingency/Repairs/Servicing/Standby			150000.00
	Total			1016490.00

	Cost of defecation per day	2784.90
	No. of Users	750.00
	Cost per user per day	3.71
	Cost of conveyance and treatment of sewage per user	1.00
	Total cost of treatment per user per day (excluding cost of land)	4.71

Assumptions and considerations	
1	Total capital cost amortized on monthly basis assuming rate of interest as 10 % for a period of 10 years
2	Cost of toiletries wages of labor taken from market survey
3	Assuming expenditure of Rs. 150 on electricity and toiletries per day
4	Considering contingencies to be 5 % of the total capital investment, annually
5	Assuming 40 liters of wastewater per person per day
6	Considering 25 users per toilet system per day

Table A4: Costing of a 500 kld treatment plant including capital cost of STP

	Operation & Maintenance Cost of a 500 kld treatment plant including capital cost of treatment plant	One time investment	Tentative existing expenditure / month	Cost /KL
1	**Capital cost (for supply, installation, testing and commissioning of electro-mechanical items including civil work)**	**10000000**	107461	**7.16**
2	**Break-up of Non-Comprehensive Offer**	-		
i	Manpower (4 Nos) + Administrator		45000	**3.00**
ii	Site expenses (Room Rent, Uniform, Staff welfare, Conveyance,Safety appliances, Tools & tackles, Stationery, Internet, telecommunication, etc)		15000	**1.00**
iii	Maintenance cost		170000	**11.33**
iv	Electricity cost		95000	**6.33**
2	**Chemicals**	-		
i	Chlorine		3000	**0.20**
ii	Polymer		1300	**0.09**
iii	Oil, grease/lubricant		1500	**0.10**
iv	MGF Media/ Activated Carbon		53000	**3.53**
	Total cost (treated water)		**491261.00**	**32.75**

Approximate expenditure per household per day	26.201
Cost of treatment of wastewater per person per day	**5.240**

Assumptions and considerations	
1	Total capital cost amortised on monthly basis assuming rate of interest as 10 % for a period of 15 years
2	Cost of chemicals taken from market survey
3	Assuming an average of 5 persons per household
4	Assuming 800 liters of wastewater generated per household

Table A5: Running cost of a 500 kld STP

Operation & Maintenance Cost of a 500 kld treatment plant			
S.No.		Tentative existing expenditure / month	Cost /KL
1	**Break-up of Non-Comprehensive Offer**		
i	Manpower (4 Nos) + Administrator	45000	**3.00**
ii	Site expenses (Room Rent, Uniform, Staff welfare, Conveyance, Safety appliances, Tools & tackles, Stationery, Internet, telecommunication, etc)	15000	**1.00**
iii	Maintenance cost	170000	**11.33**
iv	Electricity cost	95000	**6.33**
2	**Chemicals**		
i	Chlorine	3000	**0.20**
ii	Polymer	1300	**0.09**
iii	Oil, grease/lubricant	1500	**0.10**
iv	MGF Media/ Activated Carbon	53000	**3.53**
	Total cost (treated water)	**383800.00**	**25.59**

Approximate expenditure per household per day	20.469
Cost of treatment of wastewater per person per day	**4.094**

Assumptions and considerations	
1	Assuming an average of 5 persons per household
2	Cost of chemicals taken from market survey
3	Assuming 800 liters of wastewater generated per household

Table A6: Maintenance charges of a typical housing society

Freedom Park Life Housing Society (B.P.T.P.)							
S.No.	**Month**	**Maintenance charge per month**	**No. of Flats**	**Maintenance charge per month per household**	**Running cost of STP/ month**	**Cost incurred to user per month, due to STP**	**% of total maintenance charge**
1.00	Apr	3992000.00	453.00	8812.36	200000.00	441.50	5.01
2.00	May	4976000.00	453.00	10984.55	200000.00	441.50	4.02
3.00	Jun	5310000.00	453.00	11721.85	200000.00	441.50	3.77
4.00	Jul	5128000.00	453.00	11320.09	200000.00	441.50	3.90
5.00	Aug	4486000.00	453.00	9902.87	200000.00	441.50	4.46
6.00	Sept	4463000.00	453.00	9852.10	200000.00	441.50	4.48
7.00	Oct	3630000.00	453.00	8013.25	200000.00	441.50	5.51
8.00	Nov	3808000.00	453.00	8406.18	200000.00	441.50	5.25
9.00	Dec	3956000.00	453.00	8732.89	200000.00	441.50	5.06
Total		**39749000.00**	**453.00**	**87746.14**	**1800000.00**	**3973.51**	
Average		**4416555.56**	**453.00**	**9749.57**	**200000.00**	**441.50**	**4.53**

Table A7: Cost of septic tank and soak pit attached to toilets of 5 households

Septic tank and soak pit for 5 households(30 members)

S. No.	Particulars of toilet systems	Cost (Rupees)	Monthly(Rs)
1	Pourflush toilet systems including superstructure (5 no.s)	75000	
2	Septic Tank(good for 30 people) attached to soak pit	100000	
	Total	175000	1689.00

Maintenance and cleaning charges per year	25000	2083.33

Total	**3772.33**
Cost of Sanitation per head per day including cost of toilet	**4.19**

Assumptions and considerations

1	Total capital cost amortised on monthly basis assuming rate of interest as 10 % for a period of 20 years
2	Cost of chemicals and toiletries taken from market survey
3	Cost of toilet systems and septic tank taken from market survey

Table A8: Costing of a Small bore sewer system installed to a village

Small bore system for a village (population: 5000)			
S.No.	**Particulars**	**One time Cost**	**Per month**
1	Pipe laying cost	7,756,801	
2	Cost of Manholes	0	
3	System Access Points	2,300,256	
4	Clarigester (250 Septic Tanks) including internal components	25,873,667	
5	Surface Reinstatement	1,372,800	
6	Low pressure and cctv testing after commissioning	2,215,300	
7	Intermediate Pumping Station	0	
	Total	39,518,824	381365.00
8	O & M of the conveyance system in 20 years		20850
	Total Monthly expenditure		402215.00
Per head per day cost of safe disposal of waste water to a nearby sewer line			2.68
Per head per day cost of conveyance and treatment in wetland			4.18
Assumptions and considerations			
1	Total capital cost amortised on monthly basis assuming rate of interest as 10 % for a period of 20 years		
2	Detailed costing has been taken from a proposed pilot project by EIL		
3	Assuming 80 liters of wastewater generated per head per day		