PRIVATIZING SEWAGE TREATMENT IN DELHI

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Abstract

Most people living in developed regions of Delhi today are unaware of the fact that if they have a functional commode in their bathrooms, they are contributing to the pollution of Yamuna.

Despite the intentions of the government, infrastructural development for sewage and wastewater treatment has not kept pace with the increasing wastewater generation. While the developed and organized regions of Delhi are given poor waste water treatment services, the unorganized areas such as the slums are not provided any sewage treatment whatsoever as they lie outside the jurisdiction of the DJB —making the process of subsidizing sewage treatment in Delhi redundant as it does not cater to the poor.

Interestingly, the success of private sewage treatment plants has been phenomenal. Can the success of these private sewage treatment plants be mimicked in the rest of the capital? This paper looks at the scope of privatizing sewage treatment plants and proposes an alternate model for the sewage network in Delhi.

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Introduction

Most people living in developed regions of Delhi today are unaware of the fact that if they have a functional commode in their bathrooms, they are contributing to the pollution of Yamuna.

Out of all the sewage that comes in to the city, only about 30% of it is treated. (Down to Earth 2012) Despite the intentions of the government, infrastructural development for sewage and wastewater treatment has not kept pace with the increasing wastewater generation. As a result a large amount of polluted water is discharged into natural waterways. (MoEF 2009) (Amarsinghe et al. 2013, 12)

While the developed and organized regions of Delhi are given poor waste water treatment services, the unorganized areas such as the slums are not provided any sewage treatment whatsoever as they lie outside the jurisdiction of the Delhi Jal Board; this makes the whole process of subsidizing sewage treatment in Delhi redundant as it does not cater to the poor.

Can the success of these private sewage treatment plants be mimicked in the rest of the capital? This paper looks at the scope of privatizing sewage treatment plants in Delhi and contends to answer three basic arguments:

1. It argues that a centralized system is extremely cost intensive and impractical for a metropolitan city like Delhi.
2. It asserts that a privatized, decentralized and small scale waste water treatment system is more functionally efficient.
3. Decentralized waste water treatment systems are cost effective, hence becoming a viable solution for even the JJ clusters and slums for urban Delhi.

Looking at the phenomenal success of decentralized, small scale private sewage treatment plants, this paper proposes an alternate model for the sewage network of Delhi.

Methodology

This paper evaluates the scope of privatization of sewage treatment plants in Delhi.

The first section of the paper gives an introduction to the current state of sewage treatment systems in Delhi. It presents a strong case show casing the inefficiencies of the current system, and how it is affecting our natural environment as well as daily lives.

The second section is divided into two parts; the first part assesses the mismanagement and insufficient usage of the 23 Sewage Treatment Plants (STP) set up in Delhi, and the loss of capital investment due to the same. The second part looks at the cost incurred in the construction of sewage treatment plants and sewage pipeline networks. It contends that these networks are not only capital intensive, but also redundant as it only leads to increase in cost.

The third section of the paper calculates the taxes paid by an individual for sewage treatment facilities. Through various mathematical measures and statistics, it compares the per capita cost of using a STP, and the taxes paid for the same. As we will see, the taxes are highly subsidized or undervalued.

The fourth section of the paper introduces the concept of decentralized/privatized small scale treatment plants and assesses their effectiveness as compared to the conventional centralized treatment systems. The fifth and sixth section then present a powerful argument in favor of these decentralized systems, as being cost effective, less energy intensive and a viable solution for the poor.

The seventh section then assesses the practical functionality of the concept by presenting a few examples from India itself. It helps to understand that these solutions are practicable, not only in paper but in practice as well.

The last section, along with the conclusion presents a functional model for Decentralized and Privatized Treatment Systems, and suggests ways through which this can be promoted among the communities of Delhi.

Sewage Treatment in Delhi

In India, 38,255 MLD of sewage is produced every day. Out of this, it has the capacity to treat only 11,788 MLD and actually treats just about 8,251 MLD (22%) of the total sewage. 70% of sewage produced is dumped directly into water bodies, and pits without any prior treatment. If today the government decides to build sewage treatment plants for this 70% of sewage, it would cost around Rs 26,500 to Rs 105,868 Crore (Excreta Matters 2012).

In Delhi alone, around 3296 MLD (Million Liters per day) of sewage is dumped in the River. Delhi generates approximately 600 million gallons per day (MGD) of sewage, while it has an installed capacity to treat only 512.4 MGD of waste. Nearly 58 per cent of the total sewage generated by the city is dumped in the Yamuna, emptied into the river by 22 drains between Wazirabad Barrage and Okhla Barrage (Kumar 2012).

The Supreme Court on 11th November 2012 said all parameters of water quality of river Yamuna indicate that it more or less resembles a drain. The court noted the submission of CPCB counsel, Vijay Panjwan that the cumulative assessment of all parameters of water quality indicates that river Yamuna is not conforming to the desired levels and it more or less resembles a drain, especially after the Wazirabad area in Delhi. CPCB also told the court that on the basis of information so far collected on inspection of the Yamuna, the river does not have fresh water. Further, it said the national capital does not have a proper drainage system, which was a contributing factor in the pollution of the river. The counsel said there are 30 sewage treatment plants but even they are underutilized to the extent of 37%. "Only 63 percent of the sewage treatment plants are operational at present in the region," CPCB said (Gits4u 2012).

At Wazirabad in Delhi, The Yamuna is tapped for drinking water supply to Delhi. In the dry season generally, no water is allowed to flow beyond Wazirabad barrage, as the available water is not adequate to fulfill the demand of water supply of Delhi. Whatever water flows in the downstream of Wazirabad barrage is the untreated or partially treated domestic and industrial wastewater.

After 22 Km downstream of Wazirabad barrage there is another barrage, Okhla barrage, through which Yamuna water is diverted into Agra Canal for irrigation. No water is allowed to flow through barrage during dry season. Whatever water flows in the river beyond Okhla barrage is contributed through domestic and industrial wastewater generated from East Delhi, Noida and Sahibabad and joins the river through Shahdara drain (CPCB 2007).

If one really looks at it, the Yamuna In the dry season is nothing more than a drain. The city of Delhi, extracts all the water from it, and in return provides untreated and partially treated sewage water. One wonders what authorities have allowed 100% water extraction from a river, and in return sewage water is thrown back to keep the stream flowing. Around 3000 million liters of sewage is released in to the Yamuna each day (Bhaskar News 2013).

Need for Sewage Treatment

Improper and inadequate sewage treatment impacts the individuals' and environment's health in many ways:

- Threats to public health from malfunctioning septic systems, resulting in bacterial contamination of well water and swimming areas, or sewage surfacing on the ground
- Inadequate treatment that contributes to nutrient-induced algae growth or other problems in recreational and coastal waters
- Aesthetic concerns including odors, noises from aerators or other system components, or inadequately treated discharges of sewage to neighborhood ditches or streams
- High costs, lowered water tables, and construction-related disruptions associated with replacing onsite systems with sewer lines that transport wastewater to a distant centralized sewage treatment plant (EPA 2005, 7)

Impact of Sewage Pollution on Health

Toxic food: farming around Yamuna

A study conducted by three associate professors of Deen Dayal Upadhyay College in Delhi University shows that the amount of fecal matter in river water has increased exponentially since the Central Pollution Control Board came out with its findings in 2009. The amount of Fecal coliform (FC) – bacteria available in human and animal feces – has grown by as much as 30 times as compared to CPCB values.

The presence of FC indicates that the water is contaminated with human or animal waste, which makes its way to the river through millions of liters of untreated sewage water every day. Though vegetables grown on Yamuna bed in east and south Delhi are already known to have high metal content, FC content in food can bring one down with severe intestinal problems.

According to the tests, the value of FC found at Nizamuddin Bridge was 9.3 crore per 100 milliliters of water. Okhla Barrage had the least fecal content at a value of 5.2 Crore per 100 milliliters. The FC value earlier reported by CPCB was 57 lakh to 30 lakh per 100 milliliter.

"Ingestion of such contaminated food can cause vomiting, diarrhea, gastroenteritis, blood infection, dehydration, urinary infection and kidney dysfunction. We have indeed seen increasing number of such cases recently," said Dr Anoop Misra, director, Fortis C-Doc Centre for Internal Medicine, Vasant Kunj (Pushkarna 2013).

A study undertaken by TERI showed how despite government efforts industrial effluents and untreated sewage continue to choke the river. The toxins have polluted the ground water and soil. It has entered our food chain through the vegetables grown on the banks and continues to affect the people living on the banks.

Toxic metals (nickel, lead, manganese, chromium, mercury, zinc) were evidently found in the water at several locations. At one particular location, lead levels were found to be 10 times more than elsewhere in the river.

Soil samples were collected from the river bank to determine the contamination levels in the flood bank. These levels exceeded commonly used international reference values for nickel and chromium levels in soil. Lead levels ranged from below detection to 40 times over the permissible limits. Mercury concentrations too were much higher than permissible standard at all locations. Wazirabad and Okhla barrage showed high levels of different metals. A possible reason for this is the industrial effluents. While the Wazirabad section of the river receives wastewater from Najafgarh and its supplementary drains, the Shahdara drain releases its load downstream at the Okhla barrage (TERI 2012).

Status of Sewage Treatment Plants in Delhi

Current Capacity of Sewage Water Treatment Plants in Delhi

The current sewage treatment capacity of the 23 sewage treatment plants set up in Delhi is 514.75 MGD. Out of the total created capacity, only 62% (321.92 MGD) is actually utilized. Table 1 shows a comparative analysis between the total sewage treatment capacity, to the amount of sewage actually treated in these 23 sewage treatment plants.

Table 1: Total Sewage treatment capacity of Delhi per STP (In MGD) (Delhi Government 2013, 10)

S. No.	Name of Sewerage Treatment Plants (STPs)	Capacity (31.3.2001)	Capacity (31.3.2012)	Treatment on 31.3.2012	% of Utilization
1.	Okhla	140	140	112.13	80.09
2	Keshopur	72	72	46	63.89
3	Coronation Pillar with Oxidation ponds at Timarpur	46	46	7.63	16.59
4	Rithala	40	80	42.03	52.54
5	Kondli I, II, III, IV	45	45	56.40	125.33
6	Yamuna Vihar I, II	10	20	10.95	54.75
7	Vasant Kunj	5	5	4.10	82.00
8	Ghitorni	5	5	--	--
9	Pappankalan	20	20	17.73	88.65
10	Narela	10	10	1.10	11.00
11	Najafgarh	5	5	.90	18.00
12	Delhi Gate	2.20	2.20	2.37	107.73
13	Sen Nursing Home	2.20	2.20	2.54	115.45

14	Rohini		15	--	--
15	Nilothi		40	14.58	36.45
16	Mehrauli		5	2.74	54.80
17	CWG Village		1	.09	9.00
18	Molarbad		.65	.50	76.92
19	Bakkerwala		.70	.13	18.57
	Total	402.40	514.75	321.92	62.54

As one can evidently see, the sewage treatment plants are not functioning to their optimal level. The DJB and CPCB justify this with various reasons:

1. Low flow of sewage to STPs
2. Trunk and peripheral sewer lines still to be connected to these STPs
3. Rehabilitation of silted and settled truck sewer lines yet to be completed
4. Massive discrepancies in sewage management and planning in the city, saying that Delhi Jal Board had not prepared any "perspective" plan for sewage management in the 11th five-year plan.
5. Inadequate coverage of sewer network
6. lack of infrastructure and operational records; inadequate “crisis” maintenance
7. Institutional – significant overlap in the role of policy formulation, service delivery and regulation, lack of adherence to service standards, inefficient customer interface, lack of performance orientation, inadequate use of IT & MIS, inadequate service provision to the poor
8. Financial – very low tariff; low cost recovery forcing DJB to rely on excessive loan assistance from the Government, high costs, particularly energy usage (DJB 2004, 2).

Cost of Underutilization of Sewage Treatment Plants:

According to the estimates of the Delhi Jal board, Delhi produces about 680MGD of sewage. Despite having a capacity to treat 540MGD of sewage, only 367MGD of sewage is actually treated. 46% of the sewage generated in Delhi is dumped into the river Yamuna without prior treatment. (Delhi Government 2013, 10)

Table 2: Underutilized STPs in Delhi (Delhi Government 2013, 10).

S.No.	Location	No. of STPs	Installed Capacity (MGD)	Sewage Actually Treated (MGD)	Capacity Utilization (per cent)
1	Okhla	5	170	113.07	66.51
2	Rithala	2	80	43.01	53.76
3	Koshopur	3	72	23.01	32
4	Rohini	1	15	0.73	08
5	Yamuna Nagar	2	20	11.53	4.87
6	Narela	1	10	1.20	57.65
7	Pappankalam	1	20	13.45	12.00
8	Ghitorni	1	5	Nil	67.25
	Total	16	492	206.09	52.57% utilization

The above table shows that the STPs in Delhi are working below capacity and overall utilization is only 52.57% of the total capacity. The utilization of Rohini and Narela STPs is as low as 5% and 12% respectively. The DJB has spent large amounts of money in creating treatment capacity while it has failed to create the remaining infrastructure such as sewage conveyance system from places where large quantities of sewage was produced to the STPs (DJB 2013)

The plant at Ghitorni constructed in 1997 is lying idle since then. Rs 6.62 crore were spent in its construction. According to the Delhi jal Board, the STP remains idle due to “the non availability of sewage in its commanding areas”. This implies that according to the DJB, the communities living in Ghitorni produce no sewage.

The most astounding of these is the Najafgarh Sewage treatment plant, which works in close proximity to the many tributaries of Najafgarh drain. The Najafgarh STP has a capacity of treting 5 MGD; however only 18% of it is actually utilized. The Najafgarh drain everyday discharges 545.41 MGD of sewage, out of which only 30% is treated. This treated sewage from various sewage treatment plants is discharged with the Najafgarh drain where it is mixed with the untreated sewage, thereby defeating the very purpose of waste water treatment (Mahapatra 2012). The DJB stated that the reason why STPs are underutilized is because there is not enough sewage produced n the said area. This argument holds to be completely false in the Najafgarh locale.

Cost of Constructing an STP in Delhi

Between 2007 and 2012, Rs. 3132.50 crore have been spent in sewage treatment programs in Delhi (Delhi Government 2013, 10).

The below table 3, shows the cost incurred in building a Sewage treatment plant.

Table 3: Cost of constructing a Sewage treatment plant in Delhi (JnNURM 2011, 19)

Flow in Kilo liter/day	**Capacity Cost in Rs. Per Cu.M.**
25	28000
26 to 50	18000
51 to 100	11500
101 to 150	9500
201 to 600	7000 to 8000
600 to 1000	5000 to 6000

1000	3000 to 5000

The operation cost for Sewage treatment plant of Municipal Corporation (Capacity in MLD) was found to be between 1.25 to 2.0 Rs per kilo Liter of Sewage.

For constructing a STP with a capacity of 25000 litres/day the cost is Rs. 28000.
For constructing a STP with a capacity of 25,000,000 liters/day the cost is 28,000,000.
Therefore, the cost of constructing a 25MLD capacity STP comes out to be Rs. 2 crore and eighty lakhs. (JnNURM 2011, 19)

Daily Operation and Maintenance cost of STP:

The below tables show the daily operation and maintenance cost of an STP based on the technology used by it.

Table 4: Daily cost of Operation and Maintenance of STP (200 m_3)

Process system	Consumption (kWh)	Unit cost (Rs)	Total consumption (Rs)	Cost of chemicals (Rs)	Total cost (Rs)
Aerobic	150	10	1500	100	1600
Anaerobic	120	10	1200	1500	2700
Phytorid	15	10	150	50	200

Table 5: Annual cost of construction, operation and maintenance of STP (200 m_3)

Process system	Construction cost (Rs)	Operation & maintenance cost (Rs)
Aerobic	35,00,000	5,50,000

Anaerobic	33,00,000	9,85,000
Phytorid	43,00,000	1,10,000

Phytorid is a new energy saving technology which has not been used in conventional Sewage Treatment Plants. Conventional treatment plants use a combination of aerobic and anaerobic process systems that consume a high amount of energy and are cost intensive (Karodpati and Kote 2013, 71). The daily operation and maintenance cost of a conventional STP comes out to be between Rs. 1600-2700 per 2, 00,000 liters.

Cost of Constructing Sewage Networks

In Delhi alone today, there is a 9500km sewage pipeline deficit. To build these sewage pipelines, an investment of Rs. 25,000 Crore is required (Express India 2013). The massive transportation cost is sometimes unaccounted for in the construction of Sewage treatment plants. The STPs in Ghitorni, Rohini and Pappankalam remain underutilized for this very reason that there are not enough sewage networks to transport the Sewage to these plants.

Sewage and Water Charges in Delhi

For Domestic Consumers

The below table 6 shows the progressive water and sewage charges charged by the DJB.

Table 6: Water Tariff as per consumption (DJB 2009)

Rates for water charges (Rupees per month) Monthly Consumption (Kilolitre)	Service Charge	Volumetric charge (per kilolitre)
0-10	50/-	2/-
10-20	100/-	3/-
20-30	150/-	15/-

>30	200/-	25/-

The Sewage maintenance charge is 60% of water volumetric charge.

Hence, if an average household uses around 30 kilo Liters per month, the water tax for that household would be (15*30) + 150= 500.

And the sewage maintenance tax would be 60% of 500= 300rs per month.

There is no sewage meter: While a water meter is compulsory for each house hold availing water facilities from the DJB, there is no provision made for a sewage meter. Sewage flows unaccounted from households. It is also important to note that while only 60% of the water coming in is taxed for sewage maintenance, in reality however 80% of water is released out of households in the form of sewage. (Excreta Matters)

The DJB has spent around 1634.18 Crore from the year 2011-12 on the operations, maintenance and construction of Domestic Sewage treatment plants.

According to the 2011 census, the population of Delhi was said to be around 20,438,946. (India Online Pages 2012)

Now, seeing that only 30% of the people utilize the Sewage facilities given by the Delhi Jal board, the total number of people utilizing the facility comes out to be: 30% of 20,438,946= 6131683.

Hence, the cost per individual of availing the sewage treatment facilities= 1634.18 Crore divided by 6131683= Rs. 2665 per person.

Assumptions and inference:

1. A family of four consumes 30,000 liters of water in a month.
2. Therefore, the price per person for sewage treatment and maintenance comes out to be Rs. 75 per month (300/4).
3. The yearly tax per person comes out to be Rs 900 (75*12).

While the cost incurred in 2011-12 on sewage treatment systems was Rs 2665 per person, the taxes paid by households is only 33% of it. This study conclusively proves that the Sewage maintenance tax is highly subsidized or undervalued.

The tax structure that is created for domestic and industrial sewage treatment is obsolete. While the subsidization or undervaluation of Sewage treatment can be justified on the grounds that "not everyone can afford to pay for it", it is important to remember that the people incapable of affording the actual cost of the service are anyways not availing any benefits from it.

Sewage Facilities for JJ clusters and Slums in Delhi

Today, 45% of Delhi's population lives in illegal colonies. Knowing this, only 92 out of the 2000 illegal colonies in Delhi have sewage systems.

In Dec, 2012, Mr. Jawahar Singh, resident of Ekta Manch Jhuggi Jhopri filed an RTI to the Delhi Jal Board questioning the date on which sewer arrangements would be made to the said colony. In response to the RTI, the DJB replied that the water and sewer arrangements are the concern of the Slum Department of Delhi and not of the Delhi Jal Board (Central Information Commission 2010).

Interestingly in a meeting with the officer of the Delhi Urban Shelter Improvement Board (DUSIB) it was revealed that the only task of the DUSIB is to take the sewage out of the Jhuggi Jhopris. It is not their responsibility to make sure that the sewage is properly disposed or treated.

Procedure for Sanction of Water and Sewer Connection under the Delhi Jal Board

Below lists out various clauses listed by the DJB in sanctioning a new water and sewer connection:

Any person who is resident of territorial jurisdiction of Board and where services are maintained by the Board, is eligible to apply for new connection under regulation 3 and 4, subject to following conditions:

1. Technical feasibility for providing services should exist: Technical feasibility is extremely low is JJ clusters and Slum areas as they lack the basic amenities. Huge amounts of Infrastructural expenditure are required to build sewage pipes and canals, which the DJB refuses to undertake under its sanctioning procedures.

2. Applicant is required to attach the identity proof and ownership/ occupancy proof and no objection certificate from owner in case of tenant with the application: Applicants without an identity proof or living in an unorganized colony that lacks any official recognition from the government certainly does not come under the purview of the Delhi Jal Board.
3. There should not be any outstanding dues towards the Board against the property on account of water/ sewer/ development/ infrastructure charges etc.

Other norms to be followed by consumers

1. Wherever sewage system is in existence and maintained by the Board, it shall be mandatory for a consumer to obtain a sewer connection by submitting application in the format prescribed in schedule-I after paying requisite fee and charges, failing which, besides disconnection of water supply bill will be raised to such consumer in respect of Sewer charges and/or Development Charges.
2. Application may be made by the owner/occupier of a property once the construction is completed in that property or by the owner/occupier of premises where Board has laid sewerage facilities in a particular locality after the construction; provided such construction is authorized.
3. No person is authorized or allowed to put sewage in Board sewerage system other than through sanctioned sewerage connection (DJB).
4. No regular sewer connection will be allowed in a vacant plot/piece of land.
5. No individual connection will be granted to any flat or house in a cooperative group housing society/apartment complex or other domestic/nondomestic complexes where bulk connection either exists or is required to be given under the policy in force of the Board.
6. No Sewer connection will be sanctioned in the basement of any building.

These clauses have created a resistance shield for unorganized colonies to get a regular water supply. Sewage facilities and sewage treatment is a far-fetched dream for such areas of Delhi (DJB 2012, 6).

Decentralized water Treatment systems (DEWATS)

What is a Decentralized water treatment system?

Decentralized or "Onsite" wastewater treatment system is one that treats wastewater and discharges effluent into the ground 'onsite' at the location the sewage is generated. Perhaps the simplest example of this is a septic tank and leach field serving a single home. Instead of sending wastewater into a sewer system serving many homes, the water is treated and returned to the ground on the same property. Rather than operating a centralized wastewater treatment system where all sewage flows to one treatment plant, most rural communities today still use a decentralized wastewater treatment approach, traditionally with one onsite system per household, though few local leaders would ever think of their community as having a decentralized system (Decentralized Central 2005).

Centralized Vs. Decentralized Sewage Treatment Systems

A centralized sewage treatment system is one which collects sewage from a large area, such as the whole city or town and treats it collectively in gigantic sewage treatment systems. Centralized sewage treatment systems require large amounts of capital investment and are also skilled labor intensive. They require continuous maintenance and consume large amounts of electricity.

These traditional centralized Sewage treatment systems dominate Delhi's STP landscape at present. As we saw before, they are inefficient and incapable of handling the sewage produced by the whole city. Conventional and highly engineered wastewater management technologies and strategies often focus on electro-mechanical solutions that are capital intensive and require ongoing capital investments for effective operation. Additionally, these systems have shorter life-cycles compared to many alternative and naturally-based technologies which also offer opportunities for resource recovery (CCP 2003)

Demerits of a Centralized Sewage System:

1. In conventional centralized sewage treatment system, about 80% of the cost is accounted for the collection alone. The cost of collection of sewage and its conveyance to one terminal point in a city to another is very high.
2. Further, the depth of sewer goes on increasing with the increase in length of sewer line and pumping of the sewage at intermediate and terminal points requires a lot of energy.
3. Further centralized treatment systems or conventional systems aggravate the environmental problem, as large volume of the wastewater of the entire city is discharged at one place.
4. Mechanized or conventional treatment systems are efficient, in terms of their spatial requirements (0.5-1 m2 / Person Equivalent, PE - compared to natural treatment systems at 5-10 m2/ PE), but depend on economies of scale to make them economically feasible.
5. Electro-mechanical wastewater treatment technologies designed to remove high levels of biological oxygen demand (BOD) are not only huge capital investments, but also pose certain dilemmas if reuse of treated effluents is to be an option.
6. Conventional, aerobic, treatment results in maximum reductions in BOD and nutrients while it is desirable to retain biomass BOD and nutrients for agricultural production.
7. Often, the removal of pathogens requires chemical inputs to meet disinfection guidelines, which increases the operation cost and complexity of the system.
8. Dependence on chemical disinfection also complicates effluent reuse in non-restricted irrigation schemes when compared to low-cost solutions such as wastewater stabilization ponds (WSP), which are economical, produce similar reductions in BOD, nutrients, and greater pathogen reduction, but at a fraction of the cost.
9. Expense Involved In Laying Lines To Great
10. Depths Often In Densely Populated Areas (CCP 2003).

Decentralized small scale sewage treatment systems however, are a proficient and integral part of planning and upgrading urban environments to a sustainable level. There are a number of reasons why small scale sewage treatment plants are more effective in dealing with the needs of a place.

Merits of Decentralized small scale sewage treatment systems:

1. Operable with semi skilled/ unskilled labor: The operations of DEWATS are simple to understand and are operable by local communities. It does not require much external or professional help.
2. Requires little space: They are quite efficient when it comes to space management.
3. No smell: DEWATS are extremely efficient in space management.
4. Less expensive than comparable conventional treatment systems
5. Very low maintenance costs
6. Small scale sewage treatment systems would be based on the topography of the local water shed, and would result in small-scale facilities equally dispersed through environment.
7. Pathogenic reduction and nutrient recovery would occur through the use of integrated biological processes, which are also low cost.
8. This approach would allow for independent, self maintained, and self sustained facilities that are capable of recovering wastewater resources and immediately reusing them in decentralized urban farms. (CCP 2003)

Economic Incentives for DTS

1. Price for water supply may have two components

- For fresh water supply.
- For sewage treatment.

And the community which has DTS may be supplied water at lower cost. The sewage tax would of course be removed. Water tax would reduce as sewage treatment would encourage re-use of water for certain uses, such as, gardening.

2. The Resident Welfare Associations (RWAs) should be made responsible for operation and maintenance (O & M) of DTS and should be given rebate in house tax. Currently, we pay for sewage treatment in an indirect way. The government charges upper segment people through progressive taxes which help fund these central activities. House tax can be reduced for self-sufficient housing complexes.

3. In the absence of clear policy framework from the government for DTS and since the recycling of treated wastewater only partially meets the O & M costs, the onus of meeting the O & M costs rests with public/people who set up DTS in colonies. The government in such a situation should provide immediate rebate in property/house tax for those participating in DTS in order to promote DTS.

4. Land development charges levied has a component for sewerage network, which should be kept separate and be spent on DTS or centralized STP. (CPC 2003)

Transformation of Urban Waste Management

Urban waste management needs a transformation from a disposal-based linear system to a recovery-based closed-loop system that promotes the conservation of water and nutrient resources and contributes to public health.

Low Cost Sewage Treatment Systems

Low cost wastewater treatment systems are cost efficient systems that are based on the knowledge of the biological factors governing sewage water rather than new technologies that are largely chemical based. Through sedimentation, anaerobic degradation, sludge stabilization and pathogen removal, the sewage water is brought to a level of becoming less toxic that can be safely used for various needs such as agriculture and gardening. Relatively simple wastewater treatment technologies can be designed to provide low cost sanitation and environmental protection while providing additional benefits from the reuse of water. These technologies use natural aquatic and terrestrial systems.

Natural treatment technologies are considered viable because of their low capital costs, their cost of maintenance, their potentially long life cycle compared to electro- mechanical solution and their ability to recover a variety of resources (CCP 2003).

Decentralized, organic waste recovery systems that integrate the best available low-technology in the recovery of urban domestic wastewater flows are essential and appropriate components in the promotion of a comprehensive urban ecosystem health strategy.

There are many types of sewage treatment technologies that are used today. The table below lists out the technologies, and the cost incurred and reuse options that are available.

Table 7: Types of sewage treatment technologies, their cost and reuse options (Centre for Science and Environment 2010).

Name of Technology	Treatment Method	Treatment Capacity	Capital Cost	O&M cost (Rs/KLD/year)	Reuse of treated wastewater
Decentralized wastewater treatment	Sedimentation, anaerobic digestion, filtration and phyto-remediation	1- 1000 KLD	35000-70000	1000-2000	Horticulture, Biogas generation
Soil Bio technology	Sedimentation, filtration, biochemical process	5KLD-tens of MLD	10,000-15,000	1000-1500	Horticulture Cooling systems
Biosanitizer/ Eco chip	Bio catalyst-breaking the toxic/ organic contents	100 mg/ KLD	Chip cost Rs. 10000 excluding civil /construction cost	Not available In situ treatment of water bodies,	Horticulture

Soil scape filter	Filtration through biologically activated medium	1-250 KLD	20000-30000	1800-2000	Horticulture
Ecosanitation Zero discharge toilets	Separation of fecal matter and urine	Individual to community level	40000 – 50000 (excluding the cost of toilet construction)	Not available	Flushing Horticulture Composting
Nualgi technology	Phycoremediation (use of micro/ macro algae)- fix CO_2, remove nutrients and increase DO in water	1Kg treats upto ML	Rs. 350 / MLD	9000-10000/MLD	In situ treatment of lakes/ ponds, Increase in fish yield.
Bioremediation	Decomposition of organic matter using Persnickety 713 (biological product)	1 billion CFU/ml	2.25 – 3.0 lakhs/ MLD	2-2.5 Lakhs/MLD	In situ treatment of lakes/ Ponds
Green bridge technology	Filtration, sedimentation, bio-digestion and biosorption by microbes and plants	50 – 200 KLD/ sq m	200-500	20-50	In situ treatment of water Bodies

Merits & Demerits of Different Low-cost Wastewater Treatment Systems

The table 8 as shown below lists out the various types of low cost treatments, their uses, advantages and disadvantages.

Table 8: Merits and Demerits of Low-cost Wastewater Treatment Systems (CCP 2003)

Type	**Kind of treatment**	**Use for type of wastewater**	**Advantages**	**Disadvantages**
Septic tank	Sedimentation, sludge stabilization	Wastewater of settleable solids, especially domestic	Simple, durable, little space because of being underground	Low treatment efficiency, effluent not odourless
Imhoff tank	Sedimentation, sludge stabilization	Wastewater of settleable solids, especially domestic	Durble, little space because of being underground, odourless effluent	Less simple than septic tank, needs very regular desludging
Anaerobic filter	Anaerobic degradation of suspended and dissolved solids	Pre-settled domestic wastewater of narrow COD/BOD ratio	Simple and fairly durable if well constructed and wastewater has been properly pre-treated, high treatment efficiency, little permanent space required because of being underground	Costly in construction because of special filter material, blockage of filter possible, effluent smells slightly despite high treatment efficiency
Baffled	Anaerobic degradation	Pre-settled	Simple and durable,	Less efficient

Septic tank	of suspended and dissolved solids	domestic wastewater of narrow COD/BOD ratio,	high treatment efficiency, less space required because of being underground, hardly any blockage, relatively cheap compared to anaerobic filter	with weak waste water, longer start-up phase than anaerobic filter
Root Zone Treatment System	Aerobic facultative – anaerobic degradation of dissolved and fine suspended solids, pathogen removal	Suitable for domestic wastewater where settleable solids and most suspended solids already removed by pre-treatment	High treatment efficiency when properly constructed, pleasant landscaping possible, no wastewater above ground, no nuisance of odor	High space requirement, great knowledge and care required during construction, intensive maintenance and supervision during first 1-2 years
Anaerobic pond	Sedimentation, anaerobic degradation and sludge stabilization	Domestic and strong and medium wastewater	Simple in construction, flexible in respect to degree of treatment, little maintenance	Wastewater pond occupies open land, there is always some odor, can even be stinky, mosquitoes are difficult to control
Aerobic	Aerobic degradation,	Pre-treated	Simple in	Large space

pond	pathogen removal	domestic wastewater	construction, reliable in performance if proper dimensioned, high pathogen removal rate, can be used to create an almost natural environment, fish farming possible when large in size and low loaded	requirement, mosquitoes and odor can become a nuisance if undersized, algae can raise effluent BOD
Duck-weed Pond	Anaerobic except aerobic at top, Degradation of Suspended and dissolved Solids, Nutrient Removal	Sullage or Pre-treated sewage	Simple in construction, Revenue generation through pisciculture, suitable for rural and semi–rural area	High space requirement, possibility of odor cannot be ruled out, proper harvesting of duckweed is must.

Integrated- Decentralized Waste Water Treatment Systems

Integrated Decentralized Waste Water Treatment Systems are based on several natural physical treatment techniques, put together in different combinations according to the needs and the financial budgets of users. The different devices cover primary, secondary and tertiary treatment stages. The treatment applications are based on the principle of minimal maintenance, the critical parts of the treatment system work continuously and uninterrupted with low energy inputs. The technology provides treatment for domestic and industrial (non-toxic) sources. It can treat effluent flows from 1 up to 1000 m^3 per day. The technology is tolerant towards inflow fluctuation (i.e. university campuses) and does not require complex maintenance practices (CPCB 2008, 5). Below are three examples which illustrate the same.

Sangam Village: Auroville

Sangam Village is situated at about 155 Kms South of Chennai and about 10 Kms North of Pondicherry. Sangamam Project is a housing colony for the workers of Auroville, in the outskirt of Auroville region (CPCB 2008, 5).

Decentralized Waste Water Treatment in Auroville

The absence of rivers or major lakes makes it necessary to draw water needs from underground for its present population of 1500 people. If the projected growth rate towards a small city of 50,000 people is to be achieved and sustained, wastewater treatment will be an essential part of the overall city water use.

Auroville is one such place in India which has presented a tremendous example for small scale and decentralized waste water treatment. “Auroville” aspires to be a model village, which allows the experimentation, in an integral way, of innovative solutions to the current problems of the villages/housing settlements. This model has a layout that balances open/green spaces with the built environment, and integrates the necessary eco-friendly infrastructure and services It has been able to successfully bring the sewage water to the level stipulated by the CPCB except for smell control. (Auroville Centre for Scientific Research 2009, 1)

There are 25 known decentralized sewage treatment facilities in the area that use simple technologies like septic tank, planted filter, collection tank etc. The number of users of these technologies varies from 2 people to 60 people (Auroville 2013). This conclusively proves that sewage treatment systems can be developed and maintained at a very low cost for small groups of people. They do not need the intervention of the government to handle their sewage treatment needs.

Tughlakhabad: Centre for Science and Environment India

The wastewater system at CSE, implemented in 2005, has been designed to treat 8000 litres per day. The treatment modules include a settler, an anaerobic baffled reactor and a planted filter bed. The treated wastewater is stored in an underground sump.

This treated wastewater is then pumped out through 1HP automatic pump to meet the horticulture requirements of the building. (CSE Environment 2013)

Performance:

Tughlakabad Institutional area has huge water scarcity and ground water table is at the depth of 70m. About 8KL of wastewater is treated and reused. The entire water requirement for horticulture and gardening is met by the treated wastewater.

The efficiency of the system was found to be 82% in terms of BOD removal. Due to low density of the plants there was not enough nutrient removal from wastewater. The per day horticulture requirement of the premises is about 3000 liters. Recycling the wastewater fulfills these requirements.

The table below shows the performance of sewage treatment systems at the centre.

Table 9: The performance of sewage treatment systems at Centre for Science and Environment, Tughlakhabad, Delhi (CSE 2013)

	Inlet (Grey Water + Black water)	**Outlet Water**
Biochemical oxygen demand (BOD)	259 mg/L	45 mg/L
Chemical Oxygen Demand (COD)	396 mg/L	118 mg/L
Total Kjeldal Nitrogen	32.7 mg/L	29.7 mg/L
Free Ammonia	8.5 mg/L	7.8 mg/L
Total Coliform	21 MPN*/100ml	17 MPN/100 ml

Integrated Commercial Townships: A rising trend in India

Integrated townships are clusters of housing and commercial businesses with associated infrastructure such as roads, schools, hospitals, convenience shopping, water treatment plants, drainage and sewage facilities.

Many established builders such as DLF, Tata, Ansal API and Ireo already have integrated township projects in various stages of development across the major regions like Delhi-NCR. Hirco is creating similar townships in Panvel on the periphery of Mumbai, and in Chennai. Others like Omaxe, Parsvnath, Emaar MGF, BPTP and Kumar Builders have also announced multiple integrated township projects. In Noida, developers such as Logix and Jaypee Group are developing golf-centric townships, in effect offering a value additional option to customers (LaSalle 2013) (DLF Building India 2013).

Recommendations for Decentralized Systems

Policy and Rules for Promoting Decentralized Sewage Treatment System (DTS)

1. All housing constructions should provide for appropriate treatment, recycling, reuse or disposal of the wastewater generated by them. This could be on the basis of a colony, co-operative group of houses or even individual houses.

2. Use of EIA/EMP (Ministry of Environment and Forest 2001) tool for township and residential colonies also to be encouraged to identify, quantify, predict and evaluate both potential and known negative and positive impacts of any development, activity or policy

3. For new piped water supply project, corresponding capacity of sewage treatment in terms of Decentralized Treatment System (DTS) or augmentation of STP capacity should be associated as part of the project.

4. Special standards for DTS under the Environment (Protection) Act, 1986/ the Water (Prevention & Control of Pollution) Act, 1974 may be considered.

5. Provision for DTS by developers may find place in municipal bylaws and Municipal Act.

7. Town should have a scope for DTS.

8. Decentralized treatment should form part of development plan for all new settlement program.

9. The designers and builders for sewerage/drainage systems should be made responsible for the treatment & utilization of wastewaters on long-term basis.

10. AICTE (All India Council for Technical Education) may consider including courses on DTS, Diffused Pollution Control, Environmental Protection and Pollution Control Rules & regulations in Degree & Diploma curricula (CCP 2003).

11. Easing FDI norms with respect to integrated townships: With lock-in norms in place, the government may look at easing the investment parameters.

12. Increasing external commercial borrowings in township development: The Central government has already opened the doors for external commercial borrowings in township development. This provides access to cheap finance and has had a positive impact.

13. Single window clearance for real estate sector: Single window clearance has been a long-standing demand for the real estate sector. If implemented, it will greatly aid larger projects such as integrated townships, as well.

14. Financial incentives and faster clearances from states are paramount requirements.Local municipal authorities lack funds to undertake an urbanization drive of any significant scale. In such situations integrated townships with a focus on development of ancillary infrastructure is a clear solution. (LaSalle 2013)

Model Projects and Dissemination

1. Demonstration model plants using onsite DTS should be promoted/funded throughout the country for which progressive builders and Resident Welfare Associations may show the way.

2. Pilot and nodal schemes should be promoted by MOEF/CPCB.

3. The development authority like DDA (Delhi Development Authority) may install DTS at two colonies. Based on the experience, policy may be made for implementation in other colonies in future.

4. Mass awareness and public participation needs to be promoted.

5. Documentation and dissemination of case studies/practical experiences need to be taken up on a wider scale.

6. Advertisement in Press and on Television, Radio for Environment friendly sewage treatment for all housing colonies should be planned in such a way that it has scope for DTS. (CPC 2003)

Operation & Maintenance

1. Sewage fed lakes/ponds in urban centers may be converted to DTS so that water quality of lakes and ponds are improved. Such as, Suraj Kund Lake, Dumduma Lake, Sohna Lake etc…

2. Proper operation and maintenance of DTS to increase the social acceptance.

3. 'Polluters Pay Principle' should be adopted for O & M of the treatment plants. The Polluter Pay Principle will mandate people to handle the mess that they make. It will create a link between the Polluter and cleaner.

4. Segregation & reuse of wastewater at household level be encouraged. In colonies where DTS is encouraged, people reuse the recycled waste water for activities such as gardening.

5. Resource recovery like energy should be part of technology to make the system sustainable. Example: Biogas.

6. Technology selection should be on case-to-case basis.

7. The decentralized treatment plant construction and O & M responsibility should be given to specialist agencies that can take the responsibility for technology risk.

8. People who contribute wastewater should be a party right from planning, construction to operation & maintenance (CPC 2003).

Limitations of Decentralized/ Privatized Small Scale Sewage Treatment Systems: Public Opposition to small scale decentralized waste water management

When appropriately designed, sited, operated, and maintained, decentralized wastewater systems meet public health and water quality goals as well as centralized systems. Still, barriers exist, both real and imagined, that can hamper widespread acceptance of decentralized wastewater systems. These obstacles may be due to several factors:

1. Lack of knowledge and misperceptions about decentralized systems.
2. State and local regulatory barriers.
3. Lack of adequate management programs.
4. Liability and engineering fee issues.
5. Financial limitations of the community.
6. Shortcomings of Integrated Commercial Townships (Pipeline 2000, 7).

Despite all the positive hype around this form of development, integrated township projects grapple with the same problems that plague the rest of the real estate sector in India.

1. Land Acquisition: The absence of proper title deeds and the opaque functioning of local revenue departments create the first hurdle in such projects – namely land acquisition.
2. Red Tape: There are different approvals needed for submitting project plans, getting construction permits and environmental clearances, among others. It is estimated that for a simple group housing project, nearly 52 different approvals are needed. Not only does this lengthy process create delays - it increases the holding costs for the developer, causing project costs to spiral upwards.
3. Lack of Infrastructure on The Periphery: The city's peripheries are usually low on infrastructure support, and development of integrated townships needs such support to flourish. Public infrastructure development usually follows any region's development with a lag. This means the infrastructure does not keep pace with the development, and is usually planned reactively rather than being forward looking.

4. Capital Intensity: The huge investment needed upfront for the land acquisition phase — compounded by the mandatory long-term commitment of substantial funds towards development — has created an entry barrier for technologically sound sewage treatment systems. (LaSalle 2013)

If decentralized systems are to become accepted as a wastewater treatment solution, people need to be educated about the benefits of this choice.

Conclusion

When appropriately designed, sited, operated, and maintained, decentralized wastewater systems meet public health and water quality goals as well as a centralized systems does. However, with the exponential growing demands for sewage treatment, the centralized sewage treatments systems are unable to keep up with that growth. Decentralized sewage treatments systems on the other hand, can be developed along with new colonies as and when they emerge.

There are many cost efficient technologies today that are available to the common public that requires very low maintenance. The government needs to take further steps in promoting such technologies rather than focusing on the construction of mismanaged sewage treatment plants. The government's role needs to shift from a provider to a facilitator. Instead of charging a water and sewage tax, the government should fine colonies without internal on-site sewage treatment systems for the environmental damage done by them. This can be very well implemented by invoking the Polluter Pays Principle. Also, DEWATS can also be encouraged by the government by providing tax rebate to those who avail of it.

Colonies that are unable to afford sewage treatment are the only ones that the government needs to cater to. If decentralized/ privatized sewage treatment systems are encouraged in the developed urban regions of Delhi, the DJB will be able to turn its attention towards the lesser developed regions.

Decentralized, closed loop systems are in the long run cost efficient as well as environmentally sustainable. It encourages re-use of water for various purposes such as horticulture, gardening, toilet flushing etc. It helps create awareness among people toward the repercussions of their actions on the environment, and also helps them take responsibility for their own pollution. It is certainly the future of a developed and sustainably planned city.

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