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URBAN SHIT

Every four in 10 houses in Indian cities and towns use latrines connected to septic tanks. Most municipalities do not have a proper plan to dispose of the faecal sludge collected in these tanks. Where does this sludge go?

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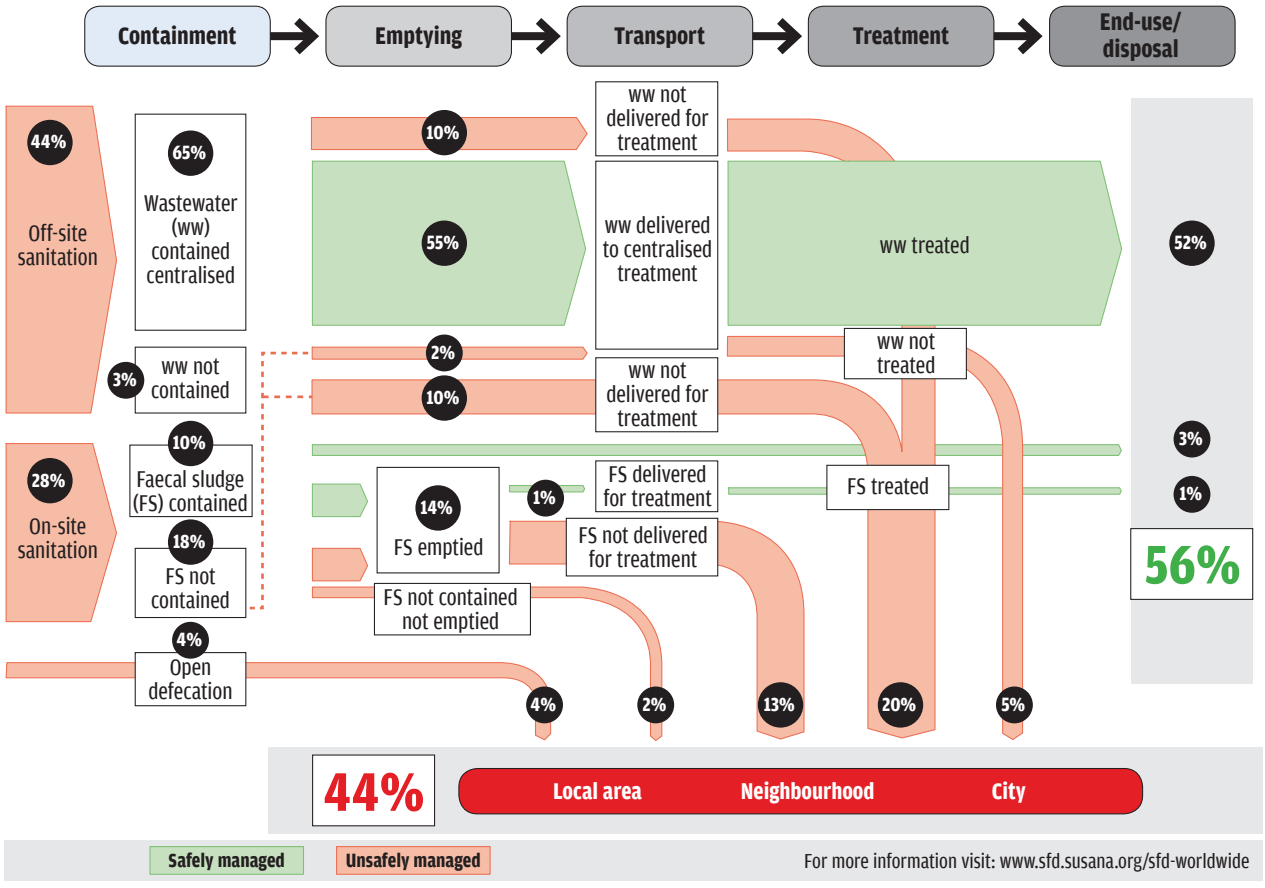
MANOJ KUMAR should know the national capital's dirty little secret: where does the excreta of its residents not connected to the sewer system go? He has been working as a septic tank cleaner for 20 years. By now he owns three vacuum tankers that suck faecal sludge from septic tanks. Accompanied by his helper Rajbir Pal, he arrives at a house in Sangam Vihar locality in south Delhi. Rajbir Pal hops off the tanker and lays out a pipe to the septic tank in the house. He uses bare hands and laughs sarcastically at the idea of using a gas mask. "We have heard of instances where workers die when they have to go deep into the tank where toxic gases are emitted. We should at least be provided gloves," he says.

It is a two-storey building that houses seven families. Its septic tank should ideally have two chambers, with an outlet connected to a soak pit or some other treatment system for safe dispersal of effluent after the faecal sludge has settled at the bottom. Instead it is a single-chambered tank without any outlet, so its entire content has to be emptied. Small wonder

Safe or unsafe? A shit flow diagram for Delhi that tracks excreta through five stages



the owner, Birender Singh, complains, "We have to empty it every month."

Amid the roar of the vacuum pump slurping the sludge from the tank, Singh seems contented, having managed to get rid of the excreta generated in his house. But does he know where the tanker is headed? "We don't know, madam. And frankly, we don't care," he says. In seven minutes the tank is emptied. He pays Rajbir Pal ₹1,000 and that for him is the end of his problem.

Back on the vacuum tanker, Kumar and Rajbir Pal head straight towards Batra Hospital, Tughlakabad. They empty the sludge into the drain outside the hospital which ends up in a bigger drain that opens into the Yamuna. When asked why they do not go to one of the 36 sewage treatment plants (STPs) spread across 21 locations in the city, Rajbir Pal minces no words. "If we go to a treatment plant, it will eat away into our earning time. We can cover three-four houses in that time." But what if they are caught? "We pay ₹100-200 and get away."

Kumar is part of an informal union of cleaners operating from outside Batra Hospital. He makes 10-15 trips in a day; in monsoons the number of trips shoots up. His tanker is just one of the 350 to 400 vacuum tankers run by individuals or unions in the National Capital Territory. So one can imagine the enormous amount of faecal sludge generated in the region—and India.

Only a third of urban houses in India are connected to the sewer system. The majority of the houses—38.2 per cent, as per Census 2011—use toilets connected to septic tanks. The problem is that the construction quality of the tanks, buried underground in populated areas, is often poor. As a result, the treatment of sewage is partial. Then there is no system for the disposal of the faecal sludge, which is in most cases emptied out surreptitiously into water bodies and municipal sewers.

It is not even practical to connect every house to the sewer system. In India, over 1.2 billion people generate nearly 1.75 million tonnes of excreta daily. A large proportion of these then proceed to

release the lever on the flush attached to the toilet. Ironically, this only aggravates the problem. Now the volume of sewage has expanded several times and the municipalities will have to separate the excreta from water at a huge cost.

If the house is connected to sewerage this sewage will travel from the building's internal wastewater collection system to the municipal sewer system. Propelled by pumping stations, the wastewater will finally reach an STP, if there is one. Creating this infrastructure for all will be prohibitively costly. Nor is it suitable to all terrains. Management of excreta on the site by using septic tanks and pit latrines is, therefore, a necessity.

Census figures show that nearly 45.3 per cent of urban houses depend on on-site systems. A large part of the wastewater from these systems seeps into the soil. This may penetrate deep enough to pollute groundwater. Emptied faecal sludge should ideally be sent to a treatment facility, where it should be treated to meet the standards set by the Central Pollution Control Board (CPCB). This, however, does not happen in most cases. Census data shows 65 per cent of the cities in the country do not have a proper arrangement for safe collection of human excreta, forget about disposal.

India does not even have specific legal provisions related to the management of faecal sludge, also called septage in municipal parlance, although a number of laws cover sanitation services and environmental regulations. It was only in 2013 that the Ministry of Urban Development issued an advisory note on septage management in urban India. As per this note, city sanitation plans, recommended by the National Urban Sanitation Policy, should be supplemented with a septage management sub-plan.

Mismanagement at every stage

Alarmed by these findings, Delhi non-profit Centre for Science and Environment (CSE) set out to follow the trail of human excreta in 11 cities across India (see 'Shit scan', *p35*). It selected the cities to cover different agro-climatic zones. This is important because the soil strata and the kind of aquifers in a region as well as the extent of urbanisation determine the waste containment and management system best suited to it, says Bhitush Luthra, one of the CSE researchers involved in the exercise.

CSE then prepared a shit flow diagram(SFD), which is a visual tool to understand how excreta is contained, emptied, transported, treated and disposed of or reused, for each of these 11 cities (see 'Safe or unsafe?'). These form part of a 50-city report prepared under SFD Promotion Initiative. Here are some observations related to different stages of faecal sludge management in India.

Containment : Bureau of Indian Standards (BIS) specifies the guidelines for construction of septic tanks in houses. The minimum liquid-holding capacity of a tank should be 1,000 litres. When the capacity of a septic tank is more than 2,000 litres, it must consist of two chambers separated by a partition. The first chamber should be twice the size of the second. BIS also mandates that the floor of the tank should be watertight. All in all, an ideal septic tank is a two-chambered lined contain-

This family at Balram Nagar in Loni, Ghaziabad, has a big, partitioned septic tank but its effluent is discharged into an open drain

Soak pits at this colony built by a construction company for its workers in Gurgaon have to be emptied every day

ment either connected to a soak pit to drain out the effluent after primary treatment or connected to some other secondary treatment system.

But these guidelines are only suggestive, not binding. As a result, most septic tanks do not conform to the recommended design. A lot also depends on the skills and experience of the mason building a septic tank and the area available to him. Consider the septic tank at the Sangam Vihar house in Delhi. Given its volume of 6,000 litres, it should have two chambers. But space constraint in Singh's house meant a two-chambered septic tank was out of the question. Sangam Vihar is a clustered colony where the surface area of a house is no more than 21 square metres.

In Delhi, the capacity of septic tanks varies from 3,000 litres to 8,000 litres in individual houses. "But most septic tanks in Delhi are single-chambered," says P K Jha, chairperson of the Delhi-based NGO, Foundation for Environment and Sanitation.

In areas like Meethapur and Pratap Vihar in Delhi, the effluent from septic tanks is discharged directly to an open ground. CSE also found that some tanks were designed with an outlet to an open drain, such as in Harsh Vihar. This is when the National Building Code, 2005, specifies that "under no circumstances shall effluent from a septic tank be allowed into an open channel drain or body of water without adequate treatment". In parts of Maidangarhi and Meethapur, CSE found cesspools, which are lined tanks with no outflow. "Poor houses have a storage tank in the name of a septic tank," Jha says.

Some may think that a law to ensure compliance with BIS standards will serve the purpose. But the field study in Agra showed this is not necessarily the case. According to the Uttar Pradesh Water Supply and Sewerage Act of 1975, the Agra Nagar Nigam (municipal body) has the power to fine the owner of an improper septic tank. Despite this, septic tanks in Agra generally do not conform to the design specified by BIS and the effluent is allowed to flow into open drains. Unlined pit latrines are also a prominent feature in the city.

It is the same case in Tiruchirappalli. Tamil Nadu's septage notification of 2014 states that the owners of septic tanks that do not meet the standards will be issued notices as per the Tamil Nadu Public Health Act, 1939. Yet septic tanks in Tiruchirappalli were not found to adhere to the standards.

Then there are cases where a mason's knowledge of local conditions beats BIS' scientific standards, such as in Bikaner. In this city of Rajasthan, septic tanks are mostly in the form of *kuii*s, lined pits with semi-permeable walls and an open bottom with no outlet or overflow. A slab is used to cover a *kuii*, which gets filled in 20-30 years. It is a common feature in peri-urban areas in Bikaner. Although *kuii*s are not a scientifically viable solution because they have an open bottom and may

pollute groundwater, CSE believes that in an area like Bikaner, where the groundwater level is astonishingly low, leachate from a *kuii* cannot percolate to groundwater. It is better to have the faecal sludge contained in the soil where, microorganisms can digest it, instead of having a conventional septic tank and risking discharge of effluent into open drains or fields.

In coastal cities Cuttack and Srikakulam pits outnumber septic tanks. This is because in these cities pits are designed in the form of concrete rings placed one over another which makes them inexpensive and easy to close and replace.

Emptying: One stark fact illuminates how neglected septage management is in the country: most septic tanks are emptied manually in Indian cities. CSE observed manual emptying in Agra, Cuttack and Aizawl. This, despite the fact that India has enacted the Manual Scavengers and Construction of Dry Latrines (Prohibition) Act, 1993, which aims to eradicate manual scavenging.

So one can imagine how many people follow directions on safety precautions and regular emptying. As per BIS standards, half-yearly or yearly emptying of septic tanks is desirable. A small amount of sludge should be left in the tank to ensure the presence of microorganisms for anaerobic digestion of sludge. As regards the safety precautions a cleaner must follow, the Union urban development ministry's manual on sewage and sewerage states that workers must be provided adequate safety gear: gloves, masks, safety belts and jackets.

How do the 11 cities fare in terms of these guidelines? In Delhi, sludge is removed from the tanks only when they are choked or overloaded. In Aizawl, the emptying frequency is three years but there were instances where tanks were not emptied for 10 years. In Gwalior also the emptying frequency was once in three years.

According to the CSE surveys, no safety precautions were undertaken by cleaners in Delhi, Agra, Dewas, Solapur, Cuttack, Srikakulam, Bikaner and Aizawl. Workers in Aizawl, however, said they had not had health problems due to lack of protective gear.

Only three of the 11 cities have taken steps to regulate emptying of septic tanks. In the rest, anyone can empty tanks and charge any fee

The country also needs standards/guidelines on the equipment used to empty septic tanks. The most satisfactory method is by vacuum tankers mounted on trucks or tractors. A new technology is in the offing which treats sludge in the vacuum tanker itself, says Amiya Kumar Sahu, founder of the National Solid Waste Association of India, a non-profit. "It will be the next big thing in the emptying business," he adds. However, the cost could be a limiting factor in adopting this technique.

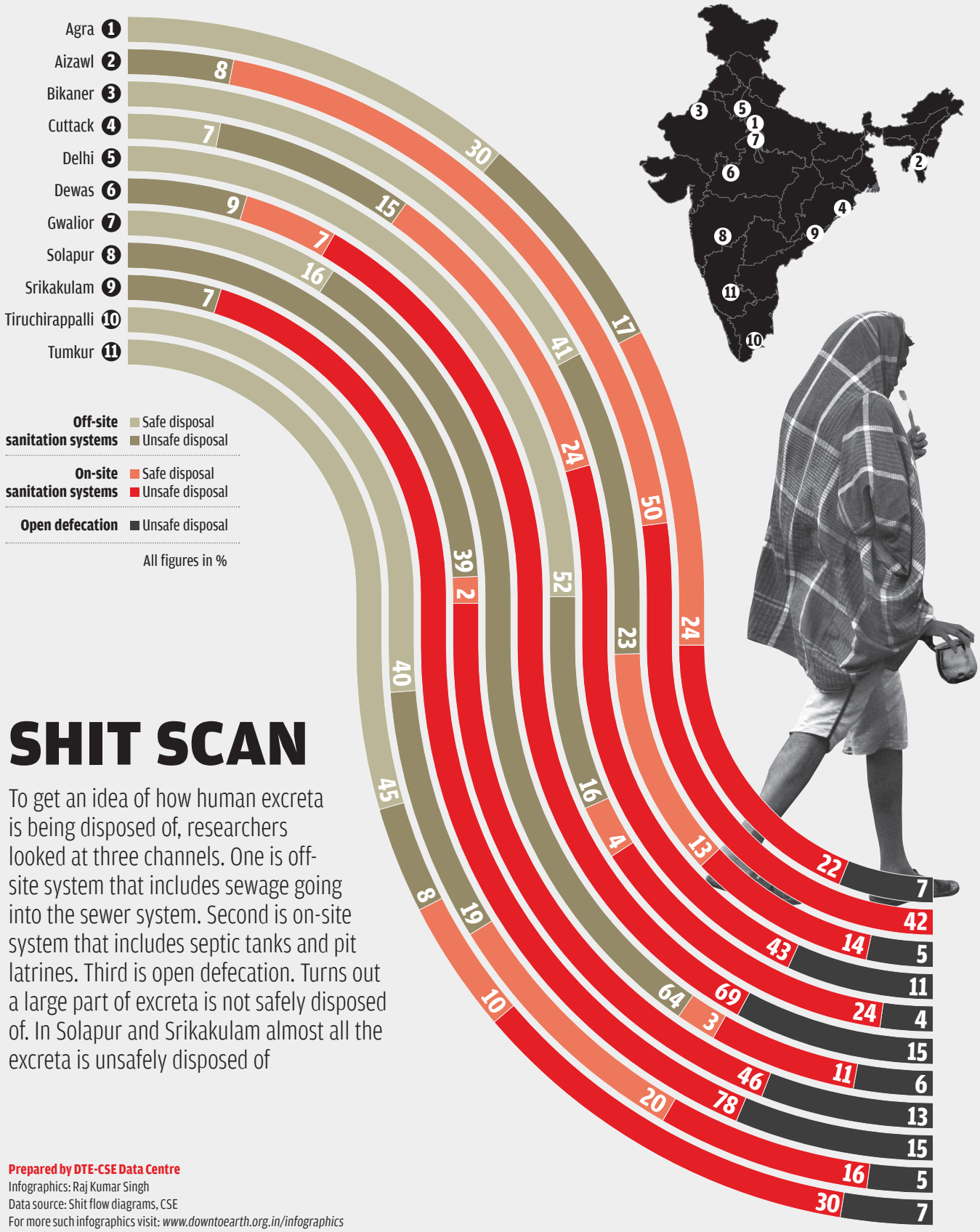
Only three of the studied cities have taken steps to regulate operators involved in emptying. In the rest of the cities anyone can empty septic tanks and charge any fee. A comparison of sludge management in different cities shows that government's involvement can bring improvements. Take the case of Dewas in Madhya Pradesh. Emptying in this city is managed and regulated by the Dewas Municipal Corporation. House owners have to submit an application to the corporation for emptying their septic tanks. The cleaners charge only ₹500 per trip, though they have to make more than one trip because the septic tanks in Dewas are oversized.

Contrast this with Srikakulam, where the private sector is responsible for emptying septic tanks. Operators there follow no safety precautions and charge between ₹1,500 and ₹2,500. In Delhi they charge between ₹500 and ₹3,000.

The solution, it seems, is a public-private partnership. Collaboration would work best because it would destroy the mafia of private cleaners, making them accountable. Private cleaners, in turn, would bring an experienced workforce.

In Delhi, where private operators dump faecal sludge at their will and charge whatever they like, the Delhi Jal Board recently got into action to regularise the business. In August 2015, the water body enacted the Delhi Water Board Septic Tank Waste Management Regulations under the Delhi Water Board Act of 1958. According to these regulations, faecal sludge can be collected and transported by only those private cleaners who have a licence. If they fail to obtain a licence and still operate, they will have to pay a fine. But the regulation fails to specify the amount of fine.

It also lists the conditions for obtaining a licence: only individuals and agencies with leak-, odour- and spill-proof vehicle and proper vacuum and discharging equipment will be given a licence.



SHIT SCAN

To get an idea of how human excreta is being disposed of, researchers looked at three channels. One is off-site system that includes sewage going into the sewer system. Second is on-site system that includes septic tanks and pit latrines. Third is open defecation. Turns out a large part of excreta is not safely disposed of. In Solapur and Srikakulam almost all the excreta is unsafely disposed of

Prepared by DTE-CSE Data Centre
Infographics: Raj Kumar Singh
Data source: Shit flow diagrams, CSE
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They must also have gas detectors, gas masks, protective gear, a first-aid box and an oxygen mask and cylinder. Licensed cleaners can dispose of sludge only at locations specified by the Board, which will also prescribe the emptying fee. "It is a difficult procedure. It has been four months since we applied for a licence. Only now has the process started," says Yasin, owner of a union of cleaners operating in and around the Loni border.

Tiruchirappalli also has operative guidelines for septage management but monitoring is weak.

Krishna Chaitanya Rao, a researcher at the International Water Management Institute, suggests that cities' municipalities should enforce scheduled cleaning of septic tanks, contract emptying activities to private cleaners through bids and adopt a call centre-based model to streamline the process. "This is of advantage to the household, as it receives improved and lowest cost service; to the municipality as it can better regulate tariffs and septage disposal; and to private cleaners as they can now have clear access to markets and be a part of the formal sector," Rao says.

Transportation, treatment and disposal: Ideally, the sludge collected should first be treated and then either disposed of according to the standards prescribed under the Environment (Protection) Act of 1986 or reused as fuel, soil conditioner or filling material, depending on the treatment method.

In reality, most of the faecal sludge collected from septic tanks is dumped into rivers, drains and sewers or emptied untreated into agricultural fields and low-lying areas. A tiny portion of it reaches STPs, though ideally it should not. Septage is high in total solids, suspended solids, biological oxygen demand (BOD), chemical oxygen demand (COD), nitrogen and potassium. STPs are not designed for this. "Treatment of septage at STPs can only be an interim solution," says Luthra of CSE, adding that "treatment can be as simple as drying the feacal sludge for reuse in agriculture."

For using treated faecal sludge in agricultural fields, WHO suggests a faecal coliform density of less than 1,000 most probable number (MPN) per gram of total dry solids, a salmonella density of less than 3 MPN per 4 g and an E coli density of 1,000 MPN/g. "The minimum one can do is let the sludge out in the sun to dry. Using raw sludge as manure is never recommended," says Sahu of the National Solid Waste Association of India.

Ideally, faecal sludge should first be treated and then reused as fuel, soil conditioner or filling material. But this is not the norm

But use of raw sludge in fields is common as seen on Ali Sher's farm. It is 5 km from the site where tankers from Loni in the National Capital Region congregate. As a tanker releases faecal sludge on his farm, Sher tells *Down To Earth* how he has been fertilising his crops using raw sludge for years. He grows wheat, sorghum and vegetables such as potato, cauliflower and turnip. "I still have to add some urea because the sludge is not enough. But I get the sludge for free. Sometimes I pay for it," he says.

No city has a treatment plant designed specifically for septage. Dewas, Srikakulam and Solapur do not even have a functional STP. In Srikakulam, private cleaners dispose of faecal sludge outside the town, where farmers use the dried sludge as compost. The Solapur Municipal Corporation dumps the faecal sludge it collects into a dump yard 10-15 km from the town, while private cleaners dump it into open drains. In Dewas, the waste-

A vacuum tanker dumps untreated faecal sludge in a wheat field in the National Capital Region

water from sewer lines ends up in the Kshipra and Kali Sindh rivers, while tankers generally discharge sludge into surface drains, nallahs, low-lying areas or agricultural fields.

In cities that have an STP not all sewage/septage reaches the plant, partly because of losses in transportation, but mostly because cleaners refuse to go to an STP.

In Aizawl cleaners transport sludge to private land in Tuirial, Bethany and Mualpui localities by paying ₹100 per trip. While Tuirial has an oxidation pond to partially treat the faecal sludge, the sludge emptied in Bethany is sometimes used for agriculture.

In fact, most STPs in the country remain under-utilised. Only 66 per cent—3,126 million litres per day (MLD)—of the actual treatment capacity of the 152 STPs spread across 15 states in the country is utilised, shows a 2015 report of CPCB. In Tiruchirappalli, the 58 MLD STP is underutilised, so it treats sewage as well as septage. In Agra, the nine STPs have a capacity of 221.25 MLD, while the sewage delivered to them is only 175.75 MLD. Agra, too, can go the Tiruchirappalli way.In Delhi as well, STPs are under-utilised. Yet, the Yamuna has become the major receptacle of treated, partially treated and untreated sewage, while septage is disposed of in low-lying areas, vacant plots, water bodies and agricultural fields. A private guard in Okhla, who does not wish to be named, says he often sees tankers empty sludge on the banks of the Yamuna.

Then there are STPs that treat sewage but the quality of treatment is not according to the prescribed norms. As per CPCB, 49 of the 152 STPs in the country exceed the BOD standard, while seven STPs violate COD standards. That's how Tumkur's treated sewage discharged into Bommasandra lake ends up choking it.

And what about effluent? CSE observed soakaways connected to individual septic tanks only in Aizawl. The saving grace in many cities is that their groundwater level is low, so leachate from pit latrines and soak pits poses no threat there.

Simple steps to sanitation

India cannot do away with septic tanks. The best it can do is to fix the gaps in handling excreta. One step the authorities can take is to train masons in the design and construction of a tank. Then, the regulation of private cleaners is equally important.

STP at home

Five-step treatment at a decentralised wastewater treatment system

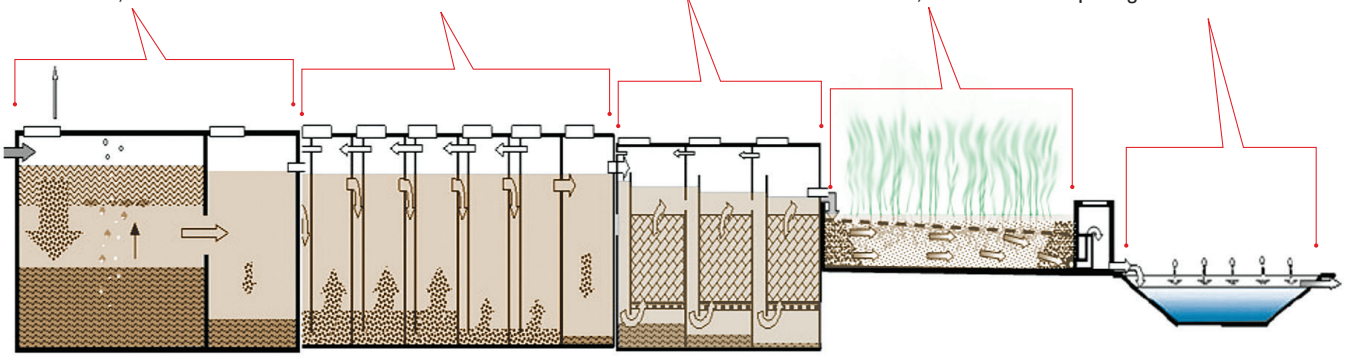
SETTLER TANK | Stabilises settled sludge by anaerobic digestion; dissolved and suspended matter remain untreated; removal of COD 20-25%, BOD 15-20%, TSS* 50-55%

HORIZONTAL BAFFLED REACTOR | Anaerobic degradation of suspended and dissolved solids; removal of COD 25-30%, BOD 30-35%, TSS 10-15%

ANAEROBIC FILTER | Water passes through filter media; enhanced digestion of organic matter; removal of COD 20-25%, BOD 15-20%, TSS 15-20%

CONSTRUCTED WETLANDS | Open shallow basin with reeds; reduces organic contents and act as a filter; Removal of COD 15-20%, BOD 20-25%, TSS 5-10%

POLISHING POND | Open shallow basin for removal of stabilised or inactive suspended substances; exposure to UV rays; removal of pathogens and odour



* Total suspended solids

It can be done through a public-private partnership. Such a partnership would give houses access to improved service, the municipality can better monitor and regulate emptying activities and private cleaners get access to markets and formal employment, wherein they are also made aware of safe sites for disposal of faecal sludge.

As for safe disposal, Suresh Kumar Rohilla, programme director, urban water management, CSE, suggests decentralised wastewater treatment system, which basically brings an STP home (see diagram above). Such systems can be used at different scales; in houses, schools and colonies.

Rohilla gives the example of Aravind Eye Care Hospital at Abhishekapakkam in Puducherry that adopted a decentralised system in 2003. It did so because its water demand for horticulture was very high. Primary treatment at the hospital is similar to an improved septic tank, called anaerobic baffled reactor with filter. It is basically a series of chambers where filter material is installed in the last few chambers. The organic matter is degraded by microorganisms attached to the filter media. This decreases BOD by about 90 per cent.

Secondary treatment is achieved through a planted gravel filter bed. It consists of a gravel bed over which reeds are grown. The roots absorb nitrates and phosphates and inject oxygen in the wastewater. This results in more than 50 per cent reduction in BOD, nitrates and phosphates. Finally, tertiary treatment is achieved in a polishing pond. It is basically a shallow pond in which ultraviolet light can penetrate deep enough to kill pathogens.

The system at Aravind Eye Care Hospital treats 270-320 kilolitres of wastewater every day and reduces dependence on fresh water.

Residents of the Ravindra Nagar colony in Ujjain, Madhya Pradesh, have built a reed bed covering 42 square metres for treating 13 kilolitres of sewage a day.

Wherever community-level solutions are not possible cities may need independent septage treatment plants. Such plants can be set up and maintained by charging a user fee.

Most importantly, cities should reuse the treated faecal sludge. "Septage is 100 per cent organic. If it is discharged into a sewer line, it will be mixed with toxic effluents, restricting its reuse," says Jha of the Foundation for Environment and Sanitation. Janicki Bioenergy Omni Processor in Dakar, Senegal, is a fitting example of reuse. This processor, funded by the Bill and Melinda Gates Foundation, takes one-third of the sludge in the city and converts it into electricity, ash and even drinking water. It produces up to 10,800 litres of clean drinking water every day from 12.3 cubic metres of sludge.

Cities can opt for a combination of these options depending on their topography, extent of urbanisation, population, land availability, proximity and availability of STPs, and proximity to residential areas. One good way to begin is by preparing the septage management sub-plan. After this one can flush and forget. ■