सत्यमेव जयते

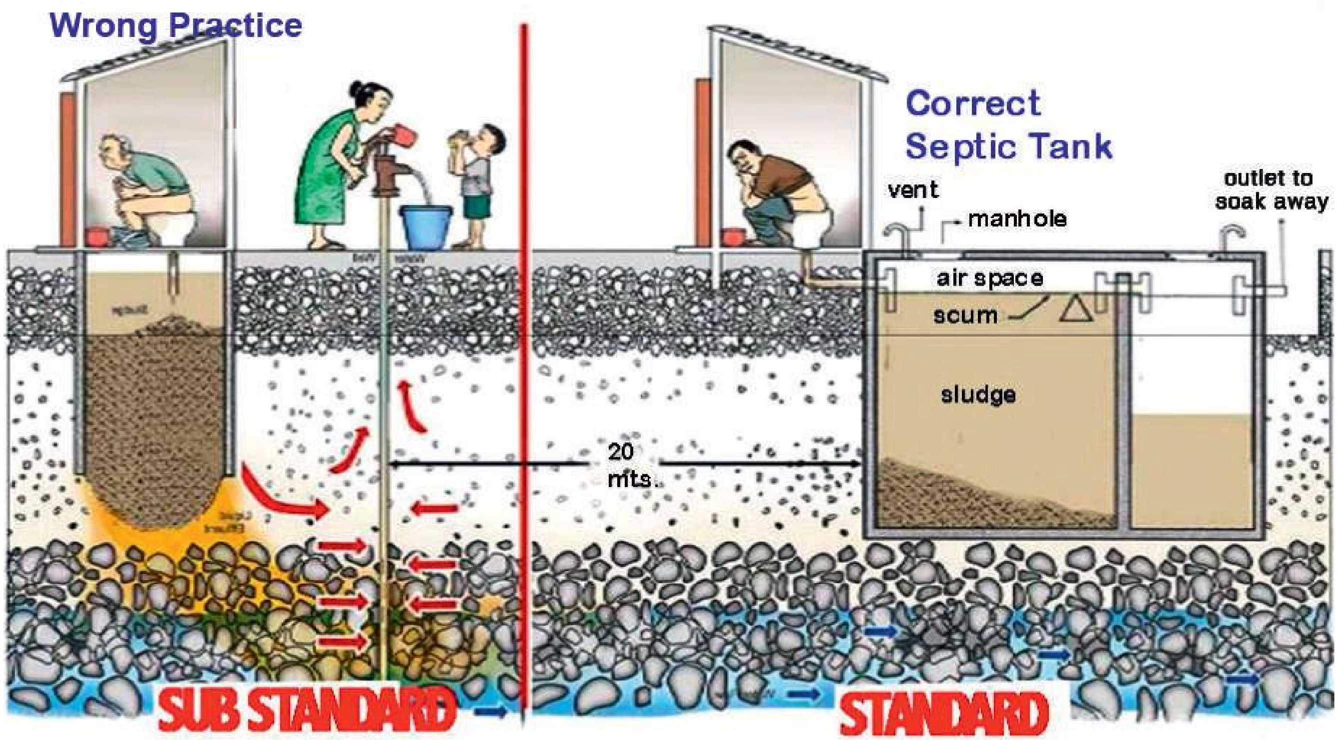
Ministry of Urban Development
Government of India

GOVERNMENT OF INDIA
NUSP
NATIONAL URBAN SANITATION POLICY
TOWARDS CITY WIDE SANITATION

ADVISORY NOTE

SEPTAGE MANAGEMENT IN URBAN INDIA

January 2013



Wrong Practice
Correct
Septic Tank
vent
manhole
outlet to
soak away
air space
scum
sludge
20
mts.
SUB STANDARD
STANDARD

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Contents

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Foreword

According to the Constitution of India, water supply and sanitation is a state subject and the states are vested with the responsibility for planning, implementation of water supply and sanitation projects including O&M and cost recovery. Since septage management is a part of sanitation and has a great influence on public health and environment, it is very important to recognize that both national government and state government must work together to tackle this problem. Census of India 2011 results have indicated that nearly 17 million urban households (more than 20 percent of the total 79 million urban households) suffer from inadequate sanitation.

According to the report of the Central Pollution Control Board (2009), the estimated sewage generation from Class - I Cities and Class - II towns is 38254.82 million litres per day (MLD) out of which only 11787.38 MLD (31%) is being treated and the remaining is disposed into the water bodies without any treatment due to which three-fourths of surface water resources are polluted.

In recognition of the need for a special focus on sanitation, the National Urban Sanitation Policy (NUSP) was adopted in October 2008 with a focus on elimination of open defecation, integrated city wide sanitation, proper O&M of all sanitary installations etc. The initiatives under the policy include rating of cities, awareness generation and support to cities for preparation of city sanitation plans. The Ministry of Urban Development conducted a rating of class I cities on sanitation related parameters in 2009-10. Out of 423 cities, only four were in the blue category scoring more than 66 points out of 100. No city achieved the distinction of being a green city i.e. a city scoring more than 90 out of 100.

The Ministry has adopted service level benchmarks for the water and sanitation sector with a view to shift the focus of urban development projects from infrastructure creation to improvement of service levels. The handbook of service level benchmarks can be accessed at http://www.urbanindia.nic.in /programme /uwss / slb /slbhandbook. The 13th Finance Commission has made it mandatory for all cities having municipalities and municipal corporations to disclose their performance in terms of these benchmarks annually. The Ministry is committed to mainstreaming these benchmarks through its various schemes.

A major part of Urban India is yet to be provided with sewer system and the people are mainly dependent on conventional individual septic tanks. Census of India 2011 results show 30 million urban households (38 percent of urban households) have septic tanks. USAID (2010) estimates, that by 2017, about 148 million urban people would have septic tanks. Although the number of septic tanks will grow steeply in the next few years, there is no separate policy or regulation for septage management in India at present. The Manual on Sewerage and Sewage Treatment, which is under revision, provides guidelines on construction of septic tanks, and brief guidelines on septage management. This document on septage management in urban India is providing the strategies and guidelines for the national level septage management. I gratefully acknowledge the contribution of Central Public Health and Environmental Engineering Organization (CPHEEO), Water and Sanitation Program (WSP), Centre for Science and Environment (CSE) and the Expert Committee constituted by the Ministry for revision and updating of the Manual on Sewerage and Sewage Treatment. This document will prove formidable for all the authorities involved in planning, designing, operation and maintenance of septic management facilities.

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January 2013

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Preface

Census of India 2011 indicates that 38% of the urban households or 30 million households rely on septic tanks system. The information on the design, construction, frequency of emptying, treatment and disposal of septage is very limited in India. While the private sector plays a large role in the emptying of septic tanks, very little if any treatment exists for the septage collected from the septic tanks. More often, the collected septage is disposed without any treatment endangering health and environment.

The National Urban Sanitation Policy emphasized the need for proper collection, treatment and disposal of sludge from on-site installations, namely septic tanks and pit latrines. While the treatment and disposal of sludge has been accorded importance in the National Urban Sanitation Policy, there is no policy or regulation on septage management. Other than the guidelines on the design and construction of septic tanks issued by the Bureau of Indian Standards and the Central Public Health and Environmental Engineering Organization, no other information is available for the proper collection, treatment and disposal of septage. Recognizing, the growing reliance, importance and the need to improve septage management, Ministry of Urban Development has developed the septage management advisory to provide guidance to states and cities on policy, technical, regulatory and monitoring aspects.

It is heartening to note that several states and cities have either incorporated septage management as part of their state sanitation strategy or integrated septage collection and treatment in the city sanitation plans. I also understand that a few states are in the process of developing septage management strategy and piloting innovative septage management projects. The learning from these initiatives should help, guide and shape the growing knowledge on septage management.

I commend the Central Public Health and Environmental Engineering Organization (CPHEEO), Water and Sanitation Program (WSP), Centre for Science and Environment (CSE) and the Expert Committee constituted by this Ministry for the revision and updating the Manual on Sewerage and Sewage Treatment for their time and efforts to develop this timely and useful document. I am sure that this advisory will be a very useful planning and guiding tool to the states and cities.

Dr. Ashok Singhvi

January 2013

Terminology

List of technical keywords used

Effluent: The wastewater that flows out of a treatment system (in this case septic tank) or supernatant liquid discharged from the septic tank.

Fecal sludge: Fecal sludge is the solid or settled contents of pit latrines and septic tanks. It differs from sludge produced in municipal wastewater treatment plants. Fecal sludge characteristics can differ widely from household to household, from city to city, and from country to country. The physical, chemical and biological qualities of fecal sludge are influenced by the duration of storage, temperature, soil condition, intrusion of groundwater or surface water in septic tanks or pits, performance of septic tanks, and tank emptying technology and pattern.

Pit latrine: Latrine with one or two pits for collection and decomposition of excreta and from which liquid infiltrates into the surrounding soil.

Pour-flush latrine: Latrine with rural pan that depends for its operation of small quantities of water, poured from a container by hand, to flush away feces from the point of defecation.

Scum: The extraneous or impure matter like oil, hair, grease and other light material that floats at the surface of the liquid, while the digested sludge is stored at the bottom of the septic tank.

Septage: The settled solid matter in semi-solid condition usually a mixture of solids and water settled at the bottom of septic tank. It has an offensive odour, appearance and is high in organics and pathogenic microorganisms.

Septic tank: An underground tank that treats wastewater by a combination of solids settling and anaerobic digestion. The effluents may be discharged into soak pits or small-bore sewers, and the solids have to be pumped out periodically.

Sludge: The settled solid matter in semi-solid condition – it is usually a mixture of solids and water deposited on the bottom of septic tanks, ponds, etc. The term sewage sludge is generally used to describe residuals from centralized wastewater treatment, while the term septage is used to describe the residuals from septic tanks.

Soak Pit: A porous-covered chamber that allows wastewater to soak into the ground. It is also known as a soak-away or leach pit.

Sullage: Domestic dirty water not containing excreta. Sullage is also called grey water.

Source: Indian Standard: Code of practice for installation of septic tanks (IS:2470 (Part 1) – 1985; Sanitation, Hygiene, and Waste Water Resource Guide, World Bank. http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTWAT/EXTTOPSANHYG/0,,contentMDK:21191474~menuPK:3747921~pagePK:64168445~piPK:64168309~theSitePK:1923181,00.html.

1. Background

1.1 Introduction to National Urban Sanitation Policy and City Sanitation Plans

India's National Urban Sanitation Policy (NUSP, 2008) defines sanitation as "safe management of human excreta, including its safe confinement treatment, disposal and associated hygiene-related practices." The NUSP envisages preparation of state sanitation strategies by states, and city sanitation plans (CSPs) by cities. The overall goal of the NUSP is "to transform Urban India into community-driven, totally sanitized, healthy and liveable cities and towns." The specific goals include awareness generation and behaviour change; open defecation free cities; and integrated city-wide sanitation (Box 1).

The NUSP specifically highlights the importance of safe and hygienic facilities with proper disposal; proper disposal and treatment of sludge from on-site installations (septic tanks, pit latrines, etc.); and proper operations & maintenance (O&M) of all sanitary facilities. The other aspects of the NUSP emphasize awareness generation, attention to the full-cycle of sanitation from safe collection to safe disposal, comprehensive provision and O&M management of household level arrangements and treatment systems. Therefore, the NUSP has accorded high importance to plan and implement actions for the organized and safe management of fecal matter from on-site installations that hitherto have received limited attention.

This advisory supplements the NUSP (and annexes on state strategies and CSPs) by outlining the contents and steps of developing a **Septage Management Sub-Plan (SMP)** as a part of the city sanitation plans (CSP) being prepared and implemented by cities. Septage refers here broadly to not only fecal sludge removed from septic tanks but also that removed from pit latrines and similar on-site toilets. This Advisory provides references to CPHEEO guidelines, BIS standards, and other resources that users of this Advisory may refer for details while preparing their SMP.

1.2 Why management of on-site sanitation needs attention?

One third of urban Indian households depend on on-site sanitation

The National Family Health Survey-3 (NFHS, 2005-06) reported that 17% urban households in India did not have access to any toilets at home, 24% households were sharing toilets (technologies not specified), about 19% had their toilets connected to sewers, the majority had on-site installations – about 27.6% households had septic tanks and 6.1% had pit latrines that were classified as "improved"[1]. Another 5% toilets were as "Flush/pour flush not to sewer/ septic tank/pit latrine" – in other words, human excreta from these installations were being let out untreated onto land and water bodies without any confinement or treatment. In other words, about 33% households had "improved" on-site systems and 5% of the households were on on-site unimproved toilets.

The National Sample Survey (65th Round, 2010) estimated that 8% of the urban households were

[1] The UNICEF-WHO Joint Monitoring Program (JMP, 2008, 2010) classifies those toilets that prevent contact with human excreta as "improved". These include facilities that flush or pour-flush to piped sewer system, septic tanks, or pit latrines; or Ventilated Improved Pit (VIP) latrines, pit latrines with slab or composting toilets. "Unimproved" facilities include defecation in the open, bucket or hanging latrines, open pit latrines or those without a slab, and facilities flushing or pour-flushing to drains or open areas (that is, not to piped sewer system, septic tank or pit latrine). The JMP classifies "shared" toilets as unimproved.

Box 1: The National Urban Sanitation Policy (NUSP): Policy Goals

A Awareness generation and behaviour change

a. Generating awareness about sanitation and its linkages with public and environmental health amongst communities and institutions;
b. Promoting mechanisms to bring about and sustain behavioural changes aimed at adoption of healthy sanitation practices.

B Open defecation free cities
Achieving open defecation free cities
All urban dwellers will have access to and use safe and hygienic sanitation facilities and arrangements so that no one defecates in the open. In order to achieve this goal, the following activities shall be undertaken:
a. Promoting access to households with safe sanitation facilities (including proper disposal arrangements);
b. Promoting community-planned and managed toilets wherever necessary, for groups of households who have constraints of space, tenure or economic constraints in gaining access to individual facilities;
c. Adequate availability and 100% upkeep and management of public sanitation facilities in all urban areas, to rid them of open defecation and environmental hazards.

C Integrated city-wide sanitation
Re-orienting institutions and mainstreaming sanitation
a. Mainstream thinking, planning and implementing measures related to sanitation in all sectors and departmental domains as a cross-cutting issue, especially in all urban management endeavours;
b. Strengthening national, state, city and local institutions (public, private and community) to accord priority to sanitation provision, including planning, implementation and O&M management;
c. Extending access to proper sanitation facilities for poor communities and other un-served settlements.

Sanitary and safe disposal
100% of human excreta and liquid wastes from all sanitation facilities including toilets must be disposed of safely. In order to achieve this goal, the following activities shall be undertaken:
a. Promoting proper functioning of network-based sewerage systems and ensuring connections of households to them wherever possible;
b. Promoting recycle and reuse of treated wastewater for non potable applications wherever possible ;
c. Promoting proper disposal and treatment of sludge from on-site installations (septic tanks, pit latrines, etc.);
d. Ensuring that all the human wastes are collected safely conveyed and disposed of after treatment so as not to cause any hazard to public health or the environment.

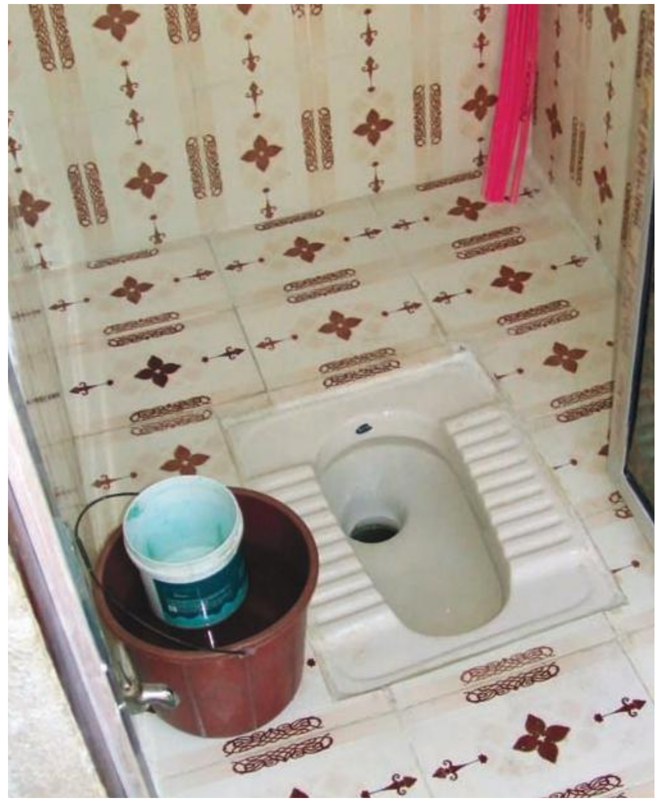
Proper operation and maintenance of all sanitary installations
a. Promoting proper usage, regular upkeep and maintenance of household, community and public sanitation facilities;
b. Strengthening ULBs to provide or cause to provide, sustainable sanitation services delivery.

Source: National Urban Sanitation Policy, Ministry of Urban Development, Govt. of India, 2008.

dependent on pit latrines, and 29% dependent on toilets connected to septic tanks. Census of India 2011 indicates that only 32.7% of urban households are connected to a piped sewer system whereas 38.2% dispose off their wastes into septic tanks and about 7% into pit latrines, underlining the pre-dominance of on-site arrangements – and it is not clear how the wastes are disposed from this majority of installations. Further, about 50 lakh pit latrines are insanitary (have no slabs or are open pits); 13 lakh are service latrines – of which 9 lakh toilets *dispose faeces directly into drains,* 2 lakh latrines are serviced by humans (illegally), 1.8 lakh latrines serviced by animals. Finally, about 18.6% urban households still do not have access to individual toilets – about 6% use public/community toilets and 12.6% are forced the indignity of open defecation. According to a USAID study (2010) by 2017, the number of urban households with toilets connected to septic tank will increase to 148 million urban households. Therefore, on-site pit latrines and septic tanks account for a substantial proportion of toilets in urban India – 48% of urban Indian households depend on on-site facilities (Census 2011), and this proportion is increasing.

It may be noted that sewerage systems only partially cover Indian cities – a NIUA (2005) study of 300 Class-I and Class-II cities noted that… "while all the metropolitan cities have a sewerage system, only a third of the Class-I cities and less than one-fifth of the smaller sized urban centers have a sewerage system. However, the coverage by sewerage systems is partial in all these urban centers".

Further, as households without toilets obtain facilities over the next few years, it is likely that many will acquire on-site arrangements like pit latrines and septic tanks in cities at locations where sewerage systems are not available.



Management of septage from on-site facilities appears to be an area of neglect

In contrast with the large proportion of on-site installations, limited attention has been accorded to proper construction, maintenance management and safe disposal of septage from septic tanks and pit latrines. While construction standards have been codified by Indian Standards Organization (ISO), the actual construction was largely left to households to manage – in practice, the installations are subject to local practices and considerable variations are observed. In many instances for example, soak-away outlets are not provided.

Limited capacities and resources with Urban Local Bodies (ULBs) also resulted in little regulation of maintenance and cleaning of septic tanks and pits – in many cases, households do not report cleaning for a number of years. Some ULBs have desludging equipment or there are private players providing cleaning services but the supply of desludging services is far from adequate. In many instances, septage is dumped in drains and open areas posing considerable health and environmental risks. Sanitary workers also work in hazardous conditions having to manually clean on-site pits and tanks without adequate protective gear and equipment. In fact, in most Indian cities, there is very limited dis-aggregated information on the types and numbers of on-site toilets and septage disposal systems and practices.

The National Rating of 423 Class-I Indian Cities (covering 72% of Indian urban population) on Sanitation (MOUD, Govt. of India, May 2010) found that 65% (274) of these cities had unsatisfactory arrangements for safe collection of human excreta (whether on-site or sewerage).

Septage management should be an integral part of sanitation schemes. State should make adequate budgetary provision for effective septage management. State governments should enforce implementation of septage management and monitoring programme at the ULB.

Urban India has limited sewage treatment facilities and little experience of septage treatment facilities

There are considerable challenges in respect of treatment of sewage – treatment capacities in Indian cities are only 31% of the total waste generated. The 35 million-plus cities have 68% of the total installed wastewater treatment capacity but nearly 39% of these treatment plants did not conform to discharge standards into water bodies (Central Pollution Control Board, 2009). While conventional sewage treatment facilities are limited (that could potentially also treat septage), there is on the other hand, limited experience in India of developing and managing septage treatment facilities of different types.

Therefore, while considerable proportion of urban Indian households depend on on-site sanitation facilities, their construction, regular cleaning, and safe disposal of septage remain haphazard. Most of the septage is let out untreated posing considerable health and environmental risks. Hence, it is crucial that septage management is accorded urgent attention in Indian cities.

The problems associated with on-site sanitation facilities can be summarized as follows:

(1) **Insufficient knowledge/capacity/awareness and public involvement:** There is a general lack of awareness of on-site systems and how these should be planned, designed, installed, operated and maintained, especially among system owners and the public at large, among the water and sanitation utilities – who have historically concentrated on centralized sewerage systems, and among the urban local bodies who did not have incentives and capacities to regulate these systems.

(2) **Inappropriate system design and selection processes:** Even though national standards have been issued, more often than not, on on-site systems are not built to these standards, and constructed and installed in an ad-hoc manner by untrained personnel. This leads to poor system performance and even failure, higher environmental risks – in many cases on-site system planning and siting functions are not linked to larger groundwater and watershed protection programs and lead to issues such as water quality problems in sub-surface sources, lakes, coastal bays, and estuaries. The practice of constructing septic tanks with outlets connecting to local open drains or channels is widely prevalent in urban India – especially the centres where sewerage systems have not yet come in (and would have carried the soak-away flows from septic tanks).

(3) **Poor O&M:** Many septic tank system failures have been linked to poor operation and maintenance. Typical causes of failure include infrequent desludging which results in sludge-filled tanks and leakages, clogged absorption fields, and hydraulic overloading caused by increased number of users, water-use following the installation of new water lines to replace wells and cisterns.

(4) **Poor inspection, monitoring, program evaluation and regulatory components:** The institutional mechanisms for inspection, monitoring, and other regulatory measures are non-existent, or even if present, are not effectively enforced. This has resulted in a situation where there is no information available that in turn leads to inaction and further deterioration of the situation on ground.

These problems result in poor system performance, public health threats, degradation of surface and groundwater, decline in property values, and negative public perceptions of on-site treatment as an effective wastewater management option.

The specifications for construction of septic tanks and soak pits are given in the Manual of Sewerage and Sewage Treatment published by the Ministry. ULBs shall ensure that the septic tanks are constructed, operated and maintained as per the guidelines given in the aforesaid manual.

2. Septage - its source & characteristics

2.1 Source

Septic tanks are the primary source of septage generation. A septic tank for the treatment of household wastewater is a horizontal continuous flow type sedimentation tank. This functions as a settling tank and digestion unit. The solids in the wastewater settle to the bottom of the tank where they undergo anaerobic degradation along with the organic matter in the wastewater. Studies have shown that only about 30% of the settled solids are anaerobically digested in the septic tank. Hence, there will be a build-up of solids in the settling tank, which if not removed frequently will affect the performance of the settling tank. Oil and grease and other lighter material will rise and float on the surface of liquid. This is referred to as scum. The tank is designed such that the sludge and scum together occupy about half to two-third of the tank's capacity (prior to desludging). Studies have established that a liquid retention time of 24 hours ensures quiescent conditions for effective settling of suspended solids. Considering the volume required for sludge and scum, septic tanks are designed with liquid holding capacity of two days (CPHEEO).

A septic tank is generally followed by a soak-away pit to disperse the effluent into the ground. The sludge settled at the bottom and the scum at the top of the sewage is allowed to remain in the tank for several months during which they are decomposed by bacteria through anaerobic digestion.

2.2 Characteristics

The quality and quantity of septage coming out of the tank depends largely on the type of sewage, the frequency of desludging, water usage and household chemicals going in the septic tank. The physical and biological characteristics of septage are highly variable. The anaerobic nature of septage results in the presence of odorous compounds such as hydrogen sulfide, mercaptans, and other organic compounds. Septage contains constituents that may result in unpleasant odours, risk to public health and serious environmental hazards. Disposal of septage into a water body could result in depletion of oxygen, eutrophication and health hazard on account of the pathogens. Therefore, knowledge of septage characteristics, its variability, dewaterability are important in determining acceptable treatment and disposal methods. The physical and chemical characteristics of septage and characteristics of septage in tropical countries are summarized in Table 1 (U.S. EPA, 1984) and Table 2, respectively.

Table 1: Physical and chemical characteristics of septage

Constituent (all units but for pH are in mg/l)	Average	Range
Biochemical Oxygen Demand	6,480	440 - 78,600
Chemical Oxygen Demand	31,900	1,500 - 703,000
Total Solids	34,106	1,132 - 130,745
Total Volatile Solids	23,100	353 - 71,402
Total Suspended Solids	12,862	310 - 93,378
Volatile Suspended Solids	9,027	95 - 51,500
Total Kjeldahal Nitrogen	588	66 - 1,060
Ammonia-Nitrogen	97	3 - 116
Total Phosphorus	210	20 - 760
Alkalinity	970	522 - 4,190
Grease	5,600	208 - 23,368
pH		1.5 - 12.6

Table 2: Characteristics of septage in tropical countries*

Parameter	Type "A" high strength	Type "B" low strength
Example	Public toilet or bucket latrine sludge	Septage
Characterization	Highly concentrated, mostly fresh FS; stored for days or weeks only	FS of low concentration; usually stored for several years; more stabilized than Type "A"
COD (mg/L)	20-50,000	<15,000
COD/BOD	5:1 to 10:1	5:1 to 10:1
NH_4-N (mg/L)	2-5,000	<1,000
TS (%)	≥ 3.5 %	< 3 %
SS (mg/L)	≥30,000	7,000 (approx)
Helminth Eggs (unit/ml)	20-60,000	4,000 (approx)

* Detailed septage characterization (BOD, SS & other microbial characteristics) as well as its dewatering characteristics (Specific resistance etc.) should be mandatory prior to the design of any septage management facility.

Source: Strauss, 1996

3. Present status & current practices

The National Building Code of India (NBC, 2005) has published guidelines for septic tank design, construction, installation, their operations and maintenance. But in reality, the sizes and designs of septic tank vary from one place to another and are influenced largely by the local construction practices, material and skill of masons.

"Septic tanks should be cleaned when a large quantity of septage has collected in the bottom of the tank." But poor knowledge and lack of maintenance services often results in accumulation of organic sludge which reduces effective volume, lower retention times and affects the system performance. As septic tanks fill with sludge, the effluent begins to resemble septage with dramatically higher pollution values. However, desludging of septic tanks is perceived as a burden by many home-owners and hence they postpone cleaning until the tanks start overflowing.

Most on-site sanitation systems are emptied manually in absence of proper mechanical systems and that too, after long periods. Private operators often transport and dispose of septage in drains, waterways, open land, and agricultural fields.

The NUSP underlines the necessity for safe confinement and treatment of human excreta. The municipalities/local government bodies are usually empowered for ensuring the safe handling and disposal of septage generated from on-site sanitary installations. In conformity with CPHEEO guidelines, these also establish local laws or regulations to govern septage handling and to meet all regulatory requirements and standards. While local bodies or utilities may be responsible for regulation over such practices, lack of systems, resources, capacities and incentives often result in neglect and continuance of uncontrolled dumping of septic tank wastes.

4. Public health & environmental hazards

Septic tank effluent and septage, with appreciable levels of organics, nitrogen and pathogens, disposed without proper treatment are a cause of concern on account of the organic carbon (as measured as BOD_5), nitrogen, phosphorus and pathogens in the effluent. Discharge of wastewater with organic carbon can lead to the decrease of oxygen and endanger the aquatic organisms in the surface waters. Nitrates in the wastewater can contaminate the groundwater and if used for drinking could cause methemoglobinemia and other health problems for pregnant women. Nitrates and phosphorus in the wastewater can also lead to eutrophication of surface waters. Pathogens reaching the ground or surface water can lead to human diseases through direct consumption, recreational contact or consumption of contaminated shell fish.

The pollutants of concern in the effluent and septage from septic tanks systems and their potential impacts on ground and surface water resources are summarized in Table 3 (Tchobanoglous and Burton, 1991).

Improper disposal of septic tank effluents and septage can pose direct and indirect socio-economic impacts too. A study by WSP estimated the economic losses due to inadequate sanitation at Rs 2.44 trillion per year to India (WSP-SA, 2010).

Table 3: Pollutants in the effluent of on-site treatment Systems

Pollutant	Reason for concern
Total suspended solids	In surface waters, suspended solids can settle and form sludge deposits that smother benthic invertebrates, fish eggs and can contribute to benthic enrichment, toxicity and sediment oxygen demand. Colloidal solids can block sunlight, affect aquatic life and lower the ability of aquatic plants to increase the dissolved oxygen in the water.
Biodegradable organics (BOD)	Biological degradation of organics can deplete the dissolved oxygen in surface waters resulting in anoxic conditions, harmful to aquatic life.
Nitrogen	Nitrogen could lead to eutrophication and dissolved oxygen loss in surface waters. High levels of nitrate nitrogen in drinking water can cause methemoglobinemia in infants and pregnancy complications for women. Livestock can also suffer from drinking water high in nitrogen.
Phosphorus	Phosphorus would also lead to eutrophication and reduction of dissolved oxygen in surface waters.
Pathogens	Parasites, bacteria and viruses can cause communicable diseases through body contact, ingestion of contaminated water or shellfish. Transport distances of some pathogens (bacteria and viruses) can be quite significant.

5. Elements of septage management

5.1 Septage generation rate

Septage generation rates vary widely from place to place depending on practices of septic tank use, number of users, water used for flushing, and the frequency of cleaning the septage. The size of a septic tank in individual houses in India ranges from 1 to 4 cubic meter, whereas the size of a septic tank in office or apartment buildings may vary from 10 to 100 cubic meter.

Adopting the (U.S. EPA, 1984) estimate of septage generation of 230 litres/year and an average household size of four, the septage generation/household would be 920 litres/year. Alternatively, assuming an average septic tank volume of 3 m^3 and emptying of septage when one-third of the septic tank is filled with settled solids, the volume of septage emptied would be 1 m^3.

5.2 Desludging of septic tanks

In Indian cities, most of the septic tanks are desludged manually. This is considered as an unpleasant and repulsive job, precipitates human contact with faecal matter, and since the sludge (including fresh excreta) generally gets spilled around the tank during emptying, this poses a risk of transmission of diseases of fecal origin – in any case, this is tantamount to manual scavenging. The Government of India has enacted the Employment of Manual Scavengers and Construction of Dry Latrines (Prohibition) Act, 1993. This Act serves as a primary instrument to eradicate practice of manual scavenging. The definition of manual scavenging as per the Act, 1993 does not specifically cover manual cleaning of septic tanks and sewers, though as outlined above, this is clearly implied. Therefore, it is essential that such cleaning operations be included in the definition of manual scavenging. Further, it is suggested that cleaning of septic tanks and sewers need to be carried out using mechanical devices that obviates the need for manual scavenging.

Given the safety and health risks of manual desludging, it is critical for cities to take measures to urgently put a stop to this demeaning practice. This must include stringent restrictions on and punitive measures for all private parties offering manual septage clearance services. Public sector units including local governments, municipalities (and water utility personnel involved in manual cleaning of sewers and septic tanks) should also be brought under strict vigil to prohibit any manual cleaning, and the full adoption of mechanical devices, safety gear for occupational safety and practices that reduce to the minimum any risk of physical contact as well as protect against hazards posed by noxious gases while cleaning septic tanks, pits or sewer systems.

The most satisfactory method of sludge removal is by vacuum tankers. Though desludging frequencies vary, it is generally recommended to desludge tanks once every two to three years, or when the tank becomes one third full. Periodical desludging also helps reduce the pollution levels in the effluent, which normally enters waterways untreated. However, a small amount of sludge should be left in the tank to ensure that a minimum level of the necessary microorganisms responsible for anaerobic digestion remain in the tank. The gas generated due to anaerobic digestion might escape when tank is open for desludging. Hence, it is highly advisable to avoid using fire (or any incendiary material) in these cases. Regular desludging activities require well-organized community and public/private service providers. Because of the delicate nature of septic systems housing microbial processes, care should also be taken not to scrub the septic clean or use chemicals such as detergents etc. to avoid the complete destruction of favorable microbes in the tank.

Before desludging, if the liquid level in the tank is higher than the outlet pipe, this may indicate clogging in the outlet pipe or in the drain. The sludge then may be collected through safe containers or pumping. Before pumping, the scum mat is manually broken up to facilitate pumping. Prior to this, the liquid level in the septic tank first is lowered below the invert of the outlet, which prevents grease and scum from being washed into the drain. After the scum mat is broken up, the contents of the tank are removed. Normally, the vacuum/suction hose sucks up to a point where 1 to 2 inches (about 2.5 to 5 cm) of sludge remains at the tank bottom to facilitate future decomposition. The sludge after removal should be transported in a controlled manner to avoid leakage or spillage en-route.

5.3 Septic tank cleaning machines and septage transportation

The following norms are suggested to work out the requirement of septic tank cleaning machines.

The vehicles are available in different capacities from 2,000 up to 12,000 litres. Total number of machines depends on the frequency of cleaning of septic tanks (once in 2–3 years) and also the distance from the location of septic tanks to the septage treatment facility. It is to be noted that the requirement of machines also varies depending upon the capacity of vehicles, road width etc. In case of bigger cities having sufficient width of roads, vehicles having larger capacities may be adopted. However, the number of septic tank cleaning machines will have to be decided based on local conditions and in consultations with the community and traffic police regarding movement of vehicle. Adequate provision for standby machines for cleaning of septic tanks may also be made.

Septage transportation is one of the most important components of septage management. There is need for evolving a standard method of collection, handling and transportation of septage. Desludging trucks act as a "mobile sewer network" for on-site sanitation systems. They collect the septage at the household level and transport it to treatment or disposal sites, thereby complimenting the functions of an underground sewer network.

Small scale vacuum trucks called Vacutug (from 200 up to 2,000 litres capacity) are also recommended for use in areas inaccessible to large desludging vehicles. The Vacutug is mounted on wheels and can be attached to a small vehicle. It can be manufactured locally to offer flexibility and mobility without losing the capacity to collect a substantial volume of fecal sludge within one operation. In case of hillside area where vehicle access is difficult, new transportation system should be implemented.

It would be desirable to develop standard operating procedures for pumping, and transportation of septage as part of a manual of practice for septage. It is best that the manual of practice be prepared by the septage program managers by first reviewing the operating procedures for specific equipment and then documenting all aspects of the day-to-day procedures. These procedures should include:

- Scheduling and routing for trucks
- Customer service protocols
- Locating tanks and cleanouts
- Proper pumping equipment operation and worker safety
- Site control, including post-pumping clean-up
- Transportation requirements, including rules of the road
- Disposal procedures at the treatment facility
- Routine service of equipment – greasing and oiling, minor repairs
- Recordkeeping for all tanks pumped and wastes discharged at the disposal facility

A manual of practice is an important document since it provides guidance for the equipment operators. Furthermore, it is a valuable training document for new employees. The manual can specify set procedures that employees should follow so that their work is done within specified guidelines. The procedures should be recorded in a step-by-step field manual that becomes an addendum to the septage management regulations.

5.4 Treatment of septage at sewage treatment plants

Co-treatment of septage along with domestic sewage at a sewage treatment plant (STP), if available, is the most desirable option. Though septage is more concentrated in its strength than domestic sewage, its constituents are similar to municipal wastewater. The STP should have adequate capacity to accept the septage without hampering the functioning of the sewage treatment plant. The municipality should monitor the incoming wastewater load to the STP and accept the septage, if the design norms are not violated with the increased load (on account of the septage). Figure 1 provides a method to estimate the allowable rates of septage addition, assuming that a holding tank is provided and that septage is added to the sewage flow intermittently. This chart takes into account the current loadings to the plant compared with its design loadings.

If the STPs are working close to the design capacity, additional loads due to disposal of septage will necessitate expansion or upgradation of the STP capacity.

The main factors in treating septage in a STP are:

- **Septage addition at the nearest sewer manhole:** Septage could be added to a sewer upstream of the STP, and substantial dilution of septage occurs prior to it reaching the STP, depending on the volume of sewage flowing in the sewer.
- **Septage addition at the STP:** Septage could be added to sewage immediately upstream of the screening and grit removal processes.
- **Septage addition to sludge digesters/sludge drying beds:** Septage could be processed with the sludge processing units of STP.

If septage is to be co-treated with sewage, it will be necessary to construct a septage receiving station. Such a station will consist of an unloading area (sloped to allow gravity draining of septage hauling trucks), a septage storage tank, and one or more grinder pumps. The storage tank is used to store the septage so that it can be discharged to the treatment plant. The septage in storage tank should be properly mixed by mixers, air diffusers for odor control. Discharge of septage upstream is preferable for the removal of grit and screenings. If there are no screening facilities ahead of the septage discharge facility, the septage should be transferred from the storage tank to the treatment plant with grinder pumps. In some cases, this transfer can be accomplished by gravity flow. If the septage is strong, it can be diluted with treated sewage. Chemicals such as lime or chlorine can also be added to the septage in the storage tank to neutralize it, to render it more treatable, or to reduce odours.

The advantages and disadvantages of treating septage at the sewage treatment plant are presented in Table 4.

5.5 Treatment at independent septage treatment plants

5.5.1 General aspect and treatment process

When an STP does not exist for a city, or the distance or the capacity of the available plant becomes a limiting factor, it is not a feasible option to transport

Figure 1: Allowable septage loadings to a sewage treatment plant having septage-holding tank (U.S. EPA, 1984)

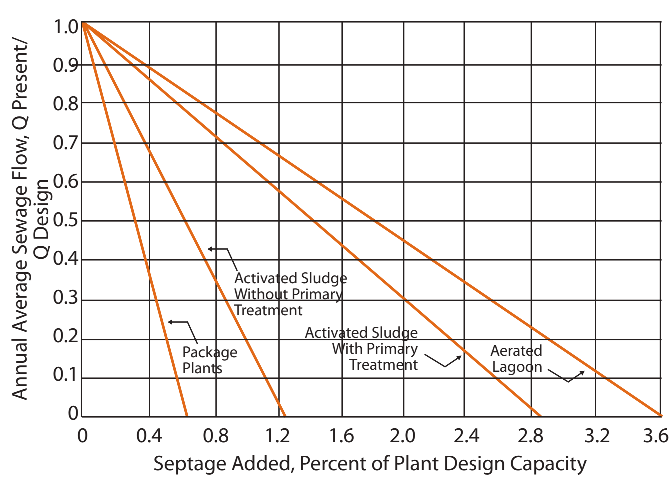


Table 4: Advantages and disadvantages of septage treatment at sewage treatment plant

Method	Description	Advantages	Disadvantages
Treatment at STPs	Septage is added to the pumping station, upstream manhole or sludge treatment location for co-treatment with sewage. Septage volumes that can be accommodated depends on plant capacity and types of unit processes employed.	Most STPs in India are underutilized and will have the capacity to handle additional septage. As skilled personnel and laboratory facilities are available in STPs, it is easy to operate and maintain.	STP performance may be hampered by addition of septage if the STP is running at full capacity. Need to be especially concerned with the increased BOD and NH_4-N load. Increased grit and sludge treatment cost (on account of increased volume of septage).

and treat the septage at the sewage treatment facilities. Hence, a treatment plant especially meant for septage treatment becomes the option to consider. Independent septage treatment plants are designed specifically for septage treatment and usually have separate unit processes to handle both the liquid and solid portions of septage. These include:

- Lime stabilization – odour control, conditioning and stabilization of the sludge
- Dewatering – sludge drying beds or mechanical dewatering
- Anaerobic/aerobic wastewater treatment – liquid from the sludge drying beds and mechanical dewatering systems
- Co-composting with organic solid waste

The choice of mechanical dewatering or sludge-drying beds would be dependent on the land availability, with mechanical dewatering systems being preferred where land is scarce and sludge drying beds being adopted where land availability is not a constraint. The benefit of using these treatment plants is that they could provide a regional solution to septage management. Many septage treatment plants use lime to provide both conditioning and stabilization before the septage is dewatered, and this dewatered sludge can be used as organic fertilizer after drying and composting. Additionally, lime stabilization also helps to reduce/minimize odour. The common practice is to add lime to raise the pH to 12 and hold it for a period of 30 minutes. The filtrate from the dewatering units needs to be further treated through treatment process such as waste stabilization ponds, anaerobic baffled reactor, constructed wetland or aerobic treatment systems before discharging into the environment.

However, the choice of an appropriate septage management system is dependent on land availability, hauling distance, technical requirements, and availability of skilled labour, legal and regulatory requirements. The management option selected should be in conformity with local, state, and central regulations.

Table 5 summarizes the septage treatment options for two conditions, namely, when space is a constraint and otherwise:

Cities will need to ascertain availability of land and land costs along with preparing preliminary estimates for the above technical options. These preliminary estimates will be utilized at the time of conducting feasibility analysis (see Section 10).

5.5.2 Pretreatment of septage

Pretreatment/stabilization includes physical and or chemical treatment to decrease odours and ease in handling for further treatment.

Table 5: Design details and indicative costs for a few treatment options

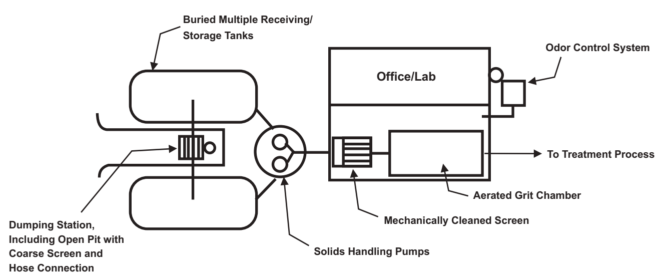
Unit operations	Treatment options	Design details
Space not a constraint		
Conditioning and stabilization	Lime treatment	2.4 – 3.0 kg/m^3 of septage
Dewatering	Sludge drying beds	0.09 – 0.23 m^2/capita
Wastewater treatment (Filtrate/liquid from dewatering units)	Any one of the options below could be adopted	
	Anaerobic baffled reactor	2- 3 m^2/m^3 of septage
	Aerobic/stabilization ponds	Storage volume 2 – 3 years
	Constructed wetland	5 – 10 m^2/m^3 of septage
Space is a constraint – dewatering with mechanical dewatering system and liquid waste from dewatering units in an anaerobic baffled reactor. The other unit operations are the same.		

Pretreatment requires (Figure 2)

- **Septage storage tank:** To store and homogenize the collected septage
- **Pumps:** To pump the septage from storage tank to the screens
- **Mechanical/manual screens:** To remove large size particles, such as plastic, rag from the septage and protect downstream treatment facilities
- **Grit channels or aerated grit chambers:** To remove coarse sand and cinder from the septage to prevent abrasion of downstream mechanical equipment, such as pumps, etc. Aerated grit chambers can also help in reducing odour emissions from the septage
- **Odour control system (optional):** To eliminate or reduce odour through treatment either in biological or carbon adsorption system

In addition, lime stabilization is also practised to stabilize, control odor, vector and pathogen destruction. Lime stabilization involves adding and thoroughly mixing lime (alkali) with each load of septage to ensure that the pH is raised to at least 12.

Figure 2: Pretreatment of septage



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

i) In the hauler truck before or while the septage is pumped
ii) In a septage storage tank where septage is discharged from the hauler truck (Figure 3).

5.5.3 Septage dewatering

The septage after lime dosing is pumped to a screw press or any other mechanical dewatering machine (Figure 4). Polyelectrolyte is added to improve the dewatering efficiency. The liquid residual/filtrate

Figure 3: Lime stabilization of septage

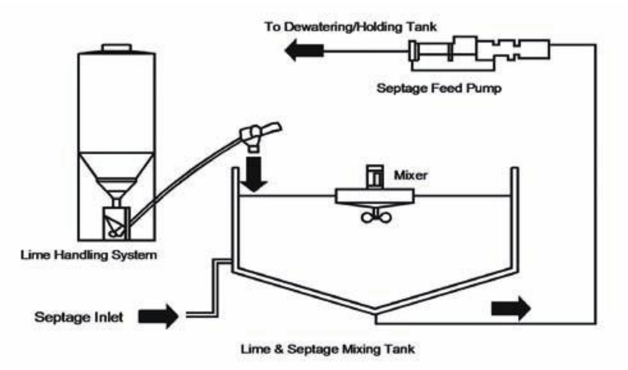
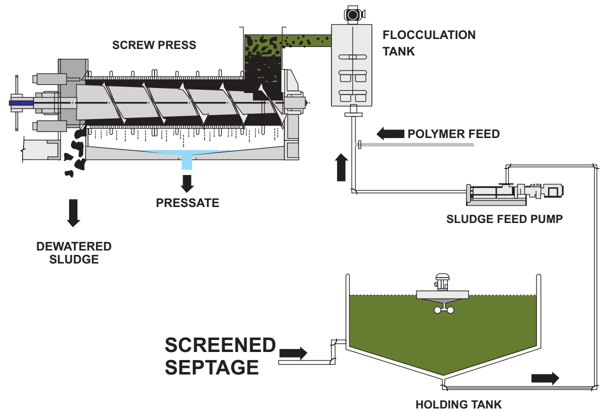


Figure 4: Typical mechanical septage dewatering system



from dewatering machine needs to be further treated before disposal. The dewatered sludge needs to be dried or composted prior to reuse as soil conditioner/organic fertilizer.

Instead of screw press, the other options can be:
1. Centrifuge
2. Belt Press
3. Filter Press

Many companies are manufacturing sludge dewatering machines.

The advantages and disadvantages at independent septage treatment plant can be summarized in Table 6.

5.6 Composting of dewatered septage or sludge

Another feasible option is composting where bulking agents are easily available. The humus produced after composting can be used as a soil conditioner.

Composting is another popular method of treating septage. Compost is defined as "the stabilization of organic material through the process of aerobic, thermophilic decomposition." During the composting process organic material undergoes biological degradation to a stable end product. Approximately 20 to 30% of the organic solids are converted to carbon dioxide and water. As the

Table 6: Advantages and disadvantages of independent septage treatment facility

Method	Description	Advantages	Disadvantages
Treatment at independent septage treatment plants	A facility is constructed solely for the treatment of septage. Treatment generates residuals, i.e., dewatered sludge which must be dried and composted (dewatered sludge) and filtrate which must be properly treated (filtrate) prior to disposal	Provides regional solutions to septage management. Also makes available organic fertilizer	High capital and operation and maintenance cost (compared to co-treatment at a sewage treatment plant) Requires high skilled manpower for the operation of mechanical dewatering machines

organic material in the septage decomposes, the compost heats to temperatures in the range of 50 to 70^{o}C and harmful pathogens are destroyed. The resulting humus-like material is suitable as a soil conditioner and source of nitrogen and phosphorus. Septage can be composted directly. The basic procedure for composting are as follows:

1. Septage is mixed with a bulking agent (e.g. wood chips, sawdust) to decrease moisture content of the mixture, increase porosity, and assure aerobic conditions during composting.

2. The mixture is aerated either by the addition of air ("aerated static pile") or by mechanical turning ("agitated") for about 28 days.

The most common "agitated" method is windrow composting: the mixture of septage or wastewater solids and bulking agent is pushed into long parallel rows called "windrows", about 1 to 2 meters high and about 2 to 4.5 meters at the base. The cross-section is either trapezoidal or triangular. Several times a week the mixture is turned over. Although specialized equipment has been developed for windrow composting, it is possible to use a front-end loader to move, push, stack, and turn the mixture. Factors affecting the composting process (U.S. EPA, 1984) include moisture content (40 to 60%); oxygen (5 to 15%); temperature (must reach 55 to 65^{o}C); pH (6 to 9); and carbon-to-nitrogen ratio (20 to 1 to 30 to 1) are detailed in the Table 7.

For effective operations there should be sufficient laboratory equipment to monitor these parameters during the composting process. Moisture can be added and turning can be increased based on monitoring results. The operator should measure temperature at least once per day by placing a thermometer into the mixture at various locations. Maintaining temperature of 50 to 60^{o}C for the compost period assures destruction of pathogens. Co-composting septage or wastewater solids with the organic fraction of municipal solid waste (MSW) is also possible. The organic fraction includes food wastes, paper, and yard-wastes (e.g. leaves, branches, shrubbery etc.). The MSW serves as the bulking agent.

Compost from septage or wastewater solids can be used as a soil amendment to reclaim land or used in landscaping or horticulture. Agricultural use or use that may include human contact (e.g. at parks or playgrounds) requires detailed laboratory analysis to confirm concentrations of pathogens and heavy metals are within safe limits. In order to produce treated septage of suitable quality for soil amendments, limiting septage collection to residential housing is required.

Table 7: Operational parameters for dewatered septage composting

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

6. Dewatered septage sludge reuse

For dewatered septage/sludge use as fertilizer in agriculture application, it should satisfy the following criteria of Class A Bio-solids of US EPA:

- A fecal coliform density of less than 1000 MPN/g total dry solids

Salmonella sp. density of less than 3 MPN per 4 g of total dry solids. WHO (2006) suggests Helminth egg concentration of < 1/g total solids and E coli of 1000/g total solids in treated septage for use in agriculture.

MSW Rules (2000) recommended the quality for compost as referred to Table 8.

In the absence of any standards, it is recommended that these be adopted until such time standards are notified by the Central Pollution Control Board.

Properly treated sludge can be reused to reclaim parched land by application as soil conditioner, and/or as a fertilizer. Deteriorated land areas, which cannot support the plant vegetation due to lack of nutrients, soil organic matter, low pH and low water holding capacity, can be reclaimed and improved by the application of treated septage. Septage sludge, as a result of lime stabilization has pH buffering capacity that is beneficial for the reclamation of acidic soils. Treated septage with a solid content of 30% or more are handled with conventional front-end-loading equipment, and applied with agricultural manure spreaders. Liquid sludge, typically with solid content less than 6% are managed and handled by normal hydraulic equipment. Treated septage contains nutrients in considerable amounts, which supports the growth of a number of plants.

Table 8: Compost quality

Parameter	Concentration not to exceed (mg/kg dry basis, except for pH and carbon to nitrogen ratio)
Arsenic	10
Cadmium	5
Chromium	50
Copper	300
Lead	100
Mercury	0.15
Nickel	50
Zinc	1000
C/N ratio	20 – 40
pH	5.5 – 8.5

7. Regulation and monitoring by ULB/city utilities

The Environment (Protection) Act, 1986 and the Water (Prevention and Control of Pollution) Act, 1974 also apply to households and cities in regard to disposing wastes into the environment. ULBs/utilities also have to comply with discharge norms for effluent released from sewage treatment plants and to pay water cess under the Water Cess Act, 1977. The ULB is responsible for ensuring the safe handling and disposal of septage generated within its boundaries, for complying with the Water Act for meeting all state permit requirements and regulations (CSE, 2010).

There are no specific legal provisions relating to septage management, but there are a number of provisions relating to sanitation services and environmental regulations, following from the above Acts. Municipal Acts and Regulations usually refer to management of solid and liquid wastes but may not provide detailed rules for septage management. Therefore, it is recommended that ULBs formulate their own bye-laws and rules for management of septage in the city – this could be taken up as a State-level activity in consonance with the Municipal Act in place.

The State and appropriate development authorities would need to review the building regulations to ensure proper construction of adequate on-site facilities for loads projected to be generated, and for ensuring safe disposal. These will need to be disseminated to the construction industry and households through periodically scheduled interactions like workshops. Sites selected for sludge application by the ULB and by other parties (like residential layouts) would need prior consent to operate from the competent authority [like the Pollution Control Board (PCB)].

The rules should address:

- Design of septic tanks, pits etc. (adapted to local conditions) and methods of approval of building plans, or retro-fitting existing installations to comply with rules
- Special provisions for new real estate developments
- Periodicity of desludging, and O&M of installations
- Operating procedures for desludging including safety procedures
- Licensing and reporting
- Methods and locations of transport, treatment and disposal
- Tariffs or cess/tax etc. for septage management in the city
- Penalty clauses for untreated discharge for households as well as desludging agents

The septage management program for the cities should provide for issuing licenses to private operators providing desludging services. All public and private sector staff should adhere to safety norms as provided in the Manual on Sewerage and Sewage Treatment published by the Ministry of Urban Development and such other safeguards that the ULB may provide under its own rules. For disposal of septage, the ULB will need to follow the standards set out in the Environment (Protection) Act, 1986, depending on the mode of disposal.

Inspection of on-site system and pumping of septic tank: This should be carried out by the ULB/utility. Following the design norms adapted to local conditions that are notified under the Septage Management Rules, the ULB should carry out regular inspection of properties with on-site systems.

Baseline Data Collection: For any serious septage management plan to be effective, robust data on septage arrangements, volumes and locations are required. The ULBs would need to make arrangements to collect baseline data – type of latrine disposal, effluent disposal arrangement, size, age, when it was last cleaned, access to the on-site system, arrangement for disposal of effluent (if any at existing installations), to plan for workable desludging schedules. It is advisable to divide the city into working zones and carry out this baseline activity in one or a few of these zones, pilot desludging schedules by area to learn operational issues and devise solutions, before scaling up to the whole ULB. The selection of zone could be based on availability of septage disposal sites – existing STPs could be potential septage disposal/application sites or trenches provided in solid waste landfill sites or suitable urban forestry sites where the septage trenches would serve to fertilize the plants. It is recommended that households in demarcated septage management zone should be within a 30 km. travel distance from identified disposal sites, for workability.

The ULB will need to coordinate with existing service providers (if any) and ensure that collection, transport and disposal of septage, is carried out in a manner safe to households, environment and public health. It would be advisable for the ULBs to set up a one-time registration mechanism for service providers with a nominal fee. This would also build up a database of available service providers within designated service areas. Periodic interactions with the service providers would aid in improving the septage management process over time.

Recordkeeping and manifests

Keeping accurate records regarding tanks emptied and volume pumped is important for billing and compliance. Recordkeeping and manifest forms are an integral part of a comprehensive septage management program. Recordkeeping requirements should be codified into the law governing the program. Manifest forms are simple receipts that specify:

- the name and address of the property owner or occupier
- septage characteristics (residential or commercial)
- the volume of septage pumped
- any notes regarding tank deficiencies, missing pipes or fittings, improper manholes or access ports, any other cracks or damage observed

Once completed, a copy of the manifest is given to the owner as a receipt. When the load is delivered to the disposal site, the disposal site operator:

- accepts the load
- verifies the volume
- takes a sample if needed
- signs the manifest proving receipt of the volume of septage disposed of

It may be advantageous for the operator to pump out multiple tanks before going to the disposal site. In this case, a multiple-load manifest form as well as individual manifest/receipt forms should be completed. The completed document or documents should be given to the local government for their records. The manifest system is a tracking and compliance tool. It helps to track and ensures that all of the septage pumped arrives at the disposal site and minimizes the opportunity for illegal discharge. It is also a record that some septage programs may choose to use for paying septage hauling subcontractors. For example, Manila Water Company pays its hauling contractors based on the cubic meters of septage delivered to the disposal site as recorded on the manifest. This system accomplishes two main goals. First, it provides an incentive for haulers to make proper disposal at the treatment facility. Second, it provides an incentive for the service provider to maximise volume of septage delivered at the disposal site. This is important since simply removing the liquid fraction of the septic tank doesn't remove the sludge, which is the fundamental goal of the emptying service.

8. Financial management

8.1 General aspect and public private partnership

Right from the planning stage, it is necessary to draw up a long term financing and investment plan for septage management for the city. While public funding (national, state and ULB level) will be needed to finance septage management systems, facilities, equipment and manpower, it will be beneficial to consider options for public private partnerships (PPP), wherever possible. As in many cities in India, as well as in other countries, services for emptying the septic tanks and their transport, involves private sector parties. Similarly, private parties may also be invited to operate and maintain the septage management facilities (as being done for STPs). However, the success of these options will be dependent on the formulation and implementation of a suitable user-fee system. A cleaning charge (payable directly by the household to the septic-tank cleaning service provider) may also be supplemented with appropriate taxes and fees the citizens pay directly or indirectly for the part/full financing of the O&M of the septage management/treatment facility (as is done in the case of STPs).

The key issues are:
1) Policy and legal framework for financing and involvement of private sector
2) Target setting for revenue generation
3) Tariff structure design
4) Role of government and other stakeholders
5) Contractual arrangements for PPP projects
6) Monitoring, evaluation and accountability for services provision, environmental and economic regulation

8.2 Costs and cost recovery

Neither the local authorities nor water supply authorities in India have adequate capital or are able to leverage finances for expensive sewer networks or sewage/septage collection and treatment facilities. Thus, major sanitation improvements are dependent on a mix of government's budgetary funding, loan assistance and user charges. Thus, the design of septage management projects need to accord high importance to financial considerations. Obtaining funds and enacting necessary tariff changes (e.g., linking revenues with expenditures) requires careful negotiation and cooperation between all stakeholders, especially when elected officials are sensitive to popular concerns regarding tariffs. Exploring financing options from several sources can help lower the financial contribution of the ULB for the project and revenue generation from the sale of end products could partially or fully meet the operations and maintenance costs.

Operations and maintenance (O&M) expenses for septage management programs typically include the following:

- Labour
- Overheads (e.g., benefits, employment taxes)
- Utilities for septage treatment
- Transportation of septage and processed septage
- Vehicles and other equipment maintenance
- Taxes
- Disposal costs for dried cake
- Licenses and permits
- Insurance
- Testing and other monitoring
- Miscellaneous supplies

8.3 Revenue generation issues

1. Political approval and effective administration of sanitation-related taxes and charges have proven to be difficult for local governments and utilities to implement. However, many cities in the country are increasingly realizing the importance of septage management and trying to introduce

taxes to recover at least part of the cost, as a part of the water bill, as is done in many locations for sewerage taxes and user charges.

2. The disadvantages are that the water service provider (in some cases, a utility not responsible for septage management) is not always able or willing to collect sanitation charges, and, while there are strong synergies in financial management, sanitation services require different skills and resources to those needed for water supply.

3. Government funding is also essential, notably for city level infrastructure like for treatment, as well as for the provision of sanitation services to the urban poor, who remain excluded from public sewerage and on-site sanitation services.

4. Some cities charge a flat rate (or zero) tariff, collect revenues lower than their O&M costs and, are dependent on subsidies from the state or, where managed by a water utility, on cross-subsidies from water supply income.

5. Wherever, septage is disposed in a sewage treatment facility for co-treatment with domestic wastewater, a tipping fee needs to be collected for the septage disposed and treated at the sewage treatment facility. The tipping fee can be calculated as a proportion (hydraulic and organic load) of the septage discharged to the wastewater treated at the plant.

6. In most cities, desludging is done only when requested by households and usually when the septic tank overflows. Costs are paid by the household directly to a private desludging company. To implement a city-wide septage management program, there is a need for the ULB and/or water supply authority to maintain a master database of on-site sanitary installations, and a system to update it for scheduling and reporting desludging of septic tanks, etc. Each ULB needs to develop a system that works for them. The ULB/water supply authority could collect fees from the households and pay the contractor for each truck-full of septage brought to the treatment facility. This would give the contractor an incentive not to simply dump the septage indiscriminately in non-designated places, as is currently being done.

7. In case septage is collected, transported, treated and disposed in a sewage treatment facility, the treated sewage and sludge shall comply with relevant Minimal National Standards (MINAS) notified under Environment (Protection) Act, 1986.

8. Reuse of treated sludge for agriculture application should comply with the standards notified for compost under US EPA /WHO guidelines and MSW Rules.

9. Operation & maintenance

9.1 General aspects

Inspection of on-site systems and pumping of septic tanks should be carried out by the ULB/ utility personnel or authorized competent agencies contracted by the ULB/utility. Following the design norms adapted to local conditions, the ULB should carry out regular inspection of properties with on-site systems. This must be combined with establishment and later updating of the master city database of on-site sanitation installations.

The ULB will need to coordinate with existing service providers (if any) and ensure that collection, transportation and disposal of septage is carried out in a manner safe to households, environment and public health. It would be advisable for the ULBs to set up a one-time licensing or registration mechanism for service providers with an annual license fee. This would also build up a database of available facilities within designated service areas. Periodic interactions with the service providers would help in improving the septage management process over time.

As described in earlier sections, appropriate recordkeeping systems and reporting procedures will need to be set up for the ULBs to establish the master database, prepare desludging schedules and update on completion, through integration to the property tax database.

9.2 Personnel, training and capacity building

It is obligatory responsibility of every local body to collect, transport and properly dispose septage as well as sewage produced in the area under their respective jurisdictions. This obligation depends upon financial status of each local body. To meet this goal it is necessary to build the capacity of the urban local bodies especially in institutional and human resources. The former aims to improve the performance of institute with assessment of service efficiency and profitability. The latter aims to motivate individual capability in terms of innovative thoughts enhancement and latest trends and information. This human resources capacity building should be systematically constructed according to individual career steps.

There will also be a need for their capacity building and training. The training should include technical, financial, regulatory, monitoring and evaluation. The training should include classroom, field visit and provide participants with hands-on-training on all aspects of septage management. It is to be emphasized that the training modules are to be prepared and delivered considering the best-available approaches to address the realities of stakeholders. Further, all the modules should be learner-centered, interactive and learning-by-doing, and should minimize one-way communication. It is equally important that the training also include exposure/field visit to familiarize participants to technology, institutional and monitoring aspects of septage management. Interaction with city officials who have successfully implemented septage management programs would be very useful as it will prepare the participants as the drivers for a successful program. All training materials should be updated and easily/readily available to participants and it would be useful to establish a centralized knowledge house/repository that could guide cities as they embark on a septage management program. This training shall also be given in the local language.

At this moment, CPHEEO is conducting Refresher Course in 21 institutes. Currently only one Refresher Course on "Low Cost Sanitation" is being conducted under this programme. In addition, CPHEEO has proposed new courses for preparation of septage management plan, and mechanised cleaning of sewerage drainage & septic tank systems. It is expected that the strengthening of PHE training will greatly help capacity building. State Govt/ULBs are requested to depute the concerned officials to participate in the training programme. The detail of PHE training programme is available in CPHEEO's website: http://www.cpheeo.nic.in.

9.3 Communication and community participation

The NUSP overview of the sanitation situation in urban India has pointed out the low priority accorded to sanitation and the lack of awareness about its linkages with public health. The fact that significant proportion of urban households is currently not connected to sewerage network highlights the importance of on-site sanitation arrangements at household level. Likewise, the uncontrolled nature of construction and septage disposal practices enjoins the need for making them aware of safe management practices, citizen's civic responsibilities and the duties of civic bodies (and facilities offered by them). In the wake of decentralized system management needs, it is necessary to adopt differentiated communication system (in terms of messages and channels) to target different stakeholders like the municipal agencies, other frontline government agencies and most importantly, the people of the city. There is a need to focus not just on awareness building, but on inculcating behavior change amongst the various constituents of civic society.

The socio-cultural biases against sanitation and sanitary work need to be targeted, and dignity and humane approach promoted with an emphasis for priority to sanitation in public affairs. The visible lukewarm attention to occupational hazards faced by sanitary workers in the cities needs immediate attention, because of the public and personal health implications and the right to dignity enshrined in our constitution. Hence, it would be desirable to develop

a septage management strategy, which addresses the following:

i. Builds constituency and support for septage management initiatives among diverse stakeholders
ii. Promotes people's participation for improving and sustaining service delivery
iii. Enhances the capacity of implementing agencies in reaching out to the households
iv. Facilitates the development of a holistic understanding of "septage management" and "good sanitation practices" amongst service providers and citizens
v. Provides clarity to the different stakeholders about their respective roles and responsibilities vis-à-vis septage management services
vi. Involves and engages opinion influencers (viz. political and religious leaders, media, eminent civil society representatives, resident welfare associations, and others) to promote septage management consciousness

Primary and secondary audiences

For the purpose of this strategy, primary target audiences is defined as those groups that have a direct role and major influence on the development and implementation of the city septage management services and those who would be most impacted by the implementation of the strategy. Secondary target audiences are individuals/institutions/organizations who have a role in influencing the course of the septage management services development and their delivery.

For the purpose of septage management, the primary target audiences are:

- Citizens – households, offices, institutions and others using septic tanks to dispose of human feces
- Service providers – municipal officials, sanitary inspectors and workers, masons
- Elected representatives at the city level

The secondary target audiences, on the other hand, include:

- The media (print and electronic)
- Civil society organizations (NGOs, resident associations, community-based organizations, professional associations, business and industry groups)
- Academic institutions such as schools, colleges and universities
- Opinion influencers (doctors, political leaders at the city level, religious and cultural leaders, eminent personalities)

Consultation workshops

The principle objective of the communication approach is to engage diverse stakeholders such as the elected and non-elected political leaders, municipal officials and workers, media, civil society and eminent persons towards improving the septage management in the city, and build constituency and develop support for such initiatives in the city. At the same time, it would also enable the households and the city officials to take informed decisions, based on enhanced knowledge and extensive consultation with diverse stakeholders. It may be appropriate for the State Govt. to hold 2–3 workshops involving diverse stakeholders wherein the knowledge about improved septage management is shared as also views are sought on how the municipalities and households could go ahead to implement such a management plan. The workshops would also be used to identify the role and responsibilities of other stakeholders such as elected representatives, NGOs, resident associations and media towards supporting this effort in a meaningful manner.

Suggested communication approaches and tools

In preparing and implementing city sanitation plans (CSP), the cities will need to bear in mind the need and advantages (in a data-sparse environment and variation of sanitation arrangements) of a participatory approach, to ensure speedy and informed planning and implementation. Further, the public-good nature of urban sanitation necessitating collective action needs to be highlighted in the minds of all stakeholders. The public health implications of insanitary disposal and faulty sanitation arrangements make it all the more crucial that a participative and transparent approach with multiple streams of communication to identified stakeholders, form one of the pillars of the CSP strategy.

Awareness needs to be created amongst authorities, households, communities and institutions which are part of the city fabric, about sanitation and its linkages with public and environmental health. CSP implementation strategies and the communication component of this should also seek to promote mechanisms to bring about and sustain behavioral changes aimed at adoption of healthy sanitation practices.

Communication would need to make use of popular and cost-effective channels (hand bills, notices, announcements in radio/TV, part of water bill, etc.) and messaging would need to be oriented to different stakeholders – households, institutions, government agencies, etc.

Examples of septage communication initiatives

Malaysia

Indah Water Konsortium Sdn. Bhd., a company owned by the Government of Malaysia, is responsible for provision of septage management and sewerage services throughout the country. It *"has been entrusted with the task of developing and maintaining a modern and efficient sewerage system for all Malaysians"*[2]. They have developed a series of promotional material that seek to inform and motivate the households to ensure the proper construction and timely maintenance and desludging of septic tanks (See Appendix C for a few examples or their website: www.iwk.com.my). Backed by effective services, their communication approach, based on concepts of appeal and approach, was based on five components:

1. Educating users (present & future)
2. Environmental & health awareness campaigns
3. Customer friendly
4. Community support
5. Corporate social responsibility

Philippines

The city of Marikina[3], Philippines has also used innovative mechanisms to inform and educate the residents on proper construction, handling and maintenance of septic tanks. As an initial step, they carried out household survey and focused discussion groups to understand the level of information and understanding among the households on issues related to septic tanks. This research also helped identify knowledge and information gaps, reasons for inappropriate behavior by the households towards septage management, and possible mechanism to reach out to the public.

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[2] www.iwk.com.my
[3] www.marikina.gov.ph

10. Planning and implementation of septage management schemes

For effective septage management plan, robust data on septage arrangements, their quantity and locations of its generation etc. are required. The ULBs would need to make arrangements to collect baseline data – type of latrine disposal, effluent disposal arrangement, size, age, when it was last cleaned, access to the on-site system, arrangement for disposal of effluent, if any) of existing installations, to plan for workable desludging schedules. It is advisable to divide the city into different sanitary zones (if not already done) and carry out the baseline survey in one or a few of these zones, pilot desludging schedules by area to learn operational issues and devise solutions, before up-scaling to the entire ULB. The selection of zone could be based on availability of septage disposal sites – existing STPs could be potential septage disposal/application sites or trenches provided in solid waste landfill sites or suitable urban forestry sites where the septage trenches would serve to fertilize the plants. In order to be economical and financially competitive, it is suggested that households in demarcated septage management zone should be within 20 to 30 km travel distance from identified treatment and disposal sites.

Further a two step process will be followed for selection of treatment system:

i) To determine the appropriate treatment option on the basis of size of town, land availability, proximity/availability of sewage treatment plants and proximity to residential areas; and
ii) To conduct a techno-economical feasibility to choose the most appropriate technology on the basis of capital, operations and maintenance costs.

The steps in planning and implementation and guidelines for selection of septage management disposal system are summarized in Table 9.

a) Collect data on the households and other properties with on-site arrangements in the city
b) List out the municipal, private and other septic tank/pit cleaning services active in the city
c) Identify catchment-wise land for septage treatment facility: use existing STP where available; or acquire land if not available for construction of septage treatment facility
d) Formulate draft regulations for septage management
e) Choose technology for septage treatment: prepare design of Septage Treatment and Disposal Facility (STDF) along with operations and maintenance costs
f) Conduct techno-economic feasibility of the STDF
g) Implement construction of septage management and disposal facility
h) Purchase vehicles and vacuum trucks etc.
i) Launch awareness campaign
j) Initiate training and capacity building
k) Provide cleaning services incrementally in areas completing surveys of tanks and pits

Table 9: Guidelines for the selection of septage disposal system

Town/ Category	Conditions	Recommended Technologies	Capital Cost	O&M Cost	Management
Unsewered Class-III, IV and V towns and rural communities	Remote land area available with suitable site and soil condition	Sludge drying beds and waste stabilization pond	Low	Low. User fees to recover O&M costs	Municipality or private (if implemented by private sector through a management contract)
	Land available but close to settlements	Lime stabilization, Sludge drying beds and waste stabilization pond	Low to medium	Low to medium. User fees to recover O&M costs	Municipality or private (if implemented by private sector through a management contract)
	Inadequate land area with unsuitable site and soil condition, but available STP capacity within 20-30 km distance	Disposal at STP	Low to medium	Low to medium. User fees to recover O&M costs	Municipality
Partially sewered medium size (Class-II towns)	Land area available with suitable site and soil condition but close to settlements	Lime stabilization, sludge drying beds and waste stabilization pond	Low to medium	Low to medium. User fees to recover O&M costs	Municipality or private (if implemented by private sector through a management contract)
	Inadequate land area, but available STP capacity	Disposal at STP	Medium	Medium. User fees to recover O&M costs	Municipality or private (if implemented by private sector through a management contract)
	Inadequate land area; no available STP capacity	Disposal at independent mechanical treatment facility	High	High. User fees to recover O&M costs	Municipality or private (if implemented by private sector through a management contract)
Class-I and metro cities	Available STP capacity	Disposal at STP	Medium	Medium. User fees to recover O&M costs	Municipality or private (if implemented by private sector through a management contract)
	No available STP capacity	Disposal at independent mechanical treatment facility	High	High. User fees to recover O&M costs	Municipality or private (if implemented by private sector through a management contract)

Appendix A

Design of independent sludge drying bed type septage treatment facility

Under the full-fledged on-site sanitation approach, no separate sewage treatment facility will be necessary as all sewage will be disposed on-site. Only the septage (septic tank sludge) will have to be safely removed for further treatment and disposal. The design of a septage treatment facility is described below with an illustration from the city sanitation plan for Hoshangabad, a town in Madhya Pradesh (WSP, 2010).

The septage cleaning frequency is assumed to be once in two years and volume decanted per cleaning is considered to be about 2 m^3. Further, it is assumed that each vehicle (smaller capacity 2,000 litres) will clear three tanks per day and the vehicle will operate for 300 days per year (Table A.1) and assuming that septage treatment facility is very close to the city.

In order to provide uninterrupted service to nearly 20,000 households that will be using septic tanks, about 11 trucks will be required, which would have to be operated for about 300 days every year to service all the households. These computations are provided in Table A.2.

The septage is proposed to be converted to sun-dried sludge cakes by dewatering on sand filter beds. Land requirement of about 10,500 m^2 (1.05 Hectare) has been estimated. Over most of the year, the septage drying time is expected to be about seven days; however, an average of 10 days is considered to accommodate longer drying periods during the rainy season. A total of 20 drying beds are proposed, considering the longer drying time in the wet season. The sludge drying beds could possibly be located near the solid waste processing site.

Treatment of filtrate

For 66 m^3/day septage, it is assumed that 80 % of water is percolated through sludge drying within 1-2 days of application. Hence, filtrate generated = 0.8 x 66 = 52.8 m^3/day or 53 m^3/day. For more than 95% solid capture, the TSS in filtrate would be 1,000 mg/L (assuming raw septage TSS 2% or 20,000 mg/L). The corresponding BOD can be assumed as 1,000 mg/L. The system can be designed based on the CPHEEO manual on sewerage & sewage treatment.

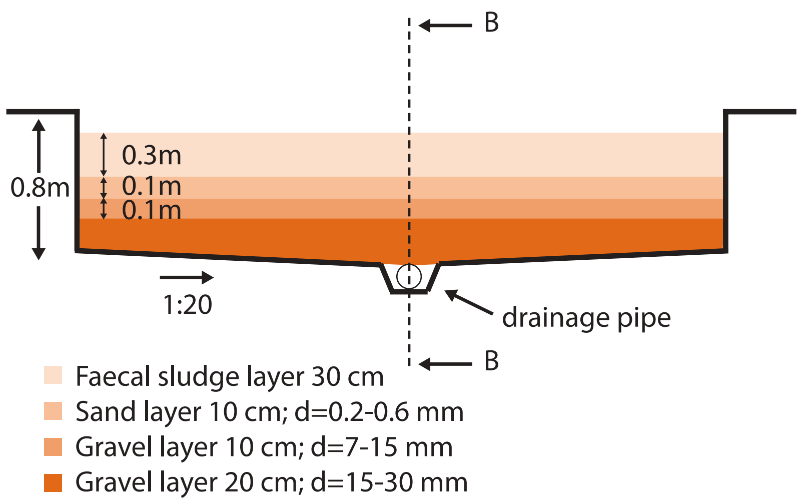
Table A.1: Basic assumptions for calculation for sludge drying bed

No.	Component	Norm
A	**Household sanitation infrastructure**	
1	Latrine connected to septic tank	1 per household
2	Grit and grease trap	1 per household
B	**Septage cleaning, treatment and disposal**	
1	No. of septic tanks cleared per vehicle per day	3 tanks per day per vehicle
2	Frequency of septage cleaning from septic tank	Once in 2 years (Norms 2-3 years)
3	Septage volume removed per tank	2 m^3
4	No. of operational days per annum	300 days

Table A.2: Computations: septic tanks cleared, septage volume and sludge drying beds

No.	Component
Septage clearance vehicles	• A total of 11 septage clearance vehicles will be needed. The ULB currently has one septage clearance vehicle • To efficiently manage septage clearance, 10 additional vehicles will have to be purchased • Out of this, 9 vehicles will be purchased in year-1, whereas 10th vehicle can be purchased in year-4
Tanks cleared per year	• No. of septic tanks cleared per year = 11 trucks x 3 tanks x 300 days • No. of septic tanks cleared per year = 9900
Daily septage volume	• Daily septage volume = 11 trucks x 3 tanks x 2 cum/day • Daily septage volume = 66 m^3
Septage drying (SD) bed	• Single drying bed area = 12 x 12 m = 144 m^2 • Max. septage depth = 0.30 m = 30 cm = 300 mm • Capacity per bed = 144 x 0.3 = 43 • Daily requirement of beds (Nos) = 66 m^3/43 m^3 = 2 • Considering a drying cycle of 10 days, a total of 20 drying beds are suggested
Indicative site area	• Total site area = SD bed area + 10 % SD bed area + area for office and dried storage + area for ancillary units. • Total site area = (2,880 + 288 + 5,000 + 2,250) m^2 • Total site area = 10,418 m^2

Figure A1: Typical sludge drying beds



Note: The layer thickness should be referred to as per BIS 849 (Requirement for water filtration equipment)

Appendix B

Design of independent mechanical septage treatment facility

This is the method of collecting and delivering sludge to a septage treatment facility where the septage is treated through mechanical dewatering and the filtrate through a biological treatment system. Figure B.1 shows the standard flowchart of such processes, which include pre-treatment, dewatering the septage, and treating the filtrate through biological process for the treatment of the organics. Example of designing a septage treatment facility is given in Table B1.

i. Characteristics of collected septage

Septage extracted from on-site treatment systems such as septic tanks is dependent on the design and frequency of emptying of septage from the septic tank. The following calculation shows how to find the sludge generation rate from a septic tank where excreta and domestic wastewater are treated together.

Flow rate of water: 135 L/person/day

Septage generation rate: 135 L/person/day × 200 mg/L × 10^{-3} = 27 g/person/day

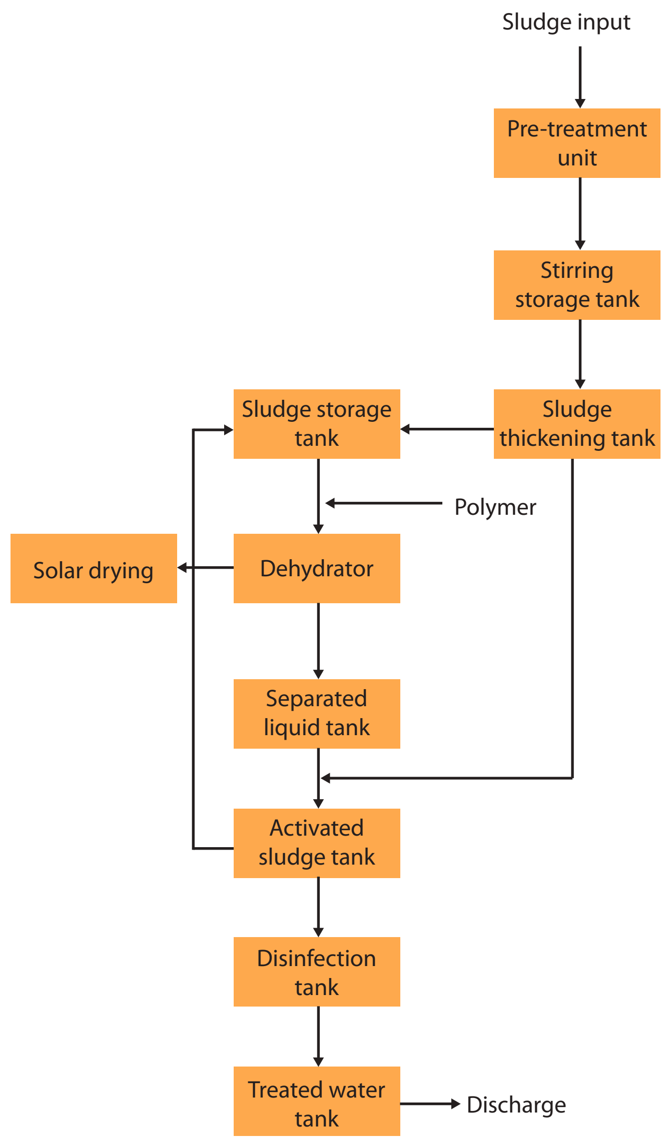
ii. Configuration of septage treatment facility

The septage treatment facility consists of pre-treatment, solid-liquid separation, activated sludge treatment, and disinfection units. The dewatered and dried septage is used as a soil conditioner/fertilizer.

Pre-treatment unit

This unit removes debris and sand and feeds the septage to the stirring storage tank, in which the septage is aerated and stirred for five or more days to make it uniform and to improve solid-liquid separation.

Figure B.1. Flowchart of treatment in a septage treatment facility



Solid-liquid separation unit

- Septage thickening tank
  This tank settles the septage by means of gravity. The tank capacity shall be determined so that the retention time is about one day. If the inflow septage concentration is 1%, the tank is expected to double it – the concentration of outflow septage is 2%.

- Flocculation mixing tank
  This tank forms flocs by adding a high-molecular or inorganic coagulant to the septage to facilitate solid-liquid separation.

- Chemical injector
  This injector, which consists of a chemical storage tank, dissolution tank, and injection pump, adds a given amount of coagulant to the flocculation mixing tank.

- Solid-liquid separator
  After the flocculation mixing tank, this unit (dehydrator) separates the septage into solid and liquid. The dehydrator is classified into centrifugal, belt press, and screw types.

- Activated sludge treatment unit
  This unit, which consists of an activated sludge tank, sedimentation tank, sludge returning unit, and air supplying unit, removes BOD-related contaminants from the separated liquid.

a. Typical design - Type design for septage collection of capacity 300m^3/day

The following is a typical design of a septage treatment facility for a population of 200,000 persons.

- Basic data:
  Number of users: 200,000
  Regular septage extraction ratio: 50%
  Septage generation rate: 30 g/person/day
  SS concentration of septage: 1%
  Septage collection rate [Q]
  Q [m^3/day] = 200,000 [persons] × 30 [g/person/day]/10,000 × 0.5= 300 [m^3/day]

- Stirring storage tank
  Septage retention time [T]: 5 days
  The necessary capacity [V] is given by the following formula:
  V [m^3] = Q × T
  = 300 × 5 = 1500 m^3

- Septage thickening tank
  Septage thickening time: [T]: 24 hours
  The necessary capacity [V] is given by the following formula:
  V [m^3] = Q × T
  = 300 × 24/24 = 300 m^3

- Dense septage rate
  The dense septage rate [Q1] is given by the following formula:
  Q1= Q × SS content of inflow septage [%] / SS content of dense septage [%]
  = 300 × 1/2 = 150 m3/day

- Septage storage tank
  Septage retention time [T]: 1 day
  The necessary capacity [V] is given by the following formula:
  V [m^3] = Q1 × T
  = 150 × 1 = 150 m^3

- Septage hydrator
  Septage hydration time [T]: 5 days a week and 18 hours a day

  The necessary capacity [C] is given by the following formula:
  C [m^3/h] = Q1/T × 7/5
  = Q1/18 × 7/5 = 15 m^3/h
  15 m^3/h × 1 units
  - Hydrated septage rate [Q2]
  Assuming that the water content of hydrated septage is not more than 80%,
  Q2 = Q1 × 2/(100 - 80)

Table B1: Example of designing a septage treatment facility

Capacity	300 m³/day		
Tank Volume	**Tank name**	**Effective volume m^3**	**Setting value**
	Mixing storage tank	1,500	Retention time: 5 days
	Thickener	300	Retention time: 1 day
	Septage storage tank	150	Retention time: 1 day
	Separate liquid tank	135	Retention time: 1 day
	Activated sludge tank	428	BOD volumetric loading: 0.4 kg/m^3/ day
	Sedimentation tank	36	Retention time: 3 hr
	Disinfection tank	3.0	Retention time: 15 min
Equipment Capacity	Centrifuge	15 m^3/h x 1 unit	Operating hours 5 days/1week, 18 h/1 day

= 15 m^3/day
- Inflow rate of liquid to be treated biologically [Q3]
Q3 = Dense supernatant + Liquid separated by dehydration
= 150 + (150 - 15) = 285 m^3/day

- Activated sludge tank
  Inflow wastewater: BOD of 600 [mg/L] or less
  BOD volume load: 0.4 [kg/m^3/day] or less
  The necessary capacity [V] is given by the following formula:
  V [m^3] = Q3×600/0.4
  = 285 × 600/0.4 = 428 m^3

- Sedimentation tank
  Assuming that the retention time [T] is 3 hours,
  V [m^3] = Q3 × (3/24)
  = 285 × 3/24 = 36 m^3

- Disinfection tank
  Assuming that the retention time [T] is 15 minutes,
  V [m^3] = Q3 × (1/24) × (15/60) = 3.0 [m^3]

b. Septage collection truck

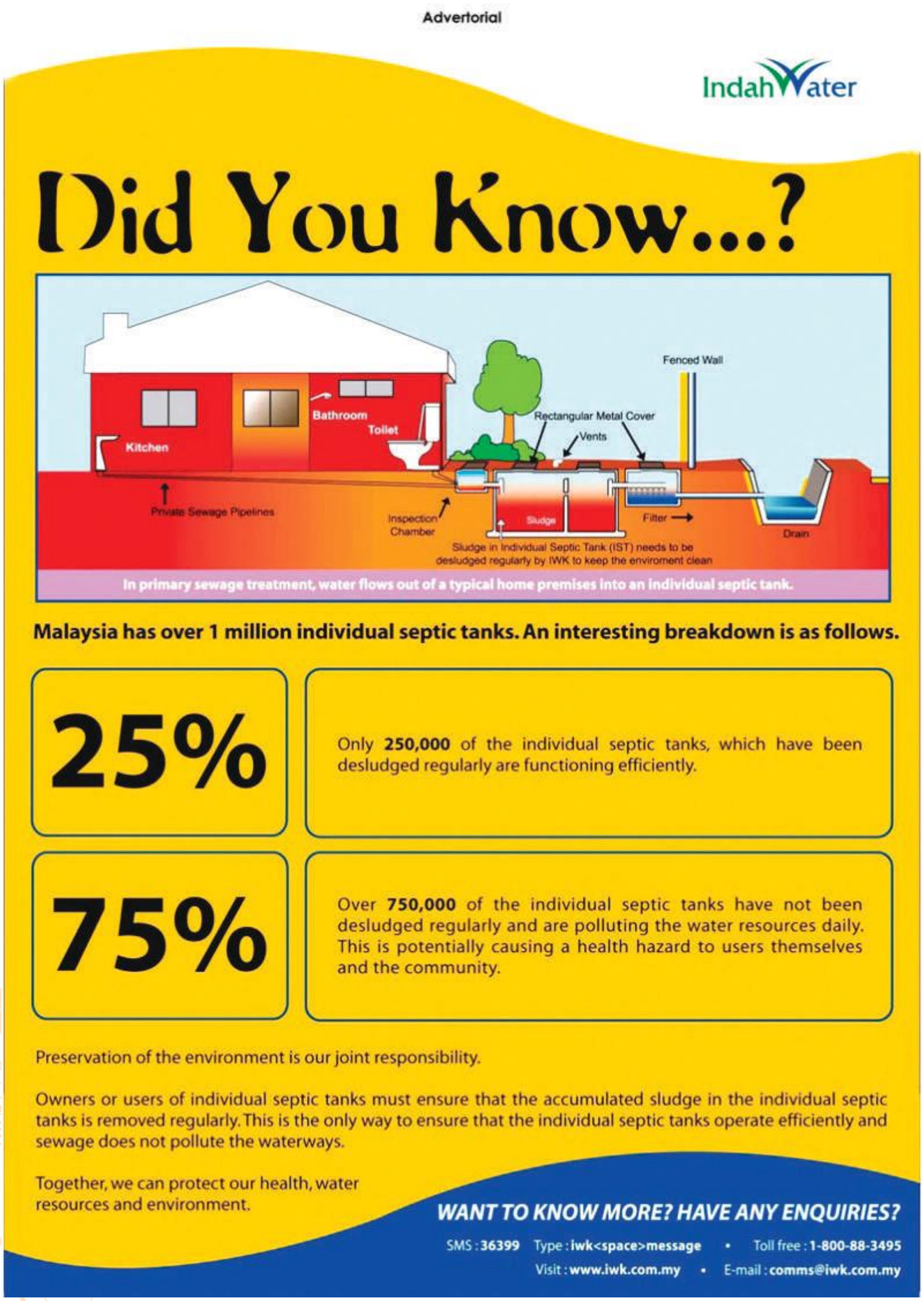
Septage collection trucks are available in a range of different capacities. It is necessary to select an appropriate truck according to the roads, traffic conditions, and transportation efficiency. In many cases, a large tank truck is used for a medium- to large-scale treatment facility, because a large amount of septage is extracted at once. The facility shall have a truck waiting space to avoid congestion when the septage delivery may be intensive in a certain time slot. Model format for calculating number of trucks required for servicing 100,000 population is provided in Table B2.

Table B2 : Model format for calculating number of trucks required for servicing100,000 population

S. No.	Parameters	Calculation	Remarks
1	Nos. of people per household	5	(A)
2	Nos. of houses	20,000	(B=100,000/A)
3	Frequency of desludging, once every	2 years	(C)
4	Nos. of houses to be desludged per annum	10,000	(D=B/C)
5	Coverage with septic tank	100%	(E)
6	Average sludge volume per house, cu.m.	2.00	(F)
7	Volume to be desludged per annum, cu.m.	20,000	(G=D*E*F)
8	Nos. of working day per annum	300	(H)
9	Volume to be desludged, cu.m./day	66.67	(I=G/H)
10	Size of each desludging truck, cu.m.	2	(J)
11	Nos. of houses per trip	1	(K=J/F)
12	Nos. of trip per day (depends on the distance)	3	(L)
13	Volume desludged per truck per day, cu.m.	6	(M=J*L)
14	Nos. of truck required	11.11 say 11	(N=I/M)
15	Standby (Range 10%-25%)	1.25	(O)
16	Total no. of trucks required	13.75 say 14	(P=NxO)

Appendix C

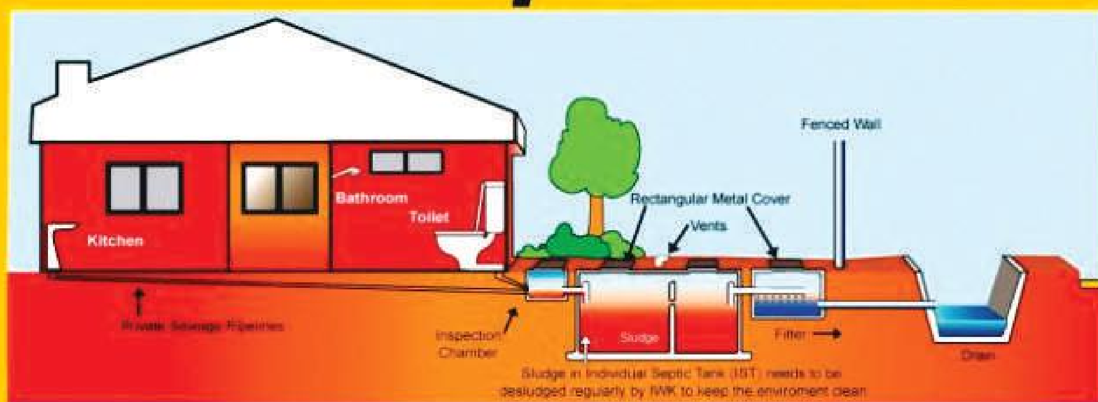
Examples of communication material used by Indah Water Konsortium, Malaysia



Advertorial

IndahWater

Look After Your Septic Tank



In primary sewage treatment, water flows out of a typical home premises into an individual septic tank.

An Individual Septic Tank (or IST) which separates and stores the solid waste safely. The water then flows out into the drains.

Today, more than ever, safeguarding our environment from pollution is paramount. This means looking after your septic tank. Do you know its purpose? A septic tank separates liquids from solids and provides some breakdown of organic matter in wastewater.

Solids and wastewater from premises' toilets, bathrooms and kitchens that flow into septic tank are usually separated. Some solids, such as soap scum or fat, will float to the top of the tank to form a scum layer. Heavier solids, such as human waste (sewage) and kitchen waste, settle to the bottom as 'sludge'.

Self-forming bacteria in the tank 'digest' these solids. The remaining liquid flows out of the tank into drains and rivers. 'Baffles' built into the tank hold back the floating scum from moving past the outlet of the tank. It is most critical that sludge in septic tanks are pumped out (desludged) regularly to prevent sludge or sewage overflow and pollute the waterways.

Accumulated solids not removed periodically can also clog the outlet pipes and affect the treatment process.

If you have one, please do your part in having your septic tank desludged at least once every two years.

Sewerage Fact #1
There are over one million premises in Peninsular Malaysia with septic tanks but only 10% are regularly desludged. Over 700,000 may be polluting the environment and our water resources.

Sewerage Fact #2
The requirements and design of septic tanks are provided under the Malaysian Standard 1228: 1991 Code of Practice for Design and

Toll free : 1-800-88-3495 SMS : 36399 Type : iwk<space>message E-mail : comms@iwk.com.my Visit : www.iwk.com.my

Advertorial

IndahWater

WHEN NEGLECT LEADS TO POLLUTION

After over a decade as the national sewerage service provider, we at Indah Water have come to the conclusion that 'septic tanks' are a subject matter that nobody wants to talk about, hear about, and worst of all, know about.

Hopefully, we can explain it to you better in writing.

As a matter of fact, septic tanks or 'sewage tanks', as they are alternatively called, are extremely important to premises which are not connected to a main sewerage system. Without such tanks, sewage and wastewater will be discharged directly into drains and pollute our waterways.

What Is A Septic Tank?

A typical septic tank consists of two storage chambers in a connected series. Raw sewage flows into the first chamber and settles at the bottom of the tank. Other materials such as fats and oil float on the surface forming a 'scum' layer. Further settlement takes place in the second chamber before partially treated wastewater flows out into the drains.

Why Is Desludging So Important?

The septic tanks are normally water tight, and usually contain liquid as well as waste material. Wastewater from toilets, bathrooms and kitchens enter the tank and flow out of it, leaving solids to settle.

Over time the tanks will be filled with accumulated solids or 'sludge'. This requires regular desludging or removal. Failing which, sewage will be discharged directly into the drains and pollute our waterways, which may cause water-borne diseases such as typhoid, cholera and Hepatitis A.

600,000 Errant Premises In Malaysia

To-date, our records reveal that there are over one million premises in the country using septic tanks. However, about 400,000 of these premises have been keeping their septic tanks operating efficiently by requesting Indah Water to remove the accumulated sludge from the septic tanks.

Our concern has always been the remaining 600,000 premises with septic tanks in the country, which have been neglecting their responsibility to maintain such tanks and end up polluting drains, rivers and lakes.

SEWERAGE FACTS

Septic tanks are settlement tanks with limited storage space, usually about 2.5 cubic metres. The maximum amount of sludge that one can store is approximately 1/3 of its total volume. If desludging or removal of sludge is not carried out regularly, the sludge level may exceed its maximum limit.

When this happens, there will be insufficient retention time and space for incoming sewage. Hence, untreated sludge will be released into the drains and pollute our waterways.

Scheduled Desludging Services

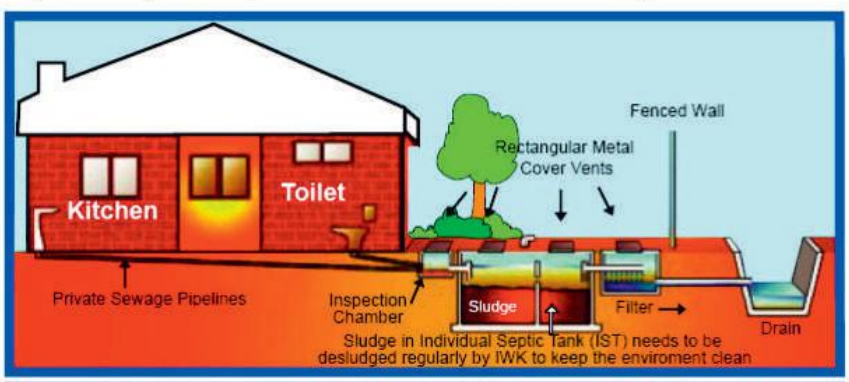
Users should understand that scheduled desludging services provided by Indah Water are solely to keep our waterways free from pollution.

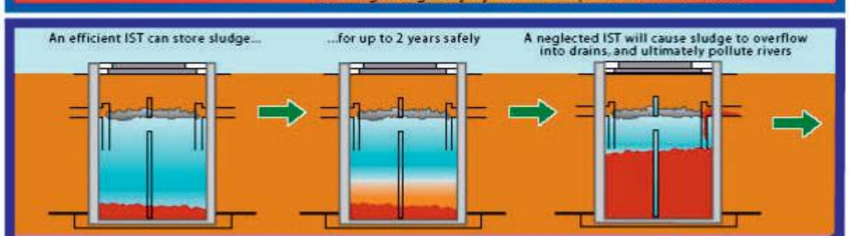
For this scheduled service and sludge management, the service fee for a house is **RM6 a month** or only **20 sen a day**. This nominal charge is re-invested in the purchase and maintenance of desludging tankers, manpower, equipment and sludge facilities to ensure that sludge is properly treated before disposed of as cover material in sanitary landfills.

As a customer you can request for additional desludging services, if required, without additional charge other than the six-monthly bills to your house or monthly bills to your commercial, industrial or government premises.

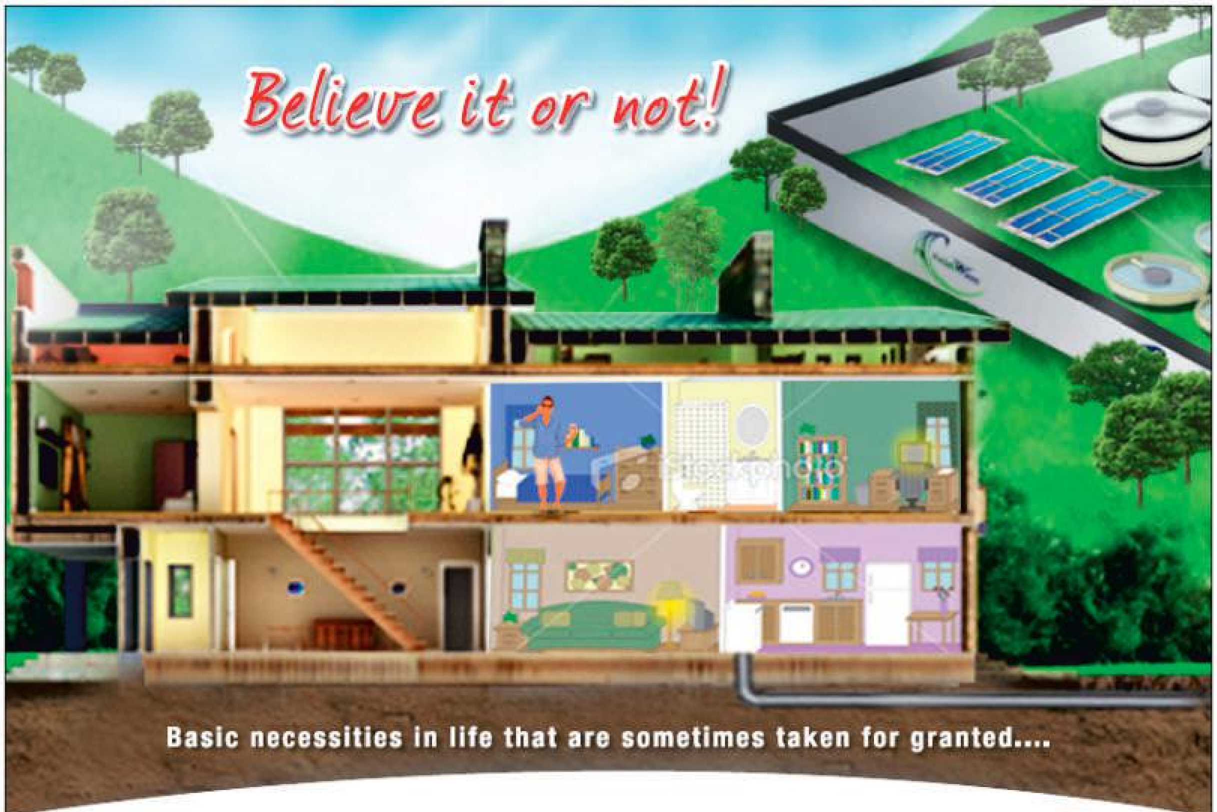
In fact, you are reminded not to make any payment to our scheduled desludging crew or representatives when the service is being provided at your premises. You only need to sign a docket to confirm the service.

Help us to help you keep our waterways and water resources free from pollution.





In primary treatment, water flows out of a premises into an Individual Septic Tank (top). The IST separates and stores solid waste, allowing effluent to simply flow out into drains (bottom).



If there is no...	Pipe Water	Electricity	Mobile Phone	Cable Television	Sewerage System
Alternatives	Well water or Bottled water	Candle, Lamp or Generator	Public Telephone	Radio, Cinema or Newspaper	Public Toilet
Effects to Life	Essential to Life	Light-up Your Life	Lifestyle	Entertain Life	Protects Life
*Monthly Charge (RM)	40.00	80.00	150.00	50.00	8.00
*Daily Charge (RM)	1.33	2.67	5.00	1.67	0.27

* Charges quoted are average

Believe it or not, Indah Water sewerage service charge to your house is only RM8.00 per month or 27 sen a day. For this payment, we ensure that sewage and wastewater from your house are treated in the public sewage treatment plants to safeguard public health, protect the water resources and long-term preservation of the enviroment.

Help us to help you preserve our environment

IndahWater

We strive to serve you better. You can reach us through:
Tel: 1-800-88-3495 | Fax: 03-2095 6002
Email: care@iwk.com.my Website: www.iwk.com.my

SMS 36399 (Type IWK<space>Message)

Photo credit: S. Vishwanath, Director, Biome Environmental; Indah Water Konsortium, Malaysia

सत्यमेव जयते

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