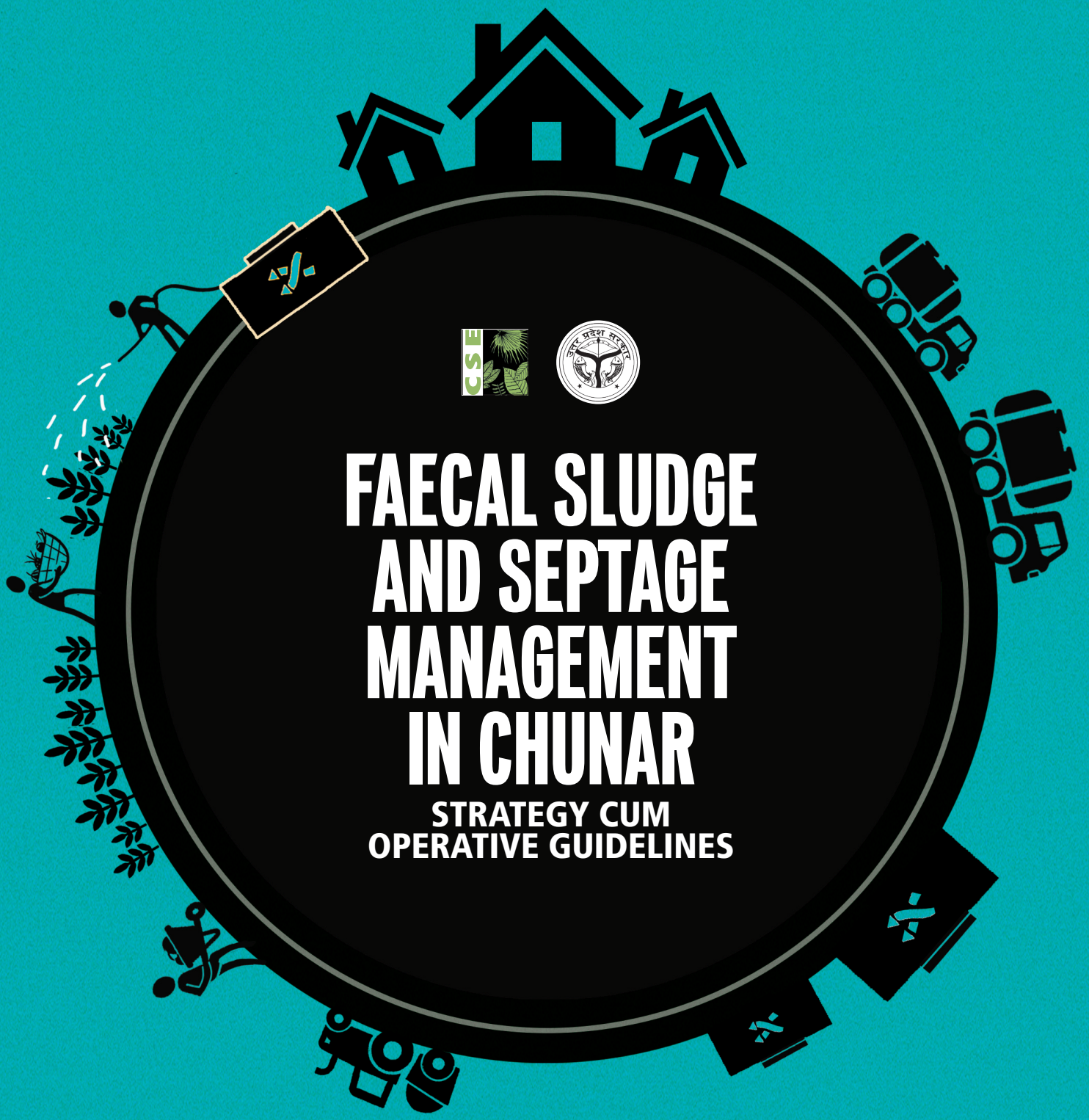

FAECAL SLUDGE AND SEPTAGE MANAGEMENT IN CHUNAR

STRATEGY CUM OPERATIVE GUIDELINES

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This report would not have been possible without the constant support of Chunar Nagar Palika Parishad, Uttar Pradesh.

We are grateful to Bill and Melinda Gates Foundation for their support to CSE— Department of Urban Development, Uttar Pradesh for mainstreaming Faecal Sludge and Septage Management in Uttar Pradesh

Citation: Suresh Kumar Rohilla, Bhitush Luthra and Bhavik Gupta 2020, *Faecal Sludge and Septage Management: Strategy-cum-Operative Guidelines*, Centre for Science and Environment, New Delhi

Published by
Centre for Science and Environment
41, Tughlakabad Institutional Area, New Delhi 110 062
Phones: 91-11-40616000
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E-mail: cse@cseindia.org
Website: www.cseindia.org

Printed at Multi Colour Services, New Delhi

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Glossary

Black water: A mixture of urine, faeces and flush water along with anus-cleansing water (if water is used for cleansing), and dry cleansing materials used to clean anus after defecation. Black water contains pathogens (of faeces) and nutrients (of urine) that are diluted in the flush water.

CNPP registered vacuum tanker: A vacuum tanker, duly registered by the transport authority of Uttar Pradesh to perform designated tasks. It should have been inspected and registered by Chunar Nagar Palika Parishad (CNPP) for desludging, transportation, and disposal of faecal sludge and septage (FSS).

Decentralized wastewater treatment system (DWWTs): An approach that includes collection, treatment and disposal or reuse of wastewater from individual homes, residential societies, isolated communities, industries and institutions at or near the point of generation. DWWTs cater to both liquid and solid components of wastewater.

Desludging: The operation, performed by a licenced operator or trained sanitary workers (of CNPP, in the present case), of removing FSS from onsite sanitation system (OSS).

Disposal: Transportation and discharge or transfer of FSS to notified locations.

Ecological sanitation (Ecosan): A form of dry sanitation that involves separation of faeces and urine in order to facilitate recycling of nutrients in local agricultural systems.

Effluent: The supernatant (liquid) discharged from an OSS. The liquid separated out from the septage is also referred to as effluent.

Faecal sludge: The settled contents of onsite sanitation systems. The characteristics of faecal sludge can differ widely from household to household, city to city, and country to country. The physical, chemical and biological qualities of faecal sludge are influenced by the duration of storage, temperature, soil conditions, intrusion of groundwater or surfacewater into onsite sanitation systems, desludging technology and pattern.

Faecal sludge and septage management (FSSM): The use of various technologies and mechanisms that can be used to treat and dispose of sludge with highly variable water content produced by septic tanks, latrines, and wastewater treatment plants.

Faecal sludge and septage treatment plant (FSSTP): An independent FSS treatment facility for remediating the solid and liquid components to prescribed standards for safe disposal and reuse. This may also refer to a sewage treatment plant (STP), wherein FSS is being co-treated with sewage.

Greywater: The total volume of water generated from washing food, clothes and dishware, as well as from bathing, but not from toilets. It may contain traces of excreta and, therefore, also pathogens.

Insanitary latrines: A latrine which requires human excreta to be cleaned or otherwise handled manually, either in situ, or in an open drain or pit into which the excreta is discharged or flushed out, before the excreta fully decomposes in such manner as may be prescribed. Provided that a water flush latrine, when cleaned by an emptier with the help of such devices and using such protective gear as notified in relevant guidelines is not to be deemed an insanitary latrine.

Leach pit or soak pit: An underground pit that is used where there is no sewer and household wastewater is drained into them to permit leaching of the liquid into the surrounding soil.

Licence: A written permission granted to any person that intends to carry out the services of FSSM having mentioned the purpose, period, name and address, and route etc. under the signature of the authorized signatory of the CNPP.

Licenced operator: Any person holding a licence to carry out desludging or emptying and transportation of FSS to a notified location.

Night soil: Human excreta, with or without anal cleansing material, deposited into a bucket or other receptacle for manual removal.

Notified location: The location of delivery and disposal of FSS, as defined and earmarked by CNPP.

Onsite sanitation system (OSS): A sanitation technology or system in which excreta is collected and stored, and emptied from or treated on the plot where it is are generated.

Off-site sanitation system: A sanitation system that involves collection and transportation of waste (or wastewater conveyed either by sewerage system or any other drainage system) to a location away from the immediate locality.

Operator: Person engaged in the business of desludging, transportation or treatment of FSS.

Person: Includes an individual or agency, or a trust, society, firm or company incorporated under relevant laws, an association of persons or a body of individual whether incorporated or not.

Pit latrine: A form of on-site sanitation with one or two pits for accumulation and decomposition of excreta from which liquid infiltrates into the surrounding soil.

Sanitary latrine: A latrine which is not an insanitary latrine.

Scheduled desludging: Regular emptying of OSSs at an interval of two–three years based on the recommendations of Central Public Health and Environmental Engineering Organisation (CPHEEO).

Scum: Extraneous or impure matter like oil, hair, grease and other light material that floats on the surface of a liquid in septic tanks.

Septage: The faecal sludge desludged from a well-designed septic tank.

Septic tank: A water-tight, onsite treatment system of domestic sewage, single-storied tank in which sanitary flow is retained long enough to permit sedimentation and digestion.

Sewage: Wastewater transported through sewers.

Sewers: Underground pipelines provided for the purposes of carrying liquid waste (wastewater) of a community.

Sewage treatment plant (STP): The place where sewage is treated to prescribed standards for safe disposal and reuse.

Taskforce: The city sanitation taskforce constituted in Chunar headed by the Executive Officer and Chairperson; the members of the committee may be co-opted by them from government departments, public undertakings, educators, and they can also be other eminent people of society.

Trained sanitary workers of CNPP: CNPP staff and contracted or hired workers engaged and trained by CNPP for the purpose of desludging or emptying and transportation of FSS using CNPP-owned vacuum tankers.

Transportation: Safe transfer of FSS through CNPP-registered vacuum tanker from the place of desludging to the notified location.

Treatment: Any scientific method or process designed to alter the physical, chemical or biological and radiological character or composition of FSS, sewage and wastewater to reduce or prevent pollution.

Vacuum tanker: It is a vehicle that has a pump and a tank, designed to pneumatically suck FSS from the OSS. These vehicles are also used to transport desludged FSS.

Wastewater: Liquid effluent from domestic or commercial human activity including effluent from toilets, kitchen and cleaning activity, which does not include effluent from manufacturing and industrial activity. Usually such effluent flows through stormwater drains, thus it includes stormwater as well.

Abstract

Chunar Nagar Palika Parishad (CNPP) is mandated with, inter alia, the function of 'public health, sanitation, conservancy and solid waste management' in accordance with the 12th schedule of the Constitution (74th Amendment Act, 1992). The Municipal Corporation Act, 1959 provides comprehensive powers to the Council and Executive Officer for effective collection, transportation, treatment and disposal of sewage (the definition of which includes septage) within municipal jurisdiction. In addition, national statutes, policies, standards and guidelines as well as state sanitation strategies and building bye-laws on sewage and septage management need compliance at the municipal level. At present, CNPP does not have a sewerage system and all households, whether they have individual toilets or use community ones, are dependent on onsite sanitation systems. Inadequate attention has been paid to the subject in the past, which has led to poor faecal sludge and septage management (FSSM) and contributed to pollution of water bodies and the environment, resulting in deterioration of public health in the city.

In view of this, these strategy-cum-operative guidelines on FSSM have been formulated to frame a set of procedures to address infirmities in FSSM. These guidelines cover the collection, transportation, treatment and disposal of faecal sludge and septage (FSS) and have been issued by the Executive Officer to ensure effective compliance with national- and state-level rules and regulations and achieve effective FSSM.

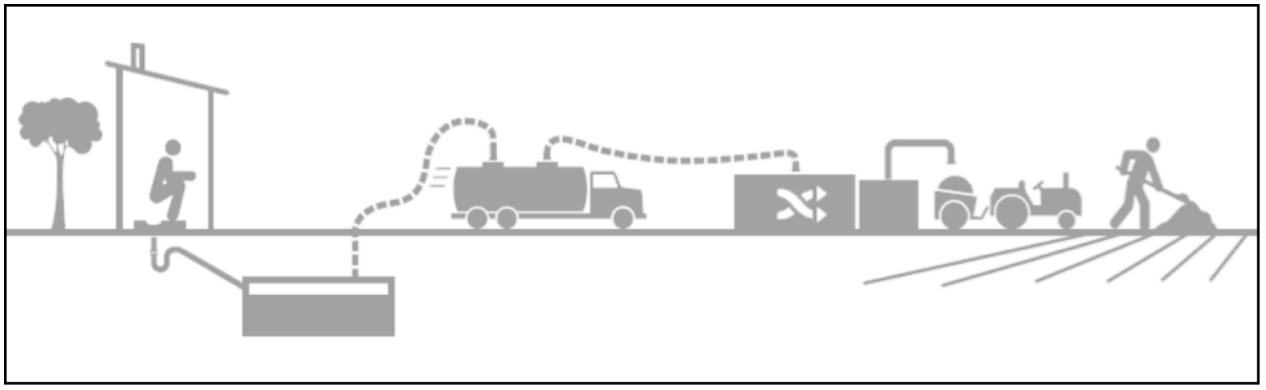
These operative guidelines are applicable to all stakeholders engaged in FSSM within the administrative boundary of CNPP. The urban local body (ULB) will undertake awareness and dissemination campaigns on the operative guidelines to ensure better compliance by all stakeholders.

1 Introduction

1.1 What is faecal sludge and septage management?

Often, sanitation focuses on providing physical infrastructure (toilets and latrines) in order to increase the 'coverage of toilets' or to achieve the gold standard of sanitation—open defecation-free cities. But in order to provide tangible and sustainable sanitation, there is a need to focus on the entire 'sanitation chain'. In simple terms, sanitation chain is an outline for understanding how excreta flows through each system [Blackett & Hawkins, 2014]. It sets out interlinked steps vital to manage faecal sludge and septage (FSS) from its generation to disposal or end use, thereby summarizing city-level outcomes. *Figure 1* depicts the components through which FSS is supposed to be managed.

Figure 1: Sanitation value chain



	Containment	Emptying and transportation	Treatment	Disposal or end use
Definition	A system which contains FSS. Treatment efficiency depends on the type of technology used	Removal and transportation of faecal waste from a containment system	Component of treatment of faecal matter and effluent	End use or disposal of treated sludge and effluent
Examples	Septic tanks, pit latrines and cesspools	Vacuum tankers, gulpers and carts	FSSTP, constructed wetlands and sun drying	Manure and treated water used in horticulture

Source: CSE, 2017

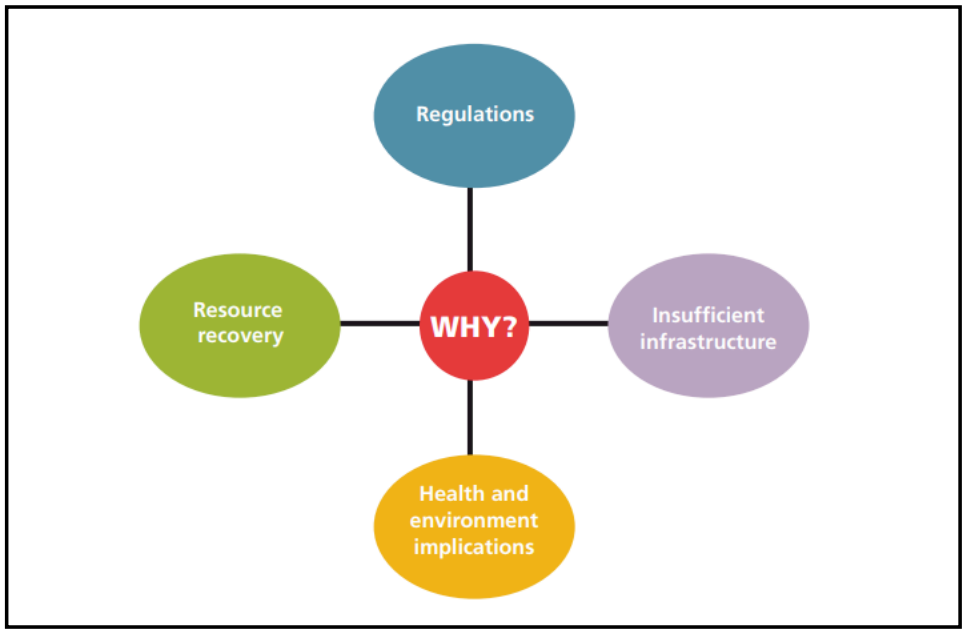
FSS is either contained (safely or unsafely) in onsite sanitation systems (OSSs), but wastewater generated from kitchens, washing areas and bathrooms, and effluent generated from outlets of OSSs, also needs management. Wastewater generated from most of the buildings in CNPP flows indiscriminately into stormwater drains, and is ultimately discharged into water bodies or gets deposited in agricultural lands within or outside cities. Thus, safe disposal and treatment of wastewater is an essential component of effective city-wide sanitation [CSE, 2017].

1.2 Why manage FSS?

There are many reasons to manage FSS. *Figure 2* broadly lists four main reasons.

Insufficient infrastructure: Sewerage systems, in addition to being cost-intensive, requires technical expertise for effective functioning and monitoring; consume large quantities of water; and entail high operation and maintenance (O&M) costs. Moreover, construction of sewer networks is a challenging task due to its technical and economic complexities, requiring close coordination between various public and private agencies. Owing to these challenges, constructing sewer networks is an arduous task and more often than not, rapid expansion of cities makes it a Sisyphean task.

Figure 2: Rationale for management of FSS



Source: CSE, 2017

Further, one of the objectives of Swachh Bharat Mission (SBM) is connecting the toilets constructed under it to sewerage lines available within 30 metres of the user interface. In the absence of sewerage lines, toilets are to be connected to septic tanks or other OSSs. This objective will lead to an open defecation-free (ODF) India, but achieving it will require emptying solutions for OSSs. This burgeoning need will either have to be catered through manual emptying or through mechanical emptying (e.g., vacuum tankers).

Another important point to realize here is that in the absence of designated disposal or safe treatment and management site(s), vacuum tanker(s) often discharge collected FSS into the environment indiscriminately. This lead to pollution of land and water bodies like rivers, waterways, etc., ultimately adversely affecting the health of residents.

Regulations: The legislative framework in India has adequate provisions at the national-, state- and city-level to protect water resources and the environment. Public health and sanitation are part of the 'constitutional responsibility' of municipalities under the 12th schedule of the Constitution (74th Amendment, 1992). Though there are no specific legal provisions relating to faecal sludge and septage management (FSSM), there are a few provisions that cover it. Some of these provisions are listed in *Annexure 6.1*.

Resource recovery: FSS has always been considered a social taboo, so the conventional thinking has been to dispose it of as quickly and secretly as possible. But there is another way of looking at FSS. It can be seen as a resource containing nutrients such as carbon, nitrogen, phosphorus and potassium, and in some cases, varying amounts of micro-nutrients such as boron, copper, iron, manganese, molybdenum and zinc. Septage can reduce reliance on chemical fertilizers and in combination with them, it can meet the requirements of nutrients for crop production. In some experiments, septage has also been used to generate energy through biogas systems and bio-methanization process.

Health and environment implications: FSS contains elements that may produce bad odour, create public health risks and serious environmental hazards. Since FSS is highly concentrated, discharging it into a water body may cause immediate depletion of dissolved oxygen and increase nutrient levels in the water, leading to eutrophication and increase in the number of pathogens, leading to a health hazard.

1.3 About Chunar

Chunar is a town on the Vidhyan Range in the Mirzapur district of Uttar Pradesh, about 273 km from the state capital, Lucknow. Agriculture is its major economic activity. The town is also known for its small- and micro-scale pottery industry, especially clay toys. Living conditions in the city are generally moderate with intermittent water supply and inadequate sanitary facilities.

About 37,185 people live in the town as per the 2011 Census, with a density of 4,480 persons per sq km, considerably higher than the state average of 828 persons per sq km. About 27 per cent of the people (9,914) live in slums.

The city exists in a triangular form with river Ganga in the west and River Jirgo in the east at an average altitude of 84 metres above the sea level. The Jirgo River merges with the Ganga at the northern boundary of Chunar. The town has alluvial sandy soil, contributed by the deposition of sand silt by the rivers. The climate is dry sub-humid to moist sub-humid. Temperature rises to a maximum of 41.8°C during the peak summer season and drops down to a minimum of 9.6°C during the winter season. Chunar city lies in a moderate-to-high rainfall region with the lowest rainfall received in April (3 mm) and highest in August (345 mm). Groundwater is available at 5–45 metres below ground level (mbgl) (pre-monsoon) and 3.1–15.5 mbgl (post-monsoon). The town experiences water-logging during monsoons; mainly attributable to its anthropogenic characteristics.

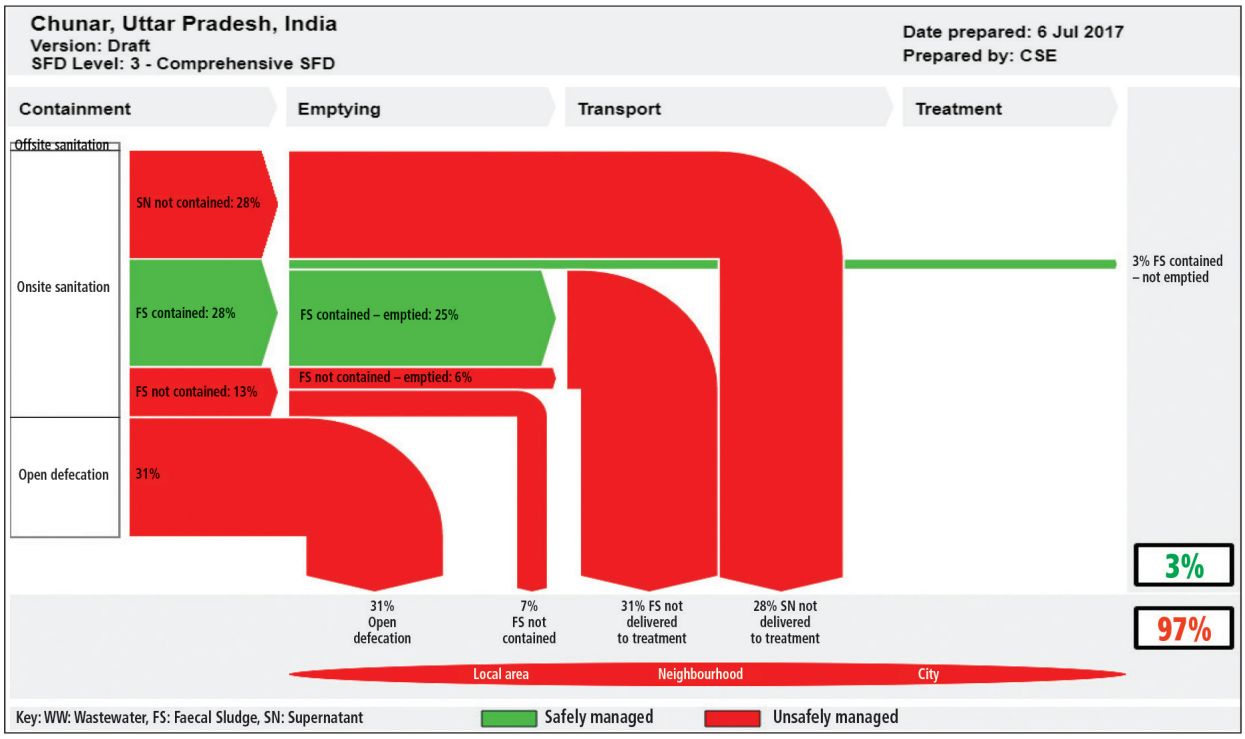
1.4 Current status of sanitation in Chunar

As per Swachh Survekshan for sanitation rankings of 4,237 cities and towns, Chunar ranked 827 out of 1,013 cities and towns surveyed in the North Zone and 506 among the 590 cites and towns surveyed in Uttar Pradesh [MoHUA, 2019].

In order to analyze existing FSSM practices of the city, Centre for Science and Environment (CSE) prepared a detailed report on the excreta flow diagram (also known as shit flow diagram or SFD) based on a detailed survey (of households, key informant interviews, focused group discussions with masons, desludgers, and physical inspection of sanitation facilities) done in Chunar city [Rohilla et al, 2018] and also prepared GIS-based maps.

Chunar has an area of 8.31 sq km, which is divided into 25 municipal wards. The core of the city is densely populated, whereas the households in the peripheral area of the city have a rural settlement pattern. The city has considerable number of lower income settlements which are primarily dependent on groundwater for their daily water requirements. The city doesn't have any sewerage network (as compared to 29 per cent urban population of Uttar Pradesh) and is completely dependent on OSS. About 69 per cent of the population has access to toilets (as compared to 96 per cent urban population of Uttar Pradesh) and the rest (31 per cent) defecate in the open (see *Figure 3*). As the city moves towards achieving ODF status, the percentage of population dependent on OSS would further increase.

Figure 3: Shit flow diagram of Chunar city



Source: Rohilla, et al., 2018

Based on the income levels of the households and the space available within the premises, two types of OSS are prevalent in the city. Septic tanks with an outlet connected to an open drain is the most common type of OSS within the city. Due to no standards being followed while constructing the containments, a few households have constructed large septic tanks, irrespective of household size, in order to reduce the frequency of desludging. Newly constructed houses have septic tanks with proper baffle walls. The lower income settlements like slums and squatter settlements are majorly dependent on pit latrines. Pits are constructed with lined walls and are open from the bottom.

Desludging of the OSS is not scheduled as prescribed by the Central Public Health and Environmental Engineering Organisation (CPHEEO) and is only carried out when a containment is full or when there is back flow. People usually get their containments desludged using the CNPP-owned 3,500 litres capacity

vacuum tanker. CNPP charges ₹3,000 per trip for desludging and usually two–three people participate in the activity. Minimal use of personal protective equipment (PPE) by the emptiers was observed during the emptying process. Additionally, manual emptying is practiced in areas with narrow lanes, where containments are inaccessible. People from marginalized castes, who reside in peri-urban areas, perform manual scavenging.

Currently, FSS generated or collected in the city in not treated. If the FSS collected is less viscous, it is disposed of in the stormwater drains nearest to the point of collection. On the other hand, if the FSS is too thick, it is dumped in farmlands, vacant plots, or rivers within or outside the city.

Understanding the gravity of the situation, the city sanitation task force (CSTF) of Chunar decided to install a dedicated treatment plant for safe management of FSS. The land was made available by CNPP at Dargahshareef Pargana Haveli area (see Annexure 6.2). The funding for the project was sanctioned under the National Mission for Clean Ganga (NMCG). This model project not only looks at infrastructure needs but also lays emphasis on creating an enabling environment for effective management of FSS across the value chain.

1.5 Need for the guidelines

Ministry of Housing and Urban Affairs (formerly, Ministry of Urban Development) aims to achieve 100 per cent containment of human waste under SBM. But the ministry recognizes that the end objectives and corresponding benefits of SBM cannot be achieved without proper FSSM and, hence, it notified a National Policy on Faecal Sludge and Septage Management in February 2017. See *Box* for the objective and specific milestones stated in FSSM policy for urban India.

Roles and responsibilities of ULBs (as defined in NFSSM Policy):

- Design, develop, plan and implement a ULB-level FSSM strategy
- Set up and ensure operation of systems for 100 per cent safe and sustainable collection, transportation, treatment and disposal of FSS
- Develop expertise, in-house and outsourced, to provide safe and effective FSSM services
- Run awareness and behaviour change campaigns to engage diverse stakeholders
- Develop training programmes for masons to build requisite skills in construction of quality septic tanks as per BIS and NBC norms
- Set up systems to ensure financial sustainability in provision of FSSM services
- Achieve objectives of FSSM policy in a time-bound manner
- Design and implement plans to eliminate manual scavenging and rehabilitate manual scavengers
- Provide funding through specific schemes and plans
- Monitor and evaluate the FSSM strategy and implementation plans
- Implement municipal bye-laws

In addition, create enabling environment for NGOs and private initiatives to achieve safe and sustainable FSSM.

Sanitation is a state subject, but on-ground implementation and sustenance of public health and environmental outcomes require strong city-level institutionalization and stakeholder engagement. Although there are some common elements across urban India, there are a number of factors, constraints and opportunities that are peculiar to cities with respect to sanitation—climate, physiographic factors, economic, social and political parameters, and institutional variables. Therefore, each city needs to formulate its own Faecal

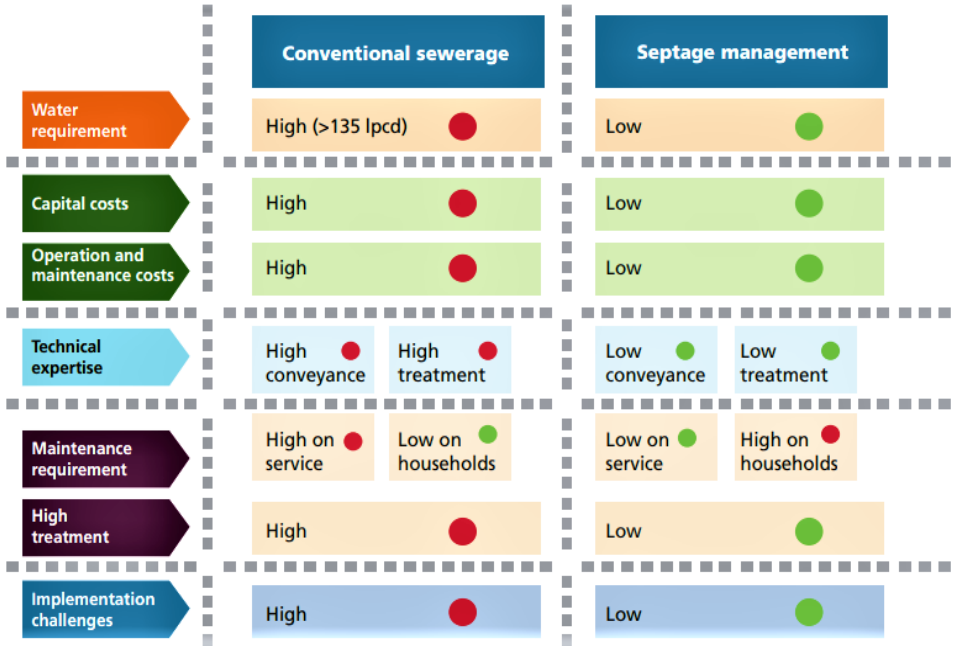
Uttar Pradesh Septage Management Policy

Uttar Pradesh Septage Management Policy was issued on 30 October 2019, keeping in mind the National Urban Sanitation Policy, 2008, National Policy on Faecal Sludge and Septage Management 2017, Swachh Bharat Mission Guidelines, Standard Operating Procedures for Cleaning of Sewers and Septic Tanks, and Manual Scavengers and their Rehabilitation Act, 2013.

The policy targets improvement in the quality of water and protection of public health by 2023. It articulates a three-pronged Septage Management (SM) Vision:

a) All preparatory activities of realizing septage management targets under a sector regulation must be completed by the end of 2019
b) Septage management to be mainstreamed by the end of 2021 in all urban local bodies (ULBs); *nagar nigams* (NNs) and *nagar palika parishads* (NPPs) should have significantly moved forward
c) All ULBs should have implemented septage management solutions in an inclusive manner, by empowering all stakeholders in the process by the end of 2023.

Figure 4: Benefits of septage management over conventional sewerage system



Source: Urban Development Department, government of Maharashtra, 2016

Sludge and Septage Management (FSSM) guidelines. As per the NFSSM policy, the city also needs to integrate these guidelines in their respective city sanitation plans. Several other stakeholders, like households, civil society organizations, the private sector (small, medium and large), research organizations, also have a critical role to play in providing safe and sustainable FSSM services to all. The services must comply with the revised service-level benchmarks for sanitation, as enumerated in *Annexure 6.3*.

Sanitation planning should be incremental, acknowledging the variations in urban conditions over time, and within and between areas, while also keeping in consideration networked and un-networked solutions. *Figure 4* explains the salient features of both conventional sewerage and septage management and the benefits of FSSM over conventional sewerage systems.

Currently, an effective city-wide monitoring process for FSSM does not exist in the city. The designs of the OSS do not comply with any standards or norms. There is a complete lack of scheduled desludging operations for OSS. The FSS is rampantly dumped on agricultural land, vacant plots and rivers, and treatment facilities for FSSM are absent.

For these reasons, a need has been felt for developing comprehensive FSSM operative guidelines for the city. Recognizing the growing importance and benefits of safe FSSM practices, there is an emerging need for framing integrated strategy-cum-operative guidelines for FSSM in CNPP.

1.6 Rationale for preparing the guidelines

The role of CSE in supporting FSSM in Chunar can be summarized as follows:

- MoHUA has enlisted CSE to provide technical support to a total of 23 towns (including Chunar) in their quest to become flagship towns vis-à-vis FSSM (D.O. MD-SBM/AA/62/2016 dated 30 May 2016).
- During the state-level meeting with the Principal Secretary, Department of Urban Development (DoUD), Government of U.P. on 25 May 2017, the state government requested CSE to prepare a detailed project report (DPR) for the FSTP in Chunar and provide handholding support to CNPP for effective FSSM in the city (PMU/194/431/2017 dated 12 July 2017).
- In the 20th Executive Committee meeting of National Mission for Clean Ganga (NMCG), held in Delhi on 15th February 2019, NMCG sanctioned the FSSM project of Chunar, to be developed as a model city for effective FSSM.
- Discussions with CNPP officials led to the realization of the requirement for operational guidelines for FSSM, so that the ULB can provide effective service to the residents and also monitor the same comprehensively.

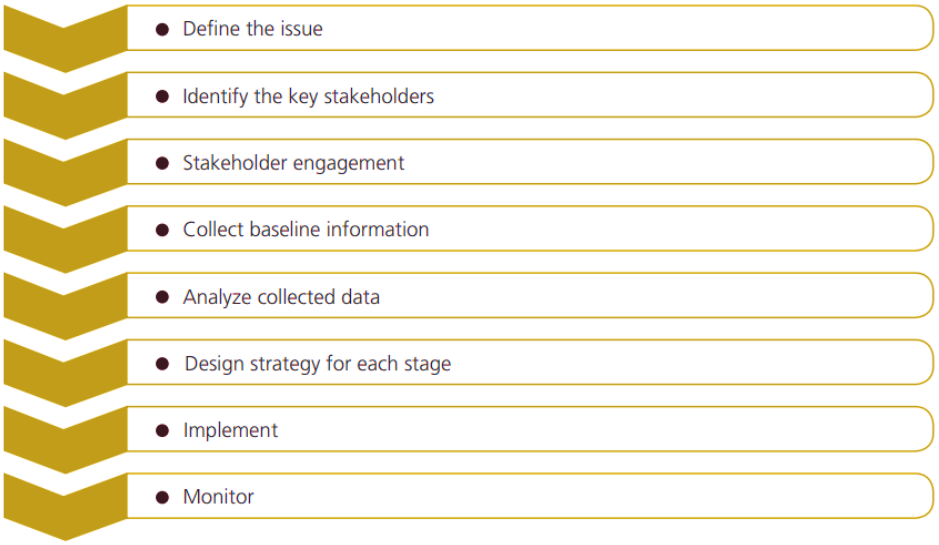
In this regard, ULB officials (Executive Officer, Jal Kal Incharge, Sanitary Inspector and other CSTF members) from Chunar Nagar Palika Parishad (CNPP) attended national exposure visits (at Bengaluru, Chennai, Delhi, Mysuru and Puducherry) to successfully implemented FSTP and also had first-hand interaction with the technology providers, municipalities and beneficiaries.

These operational guidelines have been prepared against this background and have been submitted to CNPP for necessary action and perusal.

2 FSSM planning in Chunar

FSSM is a process and requires attention at every stage of the sanitation chain. It needs to be comprehensive and requires a step-wise approach, beginning from systematic planning to ensure availability of infrastructure and human resources for collection, transportation and treatment of FSS (see *Figure 5*). It has to be sustainable and must take into consideration the socio-economic aspects of a region. Safe disposal or end use in a scientific manner is the main goal of FSSM.

Figure 5: Steps for planning septage management



Source: CSE, 2017

2.1 Approach and strategy

Initially, a city should prepare and implement a city-level strategy for FSSM which must also take into consideration wastewater or effluent management in an inclusive manner (A1). To this end, a city must prepare a baseline of existing conditions. This baseline must include information on total stations, and GIS-based surveys along with development of web-based geo-spatial information, management information system (MIS) and integration of both kinds of information on a GIS platform (A14). Tools from the FSM toolbox, such as shit flow diagrams (SFD, sfd.susana.org), can be handy for quick situational analysis, advocacy and planning.

After the successful completion of the baseline survey, a city will have to develop a city sanitation plan, detailing out the city's plan for (i) Water supply, (ii) Access to toilets, (iii) Stormwater management, and (iv) Solid waste management, in conjunction with FSSM, in a holistic manner (A2). For this, CNPP can refer to Sani-Kit (www.cseindia.org/sanikit/index.html), which is a web-based portal with a comprehensive array of essential tools to enhance the capability of urban local bodies in India to prepare a high quality, city-owned, sanitation plans.

Meanwhile, CNPP should regulate and licence private desludgers who wish to provide emptying services in Chunar city and also make it mandatory for desludging vehicles (including those owned by CNPP) to install GPS devices (A3). Additionally, CNPP should ensure: (i) Conversion of all insanitary latrines to sanitary latrines (see *Section 3.1.14*) and (ii) That all new containments are being built in line with the design and material specifications of CPHEEO and BIS.

Since, there is no treatment facility in Chunar at present, CNPP should identify, construct and designate suitable trenching site(s) for safe disposal of faecal sludge, till the time scientifically designed treatment facilities are in place (see *Annexure 6.4* for details) (A4). Moreover, since no wastewater treatment system exists or has been planned for the city, owing to which the drains discharge all wastewater in either River Ganga or River Jargo, authorities should incorporate safe wastewater management in their plans on a priority basis (A12).

Since the City Sanitation Task Force (CSTF) has already designated a suitable site for a pilot FSSTP of 10 KLD capacity and the DPR prepared by CSE for the same has been sanctioned by National Mission for Clean Ganga (NMCG); CNPP, Uttar Pradesh Jal Nigam (UPJN) and Uttar Pradesh State Mission for Clean Ganga (UP–SMCG) should prioritize construction and commissioning of faecal sludge treatment plant(s) with effective reuse of by-products for safe management of all the collected FSS (A5). By the time the FSSTP is commissioned, CNPP should ensure hiring and allocation of adequate personnel and procurement of efficient equipment for collection and transportation of FSS (A6).

Meanwhile, CNPP should formulate stringent bye-laws to curb all unsafe practices being followed in the city (A7). These should include:

- Decanting or disposal of FSS by all emptiers or desludgers only at the FSSTP
- Implementation schedule of desludging (initially in selected wards for the pilot study), containing: (i) Provisions for collection of sanitation charge (minimum ₹25 and ₹50 per month from each residential and non-residential property respectively); (ii) Provisions that each desludging of CT or PT will be charged a minimum of ₹1,000 per trip (iii) Provisions for free scheduled desludging at an interval of three years in each residential and non-residential property (iv) Provisions of penalty (₹3,000 per trip), in case any property exceeds the desludging interval of three years.

After the FSSTP is functional, CNPP shall implement these bye-laws, including the desludging schedule (only in select wards for the pilot study) (A10) and enforce 'The Prohibition of Employment as Manual Scavengers and their Rehabilitation Act, 2013' and introduce strict provisions for penalizing defaulters (A10).

Since groundwater level in the city is high (<10 mbgl), effluent from the containments shouldn't be discharged into the ground by connecting them to secondary systems like soak pits, etc. Such practices may cause groundwater pollution, especially in cases of inadequate separation between OSSs and potable groundwater sources. Thus, systems such as small-bore and shallow sewers should be implemented, which can lead wastewater to decentralised wastewater treatment systems (DWWTs) for treatment and potential reuse (A12).

During the pilot study phase, CNPP should carefully examine the quality and quantity of FSS collected and the efficiency of the treatment systems in place. Based on the study, CNPP should carry out gap analysis between existing infrastructure and probable demand. Based on this analysis, CNPP must plan and establish the required treatment system(s) at the most feasible site(s) (see *Annexure 6.5*) or tender them out to private agencies (see *Annexure 6.6*) (A11).

In order to provide effective and safe services to the OSS owners and natives of Chunar, it is necessary to build the capacity of the urban local body's officials, service providers, masons, operators, etc. This will improve the performance of the institution with assessment of service efficiency and profitability and also motivate individual capability in terms of enhancement of innovative thoughts, latest trends and information. This human resource capacity building programme should be systematically developed according to individual career steps (A8).

Timelines for the stated action plan have been presented in *Figure 6*.

2.2 Options for financing

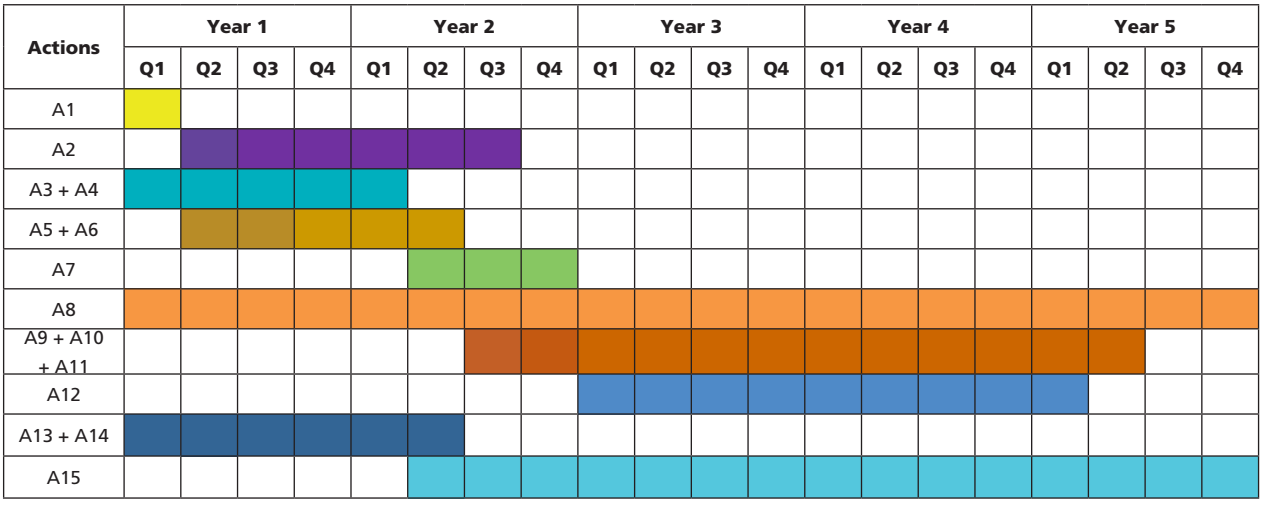
When compared with centralized sanitation systems, FSSM is cost effective. Nevertheless, most of the initial funding across the sanitation chain will have to be provided by a joint effort of the Central and state governments, primarily through allied programme funding like SBM, Namami Gange, etc.

2.2.1 Probable sources of revenue for FSSM

a. As per the Uttar Pradesh Municipality Act, 1916, Chapter V: Municipal taxation, Section 128(1), **a conservancy tax** can be levied on all properties by the CNPP from which the city undertakes collection, removal and disposal of polluted matter from privies, urinals, cesspools and other OSSs.
b. If CNPP explores the possibility of private sector involvement in FSSM, then an **escrow account** can be set up into which revenue from the sanitation charge will be transferred. The contractual amount for FSSM services provided by private parties can be paid from this escrow account to avoid delays.
c. A portion of property tax designated for FSSM, earmarked as **'sanitation charge'**.
d. **Periodic revisions for the taxes and charges** to be effected based on revisions in costs involved.
e. To the extent possible, revenue should be generated from **sale of treated FSS** for agriculture, horticulture or other purposes including local reuse of treated water to meet various non-potable requirements.
f. Funding could be explored through various Central and state schemes like SBM, PMAY, NULM, and Namami Gange, etc.
g. **CSR funding** opportunities under Namami Gange and SBM.

An investment plan suited to the local capacities will be needed by the CNPP for asset creation. In order to lower the financial burden on public investments, innovative ideas for private sector funding will have to be evolved and a revenue model to determine the user charges will have to be worked out for collection, conveyance and treatment of FSS. A generic business model canvas for FSSM has been depicted in *Annexure 6.7*.

Figure 6: Milestones and timelines



A1	Preparation and implementation of city-level integrated faecal sludge and septage management strategy-cum-operative guidelines
A2	Preparation of a citywide sanitation plan
A3	Regulation of desludging service providers and installation of GPS devices in each vacuum tanker
A4	Identification, construction and designation of trenching sites for safe disposal of FSS, till the time scientifically designed treatment plants are in place
A5	Construction and commissioning of FSSTP(s) with effective reuse of by-products (wherever feasible) for safe management of the collected FSS
A6	Ensuring adequate manpower and efficient equipment for collection and transport of FSS
A7	Framing and enforcing bye-laws for: 1. Disposal of FSS by all desludgers in only FSSTP(s) 2. Implementation schedule of desludging (initially in select ward(s) for a pilot study), containing: (i) Provisions for collection of sanitation charge (minimum of 25 and 50 from each residential and non-residential property respectively); (ii) Provisions for each desludging of CT and PT to be charged a minimum of 1,000 per trip; (iii) Provisions for scheduled desludging at an interval of three years in each residential and non-residential property
A8	Capacity building programme(s) for ULB officials, licensed operators, masons and other stakeholders
A9	Implementation schedule for desludging in select ward(s)
A10	Ensuring enforcement of 'The Prohibition of Employment as Manual Scavengers and their Rehabilitation Act, 2013' and provisions for penalising defaulters
A11	Gap analysis and construction and commissioning of FSTP(s) for safe management of generated FSS , in conjunction with the implementation of city-wide scheduled desludging
A12	Operationalising DWWTs & implementing other safe wastewater management practices across the city in an incremental approach
A13	All households with insanitary latrines to have access to sanitary latrines
A14	Conducting total station surveys and geo-tagging of all properties. This shall include development of web-based geo-spatial information and management information system (MIS) and integration of both kinds of information on a GIS platform
A15	Geo-tagging of all OSS in the city, along with their detailed attributes and integration of the same on the existing GIS platform

Source: CSE, 2017

2.2.2 Other funding models

In the absence of any special scheme-based funding, Chunar can resort to either of the financial models presented in *Table 1*.

Table 1: Alternate funding models for FSSM

	Public sector	Outsourcing	Hybrid annuity model	Private sector
CAPEX	State government, ULB or grant from a funding agency (100 per cent)		Government 20–50 per cent Private sector 50–80 per cent Use of land for FSTP on leasehold	Private sector
O&M	ULB operates and maintains the facility	Operation carried out by private sector with a service-level agreements		Complete private sector monitoring mechanism
Capital recovery	Tax from polluters and cross subsidization or expenditure budget		Tax from polluters and revenue from services	Revenue from services
Role of ULB	Ownership of assets and operations	Contract management and monitoring	Monitoring for service-level agreements	Regulatory

Source: CSE, 2018

3 Operative guidelines for FSSM in Chunar

These operative guidelines have been framed for CNPP, drawing from regulations, provisions and specification related to faecal sludge and septage from the following:

- National Building Code, 2005
- Indian Standard Code of Practice for Installation of Septic Tanks (IS: 2470); Bureau of Indian Standards (1986)
- CPHEEO Manual on Sewage and Sewerage Treatment, 2013
- Guidelines for Swachh Bharat Mission–Urban (issued by MoHUA in 2014 and revised in 2017)
- Toolkit for ODF+ and ODF++ (issued by Ministry in 2018)
- Orders of National Green Tribunal issued till August 2019
- Policies, plans, schemes, missions, guidelines, acts and standards listed in *Annexure 6.1*

3.1 Putting the system in place

The following sections provide a set of guidelines to be implemented for the approach and strategy outlined in *Section 2.1*.

3.1.1 Preparation and implementation of city-level integrated faecal sludge and septage management strategy-cum operative-guidelines (A1)

- A taskforce shall appraise these strategy-cum-operative guidelines and recommend the same to CNPP.
- CNPP will issue these guidelines for effective FSSM in Chunar city.
- All stakeholders will implement the action plan or strategy spelled out in the document to the best of their ability.
- The taskforce will convene regular meetings with all stakeholders for updates, feedback and amendments (as required).

3.1.2 Preparation of city sanitation plan (A2)

- A systematic and all-inclusive approach shall be deployed to prepare the CSP for Chunar city. *Annexure 6.8* outlines the methodology that shall be used for the preparation of this plan. The process shall involve field-level surveys (households, institutions, key informant interviews, focused group discussions and physical verification and mapping of all facilities), and desktop research (relevant policies, guidelines, ULB records, roles and responsibilities of parastatal bodies, research publications) supported with the use of advance tools such as geographical information system (GIS) and shit flow diagrams (SFD).
- CSP shall focus on five components: Water supply; access to toilets; faecal sludge, septage and wastewater management; storm water management; and solid waste management. The plan shall include baseline information, issues and challenges and an action plan for each of these components. The plan shall also include details of the institutional mechanisms and financial models needed to make the proposed interventions sustainable.
- The plan shall endeavour to achieve the vision of 'Nirmal Aviral Ganga', Jal Shakti Abhiyan and 'Swachh Chunar, Swasth Chunar' through:
  - 100 per cent access to piped safe water by minimizing O&M expenses, strengthening the revenue model and implementing an effective

monitoring and evaluation framework along with efficient redress mechanism
- o Engaging all stakeholders and implementing best management practices to conserve the quality and quantity of water resources, including through reuse and recycling of treated wastewater
- o Achieving and maintaining ODF status and moving towards ODF+ and ODF++ by optimizing the functionalities of created infrastructure and constructing new infrastructure based entirely on a demand-driven approach
- o Ensuring 100 per cent safe FSSM throughout the sanitation chain
- o Achieving 100 per cent door-to-door collection of segregated municipal waste throughout the city
- o Optimizing resource recovery from waste and ensuring that only inert waste reaches sanitary landfills
- o Training, capacitating and equipping sanitary staff on safe handling and disposal of waste, enabling them to avoid any health or environmental hazards
- o Ensuring that unpolluted stormwater flows through efficiently maintained drains and remains a potential water resource for different economic and recreational purposes

3.1.3 Regulation of desludging service providers and installation of GPS devices in each vacuum tanker (A3)

Person providing desludging service

- Any person, who wishes to provide desludging services shall obtain a licence for desludging and transportation of FSS from CNPP as per the format provided in *Annexure 6.9*. This licence shall be valid for a period of 12 months (365 days) from the date of issuance and shall be renewed by the same process.
- A licenced operator shall deploy CNPP-registered vacuum tankers that meet the approved standards for desludging and transportation. The vacuum tankers shall be fitted with GPS and the details of the GPS shall be shared with CNPP for monitoring purpose.

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- Provide licence to the person providing desludging service based on her or his past competence and experience, as per the format provided in *Annexure 6.10*
- Ensure that operators are adequately trained to adopt approved standards and procedures (*Annexure 6.11*) for desludging and transportation
- Develop performance-based contracts such that payment is linked to the performance of licenced operator(s) for providing services
- Ensure that OSS owners hire only licenced operator(s) or CNPP-owned vacuum tanker(s) for desludging and transportation of FSS and pay the user charges as per the rates fixed by CNPP
- Manage the entire process of scheduling and tracking desludging of OSSs using the form provided in *Annexure 6.12* of these guidelines. Use of online applications can also be considered for streamlining the process and for real-time monitoring and assessment.

OSS owners

- Owners shall hire only licenced operator(s) or CNPP-owned vacuum tanker(s) for desludging and transportation of FSS and pay user charges as per the rates fixed by CNPP.

3.1.4 Identification, construction and designation of trenching sites for safe disposal of FSS, till the time a scientifically designed treatment plant is in place (A4)

- Trenching shall be a temporary measure until the FSSTP gets commissioned.
- Trenching sites shall be made at multiple locations across the city. The locations of these sites shall depend on the route followed by vacuum tankers and the areas from where maximum desludging demand is received.
- Legal permissions and approval from relevant authorities shall be sought before attempting trenching as per the norms.
- For more information on the site section criteria and monitoring for safe management of trenching sites see *Annexure 6.4*.
- The following monitoring exercises need to be undertaken regularly:
  - Sampling boreholes shall be used to monitor groundwater on a periodic basis to ensure zero contamination
  - On an annual basis, soil samples may need to be taken to check contamination of soil
  - Stringent regulation and control of types of sludge disposed, to ensure no industrial, commercial or toxic sludge is present

3.1.5 Construction and commissioning of FSSTP(s) with effective reuse of by-products (wherever feasible) for safe management of all collected FSS (A5)

- CNPP, Uttar Pradesh Jal Nigam and Uttar Pradesh State Mission for Clean Ganga should work in coordination to facilitate construction and operation of the proposed FSSTP. The new facility should cater to faecal waste generated in Chunar and nearby villages.
- The legal framework applicable to FSSTP construction and the site screening criteria, as enlisted in *Annexure 6.5,* should be taken into consideration. Along with this, continuous information, education and communication (IEC) activities must go on, especially in areas in the vicinity of the FSSTP, educating people about the benefits of the plant and its impact on the environment.

3.1.6 Ensuring adequate manpower and efficient equipment for collection and transportation of FSS (A6)

- CNPP shall purchase smaller desludging equipment of 1,000 litres capacity, which can manoeuvre through the narrow lanes of Chunar city and even empty thick dried FS.
- Vacuum tankers owned by CNPP shall work simultaneously with the smaller vacuum tankers to be purchased by CNPP, so that the bigger OSSs in the narrow lanes of Chunar can be emptied more efficiently.
- Licenced operators shall deploy CNPP registered vacuum tankers that meet the approved standards for desludging and transportation. The vacuum tankers shall be fitted with GPS, details of which shall be shared with CNPP for monitoring purposes.
- Licenced operators and their staff shall be responsible for safe operation of the vehicles and equipment at all times.

3.1.7 Framing and enforcing bye-laws for effective FSSM (A7)

- CNPP shall frame draft bye-laws to ensure effective FSSM in the city. The main components of the bye-laws have been listed in *Annexure 6.13*.

- These bye-laws shall focus on issues across the FSSM service chain, thus curbing all ill-practices.
- CNPP shall present draft bye-laws to the taskforce for consultation and incorporate any feedback or comments received from its members.
- The finalized bye-laws shall be enforced by the CNPP with strict provisions for penalizing the defaulters.

3.1.8 Capacity building programme(s) for ULB officials, licenced operators, masons and other stakeholders (A8)

Awareness generation activities need to be undertaken for successful implementation of FSSM. Community acceptance and adherence to regulations and service plans set up by the ULB is only possible if there is awareness in the community. *Annexure 6.20* presents the sector- and stakeholder-specific capacity building and IEC and behavioral change communication (BCC) plan, which CNPP may follow to make Chunar a healthy, resource-efficient and smart region.

Awareness generation for residents: Members of Resident Welfare Association(s) (RWAs), community organizers, self-help group(s) (SHGs) and the general public should be sensitized periodically regarding the need for a sound FSSM, including a three-year cycle. Health hazards associated with improper design of OSSs, desludging and treatment of waste, and the ill effects of untreated wastewater discharged into fresh water or stormwater drains should be explained to residents. Awareness generation activities should be carried out at the beginning of a scheduled desludging service in all wards and then repeated periodically over the three-year cycle.

Capacity building for municipal staff: The Executive Officer, Chairperson, Engineers, Sanitary Inspectors, Health Officers, and Sanitary Workers of CNPP should be trained in safe FSSM and its best practices. This involves regular training sessions on safe desludging, treatment and disposal. Information regarding standard septic tank design, the need for periodic inspection and desludging of FSS, design of a treatment facility, tender details for engaging licenced operators, etc. should be disseminated widely to achieve safe FSSM. Training should also be provided on developing a sound institutional setup, rigorous and effective monitoring across the value chain, and safety standards; etc.

Capacity building for FSS desludging, transportation and treatment by licenced operators: The ULB should ensure all safety norms are clearly explained to the licenced operators. Licenced operators should be well trained in safe desludging and transportation of FSS, including vehicle design, process of desludging, safety gears, and safe disposal at the nearest notified location (see *Annexures 6.11 and 6.14* for more details).

Capacity building of masons and plumbers: Construction of OSSs is mainly done by masons and plumbers. Only skilled and experienced labourers can construct functional systems. Training and capacity building of the workforce can prove to be a significant contribution towards improved FSSM and CNPP should ensure this with legitimate monitoring and penalize masons and plumbers who do not abide by the guidelines.

Suggested communication approaches and tools: Awareness needs to be created amongst authorities, OSS owners, communities and institutions that are part of the city's 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 behavioural changes aimed at adoption of healthy sanitation practices. Communication would need to make use of popular and cost-effective channels (hand bills, notices, announcements over radio or TV, as part of water bills, etc.) and messaging would need to be oriented to different stakeholders—households, institutions, government agencies, etc. See *Annexure 6.15* for some examples of FSS communication initiatives.

3.1.9 Implementation schedule of desludging in select ward(s) (A9)

- Select a few wards (one–five) for conducting a pilot scale study on implementation schedule of desludging. The wards shall preferably be the ones in the vicinity of the FSSTP.
- Plan a cycle of three years for implementing a schedule of desludging in these wards. This can be done by calculating the number of desludging trips that are required per day in order to cover all the properties in a period of three years.
- Provide the first desludging free of cost or at a nominal charge to these properties and after each desludging, a date of three years hence shall be put on each OSS, when the property owner will have to get the OSS desludged.
- Levy a 'sanitation charge'—a monthly or yearly payment in place of the currently levied desludging fee (₹1,500 per trip) for each service.
- The sanitation charge shall be a minimum of ₹25 and ₹50 from each residential and non-residential property respectively.
- In case a property owner wants to get their OSS emptied in the middle of the cycle, the current desludging fee (₹1,500 per trip) shall be levied.
- For families belonging to economically weaker section, the sanitation charge can be reduced to ₹15 and for desludging done over and above the cycle, ₹600 can be charged

Please refer to *Case Study 1 in Section 5.2* to understand how Dumaguete City in Philippines implemented scheduled desludging successfully.

3.1.10 Ensuring enforcement of The Prohibition of Employment as Manual Scavengers and their Rehabilitation Act, 2013 and provisions for penalizing defaulters (A10)

- CNPP shall ensure conversion of all insanitary latrines to sanitary latrines (guidelines provided in *Section 3.1.13*).
- CNPP shall undertake a survey to identify persons engaged or employed in manual scavenging within its jurisdiction and shall complete the survey within a month's' time. The final list of persons working as manual scavengers shall be published by CNPP.
- Listed persons shall be rehabilitated in the manner stated in the Act, as follows:
    - o They shall be given a photo identity card containing, inter alia, details of all members of their family dependent on them; they (or at least one of their adult family member) shall be given, subject to eligibility and willingness, training in a livelihood skill, and shall be paid a monthly stipend of not less than ₹3,000 during the period of such training.
    - o They (or at least one of their adult family member) shall be given, subject to eligibility and willingness, subsidy and concessional loans for taking up an alternative occupation on a sustainable basis, in a manner

stipulated under relevant schemes of the Central or state governments or a concerned local authority.

- Besides these above options, CNPP shall facilitate their training, or at least the training of one adult member of their family (subject to eligibility and willingness, under the National Urban Livelihood Mission (NULM). This training shall focus on providing assistance for development and upgrading of the skills of manual scavengers so as to enhance their capacity for salaried employment as well as gainful self-employment ventures or micro-enterprises, suited to their skills, training, aptitude and local conditions. Under NULM, there is a provision for providing loan from the banks to individuals and groups.
- The taskforce and officials designated by the taskforce shall advice the CNPP on the actions needed to be taken to ensure enforcement of this Act, oversee the economic and social rehabilitation of manual scavengers, coordinate the functions of all concerned agencies, and monitor registration of offenses under this Act.
- CNPP shall impose a penalty of ₹5,000 on a manual scavenger and their employer if they are found practicing manual scavenging after CNPP has successfully conducted the rehabilitation based on the final list.

3.1.11 Gap analysis and construction and commissioning of FSSTP(s) for safe management of all generated FSS, in conjunction with the implementation of city-wide scheduled desludging (A11)

- Based on the data collected from various sources and collated in the form of the MIS (see *Section 3.1.14* of these guidelines), the taskforce shall assess the existing infrastructure and services in comparison with service-level benchmarks for sanitation (enlisted in *Annexure 6.3*).
- The taskforce shall assess the issues and challenges of the pilot-scale scheduled desludging under implementation in the city. Based on these observations, CNPP shall take precautionary and corrective action, and extend it to the rest of the city, thus implementing city-wide scheduled desludging.
- As per the study, the taskforce shall plan, design and implement FSSM interventions, including with regard to infrastructural, administrative and social requirements.
- In order to effectively plan, design and implement treatment interventions, site and technology selection shall be carried out as elucidated in *Annexures 6.5 and 6.16*.

3.1.12 Operationalizing DWWTs for safe management of effluent and greywater (A12)

- Taking information from the MIS (refer *Section 3.1.14* of these guidelines), CNPP and UPJN shall carry out a reconnaissance survey to plan for a decentralized approach for managing wastewater in Chunar city.
- CNPP and UPJN should draw in private players for implementation of interventions such as small-bore sewers, shallow sewers, and DWWTs, whose contracts can further be extended for O&M of the systems.
- The tendering process, which the CNPP and UPJN shall follow to allocate work orders to private players, has been detailed out in *Annexure6.6*.
- CNPP and UPJN must oversee the construction of the systems to ensure that there is no deviation from the approved design and the quality of the construction materials used conforms to specifications. For this, CNPP and

UPJN can refer to the menu on unnetworked technology (MOUNT, www.cseindia.org/mount/home), which is an aggregator platform for various sustainable technologies, encouraging and disseminating knowledge and good practices for wastewater management.

- After the DWWTs is commissioned, CNPP and UPJN shall ensure no property discharges its wastewater into stormwater drains. There shall also be a penalizing provision regarding this in the bye-laws (see *Section 3.1.7* of these guidelines).

*Please refer to *Case Study 2 in Section 5.2* for an example of how a residential neighbourhood in Mumbai, India implemented a decentralized wastewater treatment system and reuse the treated water for maintaining the green areas in their premises.

3.1.13 All households with insanitary latrines to have access to sanitary latrines (A13)

- CNPP shall undertake a survey to evaluate the designs of existing containment systems and insanitary latrines in the city.
- It shall issue notices to owners of insanitary latrines to convert them to sanitary latrines and educate them as to how they can retrofit existing OSSs. The notices shall have strict deadlines, failing which the owner or inhabitant of the property needs to be penalized.
- For slums and informal settlements, in case there is not enough space available in each household, CNPP shall issue notices to owners to demolish insanitary toilets and CNPP shall construct a sanitary community toilet in their vicinity. The necessary arrangements for hygienic upkeep of these community toilets shall also be made by CNPP.

3.1.14 Conducting total station surveys and geo-tagging of all properties. This shall include development of web-based geo-spatial information and MIS, and integration of both on a GIS platform (A14)

- Develop a common digital geo-referenced base map in the GIS environment using high-resolution satellite images and various other city survey maps at 1:2,000 for the entire city or township. This shall be used by the designated departments of CNPP and other stakeholders for detailed mapping (see *Annexure 6.17* for features to be included in the base map).
- The base map shall be updated regularly to maintain an accurate and reliable information database on properties and all components of infrastructure on a common, scalable and physically verifiable platform of GIS.
- Mapping of all existing infrastructure and municipal facilities (e.g., water connections and OSSs) onto a GIS-based map shall be carried out. This will allow spatial analysis of service provision levels, revenue generation and social composition, particularly for identifying the location of poor and socially excluded communities. Integration of MIS and geo-spatial information on a GIS platform shall assist and improve the analysis of GIS-enabled spatial and non-spatial data.

3.1.15 Geo-tagging of all the OSS in the city, along with their detailed attributes and integration of the same on the existing GIS Platform (A15)

- Drivers of the CNPP-registered vacuum tanker must be given a service notice (see *Annexure 6.12*), which shall be filled with utmost precision by the operator and signed by the OSS owner. The service notice includes

detailed attributes of the OSS, which when filled by the operator while providing desludging services, shall eventually create a city-wide database.
- The location of OSSs within the premises of the property (building or plot) in CNPP must be fed into the GIS base map and its corresponding data to provide spatial attributes of the OSS.
- The database thus prepared shall be integrated with MIS and geo-spatial information on a GIS platform, which will assist and improve the analysis of GIS-enabled spatial and non-spatial data.

3.2 Creating an enabling environment for system sustainability

Following are the key elements of FSSM covered under this set of guidelines: i. Design and construction of OSSs for FSSM; ii. Desludging of FSS; iii. FSS transportation; iv. Treatment, disposal, and reuse of FSS; and v. Record keeping, reporting, monitoring and feedback systems

The following sections provide the set of guidelines to be implemented for the aforementioned elements.

3.2.1 Design and construction of OSSs for FSSM

- CNPP shall ensure that all properties adopt the design of septic tanks prescribed by the CPHEEO manual and IS 2470. Bio-digesters and bio-toilets advocated by SBM should be promoted by CNPP at par with septic tanks as they are cost effective and environment friendly.
- CNPP shall ensure that the OSS's design conforms to the standards at the time of approval of building plan. The design specifications of septic tanks, twin pits, bio-digesters, and bio-toilets have been provided in *Section 4*.
- CNPP shall inspect the OSSs during their construction to ensure that there are no deviations from the approved design and the quality of the construction materials being used conforms to the specifications of Indian Standard Codes. These provisions shall also be included in the Municipal Building Bye-laws of the city.
- More advanced (two-chambered) septic tanks with filter, anaerobic baffled reactors with filter, etc. shall be encouraged to be adopted by institutions and bulk generators such as hotels, colleges, and group housing projects to promote reuse.
- CNPP shall provide training to local masons and plumbers so that they can construct well-designed robust containments that are in line with the standards (see S*ection 3.1.8* of these guidelines for details).
- For safe and economical management of wastewater technologies such as DWWTs, soil biotechnology, constructed wetland, phytorid and in situ wastewater treatment system shall be promoted by CNPP.

3.2.2 Emptying and desludging of FSS

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- Inform an OSS owner whose desludging is scheduled at least five days prior to the service, instructing them to ensure that the OSS is accessible for the service. A digital reminder via mobile phone should also be sent on the day of appointment.

Licenced operators

- The operators shall have trained workers equipped with uniforms, personal protective equipment (PPE) (for a list of PPE, see *Annexure 6.14*), tools and vacuum tankers.

- The operators shall be adequately trained to adopt approved standards and procedures for desludging and transportation (see *Annexure 6.11* of these guidelines, for precise procedure to be followed by service providers).
- Desludging workers shall wear appropriate PPE when on duty.
- Workers shall be prohibited from entering an OSS and it should be done only in exceptional cases with requisite precautions, safety equipment and permission of CNPP.
- After each desludging operation, the area shall be properly cleaned and disinfected with relevant cleaning agents such as bleaching powder and lime. Workers shall also follow proper hygienic practices such as washing hands with soap.
- While attempting the desludging service, if the owner of the OSS is not available (not present at the property) or not willing (does not want to avail the service) to desludge the OSS during scheduled desludging, then at least two attempts shall be made in a gap of 15 days before reporting as 'unavailable' or 'unwilling'. Contractors shall comply a list of such properties and submit it to the CNPP fortnightly.

OSS owners

- Owners of OSSs must undertake desludging of the systems once every three years (for residential, commercial and institutional establishments) and twice a year (for community and public toilets) or when they get filled-up or based on running efficiency of the treatment plant, whichever is earlier.
- The owners whose desludging is scheduled must ensure safe access to the containment for emptying.

The guidelines in *Section 3.2.2* shall apply only after implementation of scheduled desludging in the area.

3.2.3 FSS transportation

- Licenced operators and trained sanitary workers of CNPP shall be responsible for safe operation of vehicles and equipment at all times.
- Transportation shall be undertaken via pre-defined routes, avoiding busy roads and peak traffic.
- Drivers of the CNPP-registered vacuum tankers must be given a service notice (see *Annexure 6.12*), made in quadruplicate, for each desludging operation. One copy has to be handed to the OSS owner, a second copy has to be filled at the disposal site, a third copy at the control centre with signature and stamp, and the fourth copy has to be submitted to CNPP. The service notice should be signed by the OSS owner, desludging operator, FSSTP operator, designated person at control centre, and CNPP official.
- In due course of time, CNPP shall develop a mobile phone-based online application process to further streamline service notice. This process shall enable CNPP to carry out real-time monitoring of the whole process, thus maintaining quality service for residents.
- GIS shall be used to better plan the route of the CNPP-registered vacuum tankers and tracking these for regular record keeping.
- In the event of accidental spillage of FSS, the operator shall immediately take action to contain the FSS, minimize the environmental impact, and carry out clean-up procedures. The operator shall notify concerned officials of CNPP about the spillage and the nature of remedial action within 24 hours. Penalties shall be imposed on the licenced operator(s) who do not comply with these guidelines.

- CNPP-registered vacuum tankers shall be directed to transport FSS to the designated treatment facility as per the approved process. Service providers should be prohibited from disposing the FSS at any other location and would attract penalties for the same.

3.2.4 FSS treatment, disposal and end-use

- The operator of the FSSTP shall implement a comprehensive environmental management plan to ensure compliance with environmental and social standards.
- It is the responsibility of the operator of FSSTP to ensure compliance with treatment and discharge norms. The reuse of treated waste shall be permitted as per standards and norms.
- Treated FSS shall be reused or safely disposed only after it meets the parameters enumerated in *Annexure 6.18* of these guidelines. Various possible reuse options have also been outlined in the same annexure.
- CNPP can levy charges on the residents for treatment and disposal of FSS as per requirements.
- CNPP reserves the right to suggest locations for FSS disposal and the operators of collection and transportation must comply with the same.

The guidelines in this section shall become effective only after completion of the FSSTP.

3.2.5 Record keeping, reporting, monitoring and feedback systems

At each stage of sanitation chain, i.e., from containment till end-use, monitoring is essential (see *Annexure 6.19*). Any lapse in monitoring means unavoidable delays in achieving the goals of the programme. The completed document(s) with signatures of the household or property, vacuum tanker operator and treatment plant operator should be submitted to CNPP for their records. Payment to the vacuum tanker operator should only be made if there are signatures of all stakeholders.

Management Information System (MIS): Information related to FSS generation and collection from residential and commercial establishments needs to be collected by CNPP. Household-level details of insanitary latrines, identification of OSS location, service provider in-charge for each location, vehicle details, location of FSS treatment facilities, and decant facility details should be duly collected by CNPP.

Consumer grievance redress system: When any service is offered, there are always some issues and challenges associated with them. Customer satisfaction should be the main objective of the service provider. In FSSM, many stakeholders and beneficiaries are involved. It may not be possible that each beneficiary is satisfied with the services. Therefore, for appropriate disposal of the complaints with FSSM, CNPP must establish and maintain a control centre for customers to phone and request desludging services, or register complaints. It should have 24 × 7 voicemail recording facility and must be staffed from 10 a.m. to 5 p.m. on all working days, by operators who are well-versed in local languages. Nodal officers must be appointed to dispose of the complaints at each stage of FSSM. However, in case the complaint is not addressed or the user is not satisfied, there should be a provision to take the complaint to higher authorities or institutions (e.g., pollution control board) for appropriate action.

4 Onsite sanitation technologies

Onsite sanitation systems are options which help treat waste at source, rather than dealing with it several miles away in a centralized manner. These systems deal with the collection and storage of black water from latrines. They also deal with partial anaerobic treatment of solids that settle down in tanks and pits. The following sections discuss the various types of OSSs, viz. septic tanks, twin-pits, bio-digester and bio-toilets and their respective design considerations.

4.1 Septic tank

Bureau of Indian Standards (BIS) provides a code of practice for installation of septic tanks (IS 2470 [Part 1] 1985). It illustrates design criteria to construct the septic tank based on certain assumptions. It provides details to design installations for small and large areas considering the population. Comprehensive design standards on OSS are provided in Part A of manual on sewerage and sewage treatment published by Central Public Health and Environmental Engineering Organization, the research wing of MoHUA. The standard designs for prevalent and safe onsite sanitation technologies have been stated in this section. Also, septic tanks in India are meant for black water only.

4.1.1 Specifications of a septic tank

- Rectangular: Length to breadth ratio should be 3 to 1
- Depth: Between 1–2.5m
- Two chambered: First chamber should be two-thirds of the total length
- Three chambered: First chamber should be half of the total length
- Access cover above each chamber
- Watertight, durable and stable tank

Table 2: Recommended sizes of septic tanks

Number of users	Length (m)	Breadth (m)	Cleaning interval)	
			1 year	2 year
			Liquid depth (m)	
5	1.50	0.75	1.00	1.05
10	2.00	0.90	1.00	1.40
15	2.00	0.90	1.30	2.00
20	2.30	1.10	1.30	1.80
50	5.00	2.00	1.00	1.20
100	7.50	2.65	1.00	1.20
150	10.00	3.00	1.00	1.20
200	12.00	3.30	1.00	1.24
300	15.00	4.00	1.00	1.24

Note 1: The sizes of septic tank are based on certain assumptions (liquid discharge). While choosing the size of septic tanks, the exact calculations shall be made. For information regarding the same, please refer to BIS: 2470 (part 1)—1985)

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

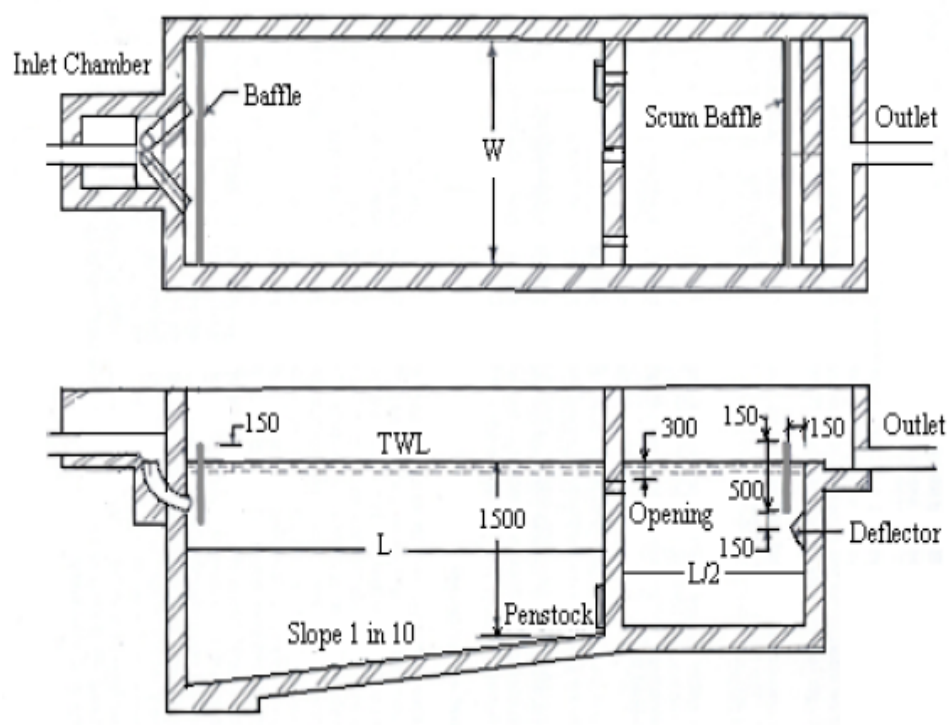
Source: CPHEEO, 2013

4.1.2 Capacity of septic tanks

Knowledge about the capacity of a tank is useful to understand the duration for desludging. The following are key points useful to measure the capacity of a septic tank:

- Sedimentation: An area of 0.92 m^2 is required for every 10 l/minute peak flow rate to support adequate sedimentation of suspended solids. Generally, the depth of the sedimentation zone is 0.3 m.
- Sludge digestion: The capacity of the digestion zone works out to be 0.032 m^3/capita.
- Sludge and scum storage: For an interval of one year of sludge cleaning, a sludge storage capacity of 0.0002 x 365 = 0.073 m^3/capita is required.
- Free board: At least 0.3 m

Figure 7: Structure of a septic tank



Source: CPHEEO, 1993

4.1.3 Types of septic tanks

Many different types of septic tanks exist, classified on the basis of the number of chambers, intensity of treatment and complexity of the system.

Conventional system

a) Single-chambered septic tank
b) Two- or three-chambered septic tank

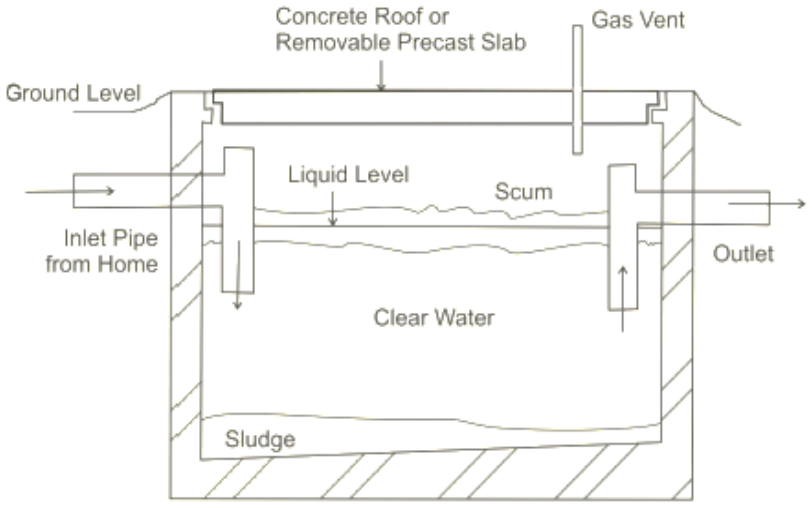
Improved system

a) Two-chambered septic tank with filter
b) Anaerobic baffled reactor with filter

Single-chambered septic tank

Single-chambered septic tanks are tanks in which anaerobic digestion takes place. This type of OSS requires frequent emptying as the rate of digestion of solids is comparatively low. This conventional type of septic tank is not suggested as an on-site treatment system because of its low efficiency and high maintenance requirements [GIZ-CSE-ECOSAN, 2015].

Figure 8: Structure of a single-chamber septic tank

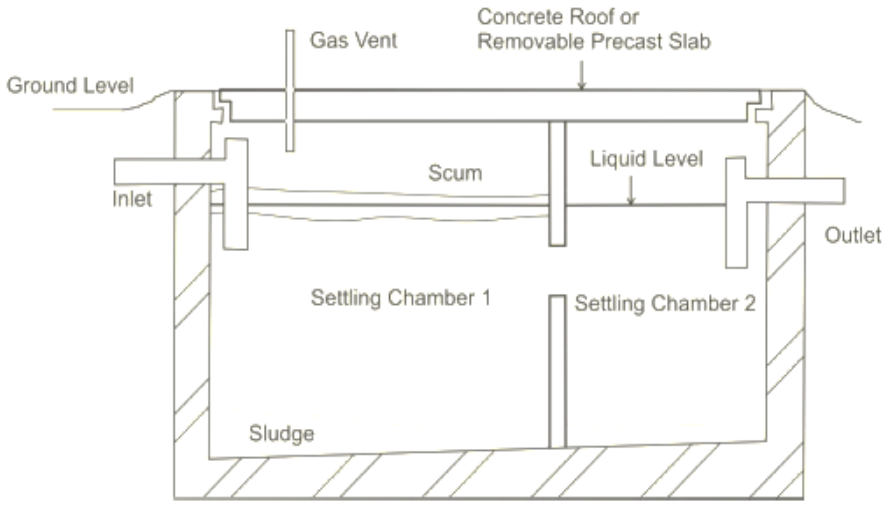


Source: GIZ-CSE-ECOSAN, 2015

Two-chambered septic tank

Two chambered septic tanks have two chambers where the first chamber should be at least twice the capacity of the second chamber or two-thirds of the total length. Most solids settle in the first chamber and the separation between the chambers is to prevent scum and solids from escaping with the effluent. A T-shaped outlet pipe will further reduce the scum and solids that are discharged. Generally, these septic tanks have to be emptied every two to three years [GIZ-CSE-ECOSAN, 2015].

Figure 9: Structure of a two-chambered septic tank

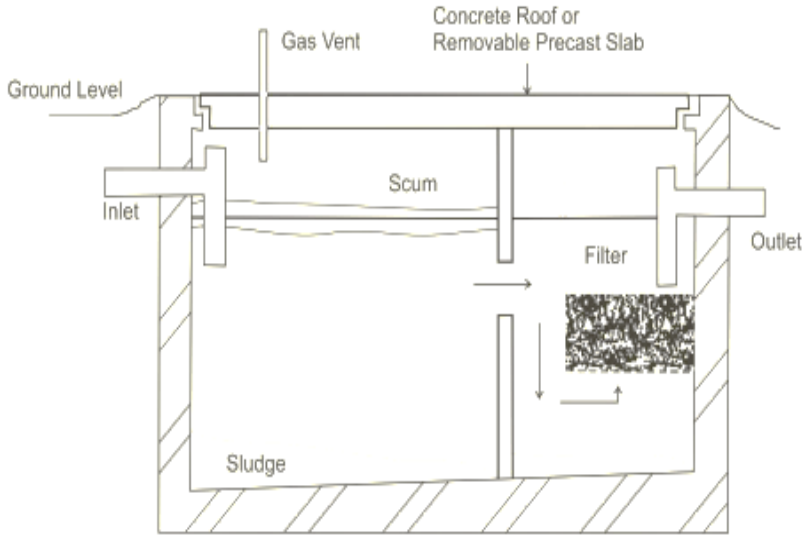


Source: GIZ-CSE-ECOSAN, 2015

Two-chambered septic tank with filter

This type of system incorporates two chambers with a single filtration chamber resulting in improved treatment. As wastewater flows through the filter, particles are trapped and organic matter is degraded by the active biomass that is attached to the surface of the filter material. Commonly used filter material includes gravel, crushed rocks, cinder or specially made plastic pieces. Typical filter material sizes range from 12–55 mm in diameter. Ideally, the material will provide between 90–300 m^2 of surface area per 1 m^3 of reactor volume. By providing a large surface area for bacterial mass, there is increased contact between the organic matter and active biomass that effectively degrades it. Suspended solids and BOD removal can be as high as 85–90 per cent but is typically between 50–80 per cent. Nitrogen removal is limited and normally does not exceed 15 per cent in terms of total nitrogen [GIZ-CSE-ECOSAN, 2015].

Figure 10: Structure of a two-chambered septic tank with filter

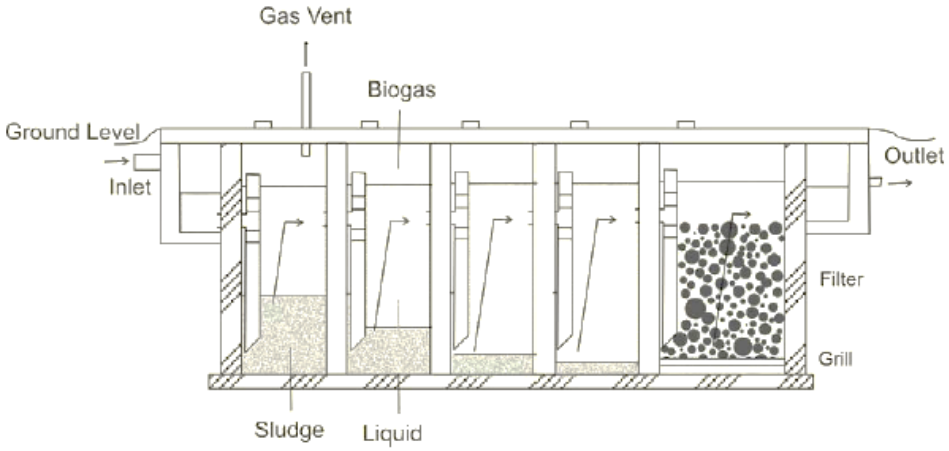


Source: GIZ-CSE-ECOSAN, 2015

Anaerobic baffled reactor with filter

An anaerobic baffled reactor with filter is an improved septic tank with a series of baffles under which wastewater is forced to flow. It incorporates one or more filtration chambers where particles are trapped and organic matter is degraded by the biomass that is attached to the filter media. BOD may be reduced by upto 90 per cent, which is far superior to that of a conventional septic tank. In practice, septic tanks are not made according to the IS code, hence the system is not very efficient. This fact affects the desludging time and the quality of effluent and septage emptied from these tanks.

Figure 11: Structure of an anaerobic baffle reactor with filter



Source: GIZ-CSE-ECOSAN, 2015

4.2 Twin-pit

It consists of a superstructure (toilet) and treatment units (two-chambers). The two underground chambers (pits) are provided to hold FS.

4.2.1 Specifications for designing a twin-pit

Twin-pits are normally offset from the toilet and should be at least one meter apart from each other. A single pipe leads from the toilet to a small diversion chamber, from which separate pipes lead to the two underground chambers. The pits should be lined with open jointed brickwork. Each pit should be designed to hold at least 12 months accumulation of FS. Wastewater is discharged to one chamber until it is full with FS. Discharge is then switched to the second chamber. Just before the second chamber is full with FS, the contents of the first pit are dugout, which have been reduced with anaerobic process. Recommended sizes of twin pits as per size of family and number of users have been provided in *Table 3*.

Table 3: Specifications for designing a twin-pit

Type	Number of users					
	Five		10		15	
	Diameter	Depth	Diameter	Depth	Diameter	Depth
Dry pit	900	1,000	1,100	1,300	1,300	1,400
Wet pit	1,000	1,300	1,400	1,400	1,600	1,500

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

Source: CPHEEO, 2013

4.2.2 Capacity of a twin-pit

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

Table 4: Sludge accumulation rates

Material used for anal cleansing	Effective volume in cum per capita per year*		
	Pit under dry conditions	Pit under wet conditions	
		With successive desludging intervals	
		Two years	Three years
Water	0.04	0.095	0.067
Soft paper	0.53	0.114	0.8

* Effective volume is the volume of the pit below the invert level of the pipe or drain.

Source: CPHEEO, 2013

4.3 Bio-digester

Bio-digesters of the kind advocated under SBM are widely used to provide 80 per cent treatment of wastewater from individual household latrine (IHHL), household clusters or institutional buildings where there is no sewerage network. The technology has been developed by DRDO. For more information, see *Figure 13* and *Figure 14*.

4.3.1 Specifications of a bio-digester

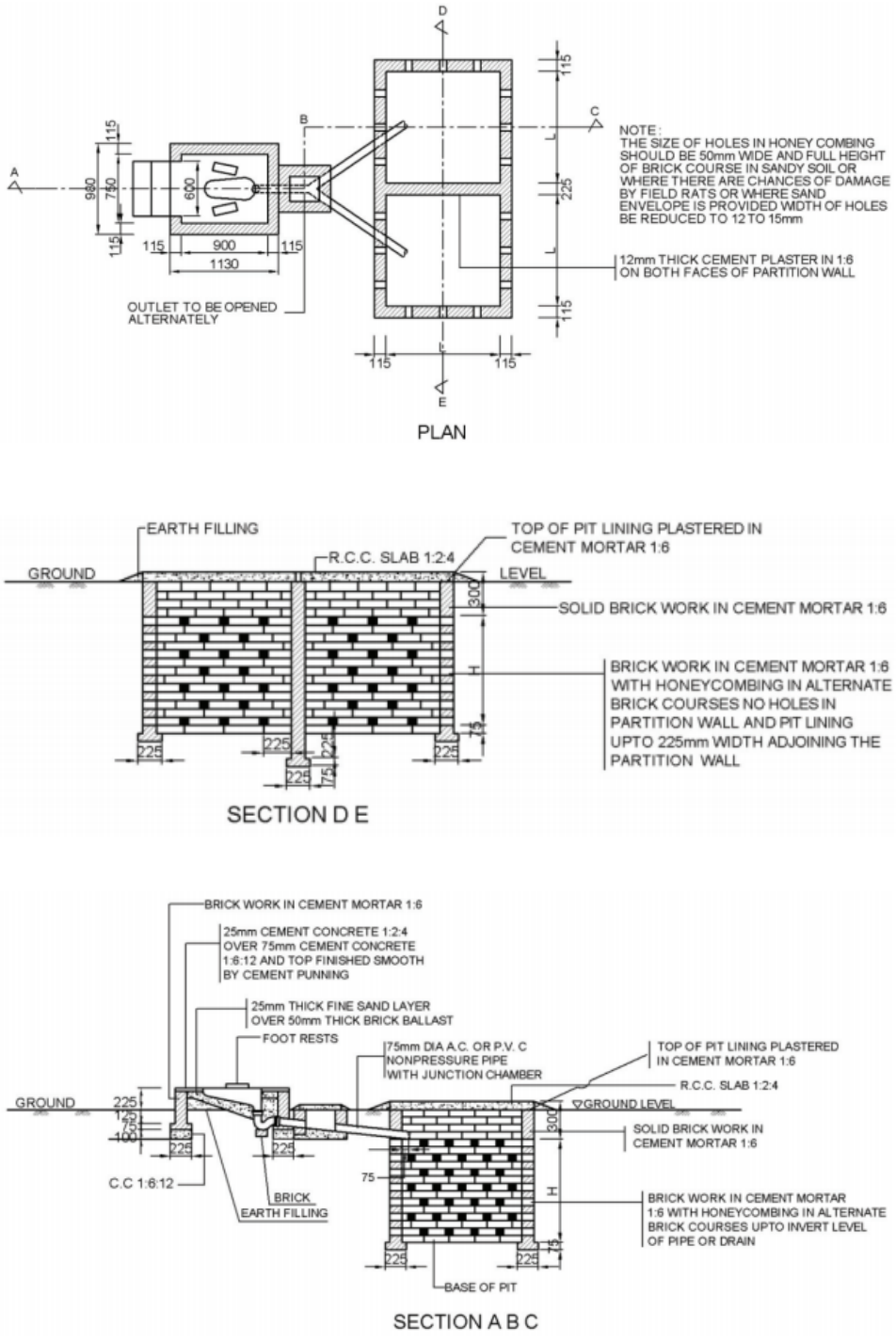
Bio-digester technology has two key components:

- Anaerobic microbial consortium
- Specially-designed fermentation tank

The microbial consortium has been made by acclimatization, enrichment and bio-augmentation with cold active bacteria collected from Antarctica and other low-temperature areas. It is composed of four clusters of bacteria belonging to hydrolytic, acidogenic, acetogenic and methenogenic groups with highly efficient bio-degradation. The fermentation tank is made of metal or fiber glass reinforced polymer (FRP) and has provisions for immobilizing bacteria in large numbers. The following are the specifications for building a bio-digester:

- Land requirement: 25 sq ft.
- Tank's internal dimensions: 1,336 mm x 1,036 mm x 900 mm
- Diagonal partition wall of 8 mm thickness (adequately stiffened by ribs)
- Tank is buried 600 mm deep and anchored by 300 mm long stainless steel (SS-316) anchor bolts at corners
- FRP tanks of 8 mm thickness
- Provision of water sealed outlet from the tank

Figure 12: Structure of a latrine with twin-pits



Source: GIZ-CSE-ECOSAN, 2015

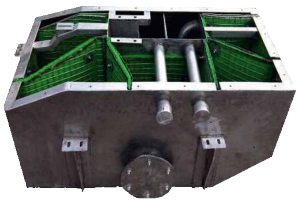
4.3.2 Capacity of a bio-digester

For five–six users, the total capacity:

- 700 litres (1,000 mm x 700 mm x 1,000 mm depth). Where space is a constraint, the depth of the tank can be increased to 1.5 m

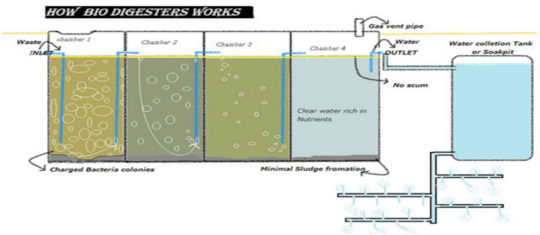
- Volume of anaerobic compartment (30 per cent of the total capacity): 210 litres
- Tank may be constructed with masonry as well [MoUD, 2014]

Figure 13: Image of a bio-digester



Source: DRDO, 2017

Figure 14: Working of bio-digester



Source: DRDO, 2017

4.4 Bio-toilet

This technology is different from DRDO patented bio-digesters as it revolves around aerobic digestion, which involves a different multi-strain bacteria that breaks down waste matter through oxidization (see *Figure 15* and *Figure 16*).

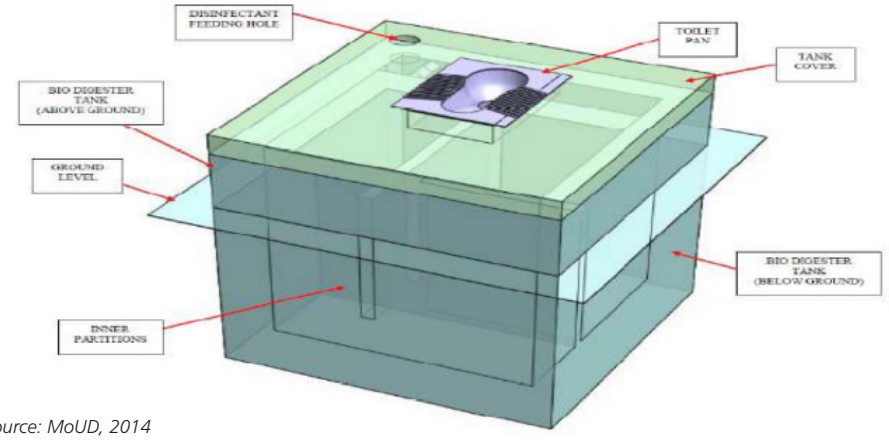
4.4.1 Specifications of a bio-toilet

Bio-toilets are built with multi-chambered bio-tanks in which the waste is stored. The movement of the waste is slowed down as it flows from one chamber to another by a special process in the bio-tank, such that the multi-strain bio-media present in the tank can digest the waste and convert it fully into non-toxic neutral water [MoUD, 2014].

A bio-toilet system consists of:

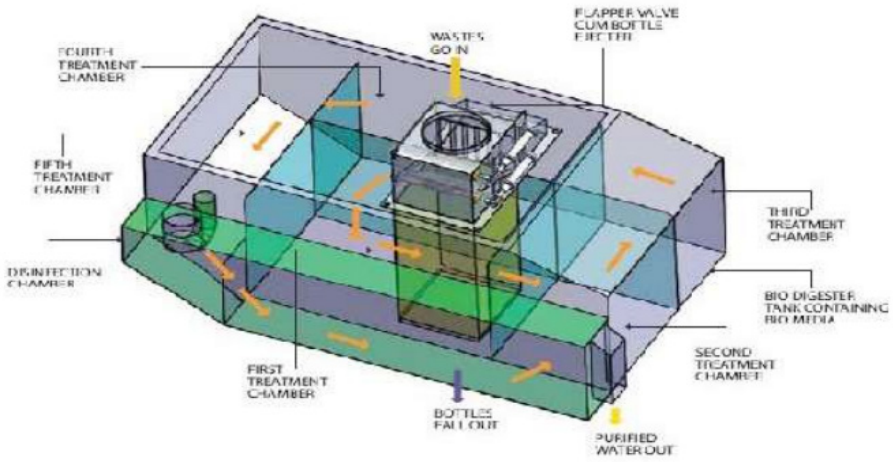
- Bio-digester tanks (bricks and mortar, FRP and steel)
- Superstructure (bricks and mortar and FRP)
- Indian pan and WC
- Size: 4 x 4 ft tank base, 4 ft tank height, 6 ft superstructure height.
- Maximum usage recommended: 30 defecations per day per bio-toilet (no limit on urination)
- Land requirement: 16 sq ft.

Figure 15: Structure of a bio-toilet



Source: MoUD, 2014

Figure 16: Sectional view of a bio-digester



Source: MoUD, 2014

5 Implementing the guidelines

5.1 Institutional roles and responsibilities

In Uttar Pradesh, there are a few institutions at the city- and state-level that take care of FSSM. This section lists the suggestions under the National Urban FSSM policy, which highlights that each state and city needs to formulate its own FSSM strategy and integrate it with their respective state and city sanitation plans, which have to be in overall conformity with the national policy. The roles and responsibility of each level of institution has been enumerated in *Table 5*.

Table 5: Roles and responsibilities of institutions

Institution	Role	Responsibility
Department of Urban Development, Government of Uttar Pradesh	• Technical, financial and administrative support to CNPP • Encourage coordination and cooperation among different agencies • Regulate and help CNPP set up systems to ensure financial sustainability in provision of FSSM services	• Develop state-level FSSM strategies and implementation plans • Develop operative guidelines on FSSM • Training and capacity-building of ULB officials and others engaged in provision of FSSM services • State-level awareness and behaviour change campaigns • Create an enabling environment for participation of the private sector, NGOs and CSOs in provision of FSSM services including to the poor and marginalized households and areas • Funding through specific schemes and plans • Support research and capacity-building in the sector • State level monitoring and evaluation
Directorate, Urban Local Bodies, Government of Uttar Pradesh	Nodal Agency for all FSSM related initiatives at CNPP	• Guiding CNPP for effective implementation of city-level FSSM related strategy • Ensure strict compliance with the provisions of the Prohibition of Employment as Manual Scavengers and their Rehabilitation Act, 2013 by CNPP
Chunar Nagar Palika Parishad	• Administrative support to implementing bodies (like UPJN, UP-SMCG, etc.) of proposed interventions • Encourage coordination and cooperation among all service providers and operators • Create enabling environment for NGOs and private initiatives to achieve safe and sustainable FSSM	• Design, develop, plan and implement ULB-level FSSM strategies • Set up and ensure operation of systems for 100 per cent safe and sustainable collection, transport, treatment and disposal of FSS • Develop expertise, in-house and outsourced, to provide safe and effective FSSM services • Run awareness and behaviour change campaigns to engage diverse stakeholders • Develop training programmes for masons to build requisite skills in the construction of quality septic tanks as per IS codes • Set up systems to ensure financial sustainability in provision of FSSM services • Achieve objectives of National and State FSSM policies in a time-bound manner • Design and implement plans to eliminate manual scavenging and rehabilitate manual scavengers • Funding through specific schemes and plans • Monitor and evaluate FSSM strategies and implementation plans • Implement municipal bye-laws

Institution	Role	Responsibility
Chunar City Sanitation Task Force	• Providing overall guidance to the implementing bodies (like UPJN, UP-SMCG, etc.) of proposed interventions • Approving progress reports provided by the implementing bodies • Approving CSP after consultation with citizens • Issue briefings about the progress to media and state government • Generating awareness amongst city's citizens and other stakeholders • Recommend to the CNPP fixing of responsibilities for city-wide sanitation on a permanent basis	• Review of action plans for declaring the city ODF • Review of execution of ODF action plan periodically • Review progress of individual household toilets and community toilets periodically • Review the action plan and execution of FSSM in the city • Review the action plan for behaviour change communication (BCC) • Actively support citizen mobilization for ODF • Actively support citizen engagement for Swachh Bharat on an ongoing basis • Monitor activities undertaken for thematic drives every fortnight • Review and make recommendations to CNPP on requirements for change in rules and regulations to achieve city-wide sanitation
National or State Mission for Clean Ganga	Financial assistance to project implementing bodies	• Funding the projects for Chunar to achieve effective FSSM
Ganga Pollution Prevention Unit, Uttar Pradesh Jal Nigam	Technical support to CNPP	• Implement and maintain the technical interventions for Chunar to achieve effective FSS and wastewater management • Prepare standard operating procedures (SOPs) for fluent operation of various components across the sanitation value chain
Uttar Pradesh State Pollution Control Board	Assist CNPP to discharge its daily basic obligations to safeguard environment	• Monitor and enforce compliance with environmental laws and rules applicable for safe and effective FSSM • Assist in formulation of advisories, guidelines, SOPs, manuals, etc. to ensure environmental compliance for FSSM operations
Ward Councilors	Help resolve local issues and represent local views in the Municipal Council (Board)	• Lead the ward-level FSSM, IEC and awareness generation programme • Ensure compliance with FSSM bye-laws • Ensure scheduled and regular desludging of all OSSs • Assign representatives for community-level IEC and monitoring
OSS owners	Engage with decision-makers at the state- and ULB-level to ensure they receive good quality FSSM services	• Timely and regular emptying of septic tanks through approved entities • Regular maintenance and monitoring of septic tanks • Timely payment of user fee and charges, if any, towards FSSM services • Practice building bye-laws for construction of OSSs
Academia, research and civil society organizations	Support CNPP in exploring solutions to local issues based on primary research and local observations	• Undertake primary research to further safe and sustainable sanitation • Develop models for safe and sustainable delivery of FSSM services to all • Support implementation of FSSM activities at the ground level • Raise awareness and sensitization regarding the importance of safe city-wide FSSM to all stakeholders • Provide monitoring support to ULBs on any unsafe practices that may impact safe and effective FSSM • Carry out regular interactions with ULB to discuss issues and be a part of solutions
Police	Successful enforcement of FSSM bye-laws	• Patrolling the city and arresting any violators of the bye-laws • Submitting incident reports in a timely manner to CNPP and court

Institution	Role	Responsibility
Panchayati Raj Department, Uttar Pradesh	Coordinate with CNPP and utilize the urban infrastructure for effective FSSM in nearby villages	• Design, develop, plan and implement village-level FSSM strategies • Set up and ensure operation of systems for 100 per cent safe and sustainable collection, transport, treatment and disposal of FSS • Develop expertise, in-house and outsourced, to provide safe and effective FSSM services • Awareness and behaviour change campaigns to engage diverse stakeholders • Develop training programmes for masons to build requisite skills in the construction of quality septic tanks as per IS codes • Set up systems to ensure financial sustainability in provision of FSSM services • Achieve objectives of National and state FSSM policies in a time-bound manner • Design and implement plans to eliminate manual scavenging and rehabilitate manual scavengers • Create funding through specific schemes and plans • Monitor and evaluate FSSM strategies and implementation plans • Enforce by-laws for effective implementation of FSSM
Chunar Technical Support Unit, Centre for Science and Environment	Provide technical support to the FSSM cell of CNPP, with the objective to improve the existing institutional framework	• Provide handholding support in the implementation of action plans and strategies, as listed in the city FSSM guidelines and strategy endorsed by CSTF • Build capacities and sensitize CNPP officials, elected representatives and other stakeholders on improved planning, designing and implementation of effective FSSM • Enable city authorities in the use of GIS-based tools to strengthen monitoring, pre- and post-intervention(s) • Assist CNPP in developing appropriate IT tools like app or website with GPS, to support on-call sanitation services

5.2 Case studies

Case 1: Dumaguete City, Philippines

Dumaguete City started planning its septage management programme in 2006, but due to a conflict with the host community, it was not until 2009 when septage started flowing. The host community was appeased through the promise of employment and investment, which the city has made good on. It is safe to say that six years later, the host community is truly happy with the programme. This was a clear case of turning the NIMBY (not in my backyard) syndrome to PIMBY (please put it in my backyard). Since the construction of the facility, the road into the community has been repaired and a health center has been established—all from the revenue of the septage management programme.

The programme is a joint effort by the city government and the Dumaguete City Water District. The City operates the treatment plant and the Water District conducts the desludging. A tariff of two pesos (about five US cents) was added to the water bill for each cubic meter of water consumed (about US $1 per family per month). District water coverage is at about 95 per cent, so adding the fee to the water bill made sense. The programme was funded through the city's own internal resources. No outside funding was required for the facility construction or purchase of trucks. The initial investment was fully recovered after four years of operation. Meanwhile, the water district scaled up their efforts as well. They developed their own laboratory which became accredited for water and wastewater analysis. They adopted a database to include septage services, and began providing these services.

The city utilized a bottom-up approach to develop the programme. They conducted a stakeholders meeting and assigned a Technical Working Group to make recommendations on technical issues. A local ordinance was drafted and approved, which became the model ordinance adopted by the Philippines Department of Health. The ordinance is printed in the Operations Manual on the Rules and Regulations Governing Domestic Sludge and Septage, Philippines Department of Health, 2008.

In order to implement scheduled desludging, the city was sub-divided into zones and a schedule was developed. Promotion campaigns were conducted to raise interest and awareness about the programme, and these were phased-out in time. The collection programme operates with seven trucks of between 1.5 cubic meters and six cubic meter capacity. Tanks are fabricated on-site with a staff welder for significant cash savings. One full-time mechanic manages the vehicles while relying on some helpers from time to time.

The site for the treatment plant is a two-hectare plot located on the banks of the Okoy River. The treatment plant uses a collection station with trash screen and grit chamber, followed by a series of lagoons and wetlands to achieve very high levels of wastewater treatment. Effluent BOD and TSS are both typically less than 20 mg/l—not bad for a totally passive system. Nineteen workers are employed to operate and maintain the facility, including operators, security guards and landscape staff.

Case 2: Mumbai, Maharashtra, India

Background

Naval Civilian Housing Colony is a residential housing neighbourhood for officers and their families situated in Kanjurmarg, Mumbai, India. The colony has 20 blocks of buildings with residential facilities, a mess, hospital, sports complex, market area and administrative offices. The SBT-based DWWTs treats wastewater generated from seven residential building blocks—each building having 24 apartments.

Wastewater and effluent management

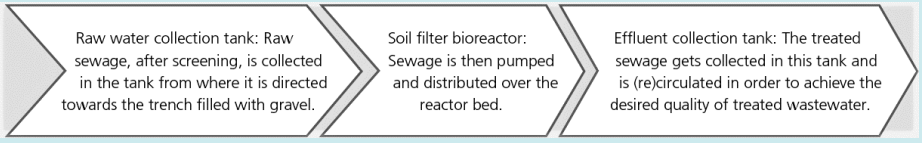
SBT is a green technology for water purification using a natural and novel high-efficiency oxidation process at competitive costs.

Features

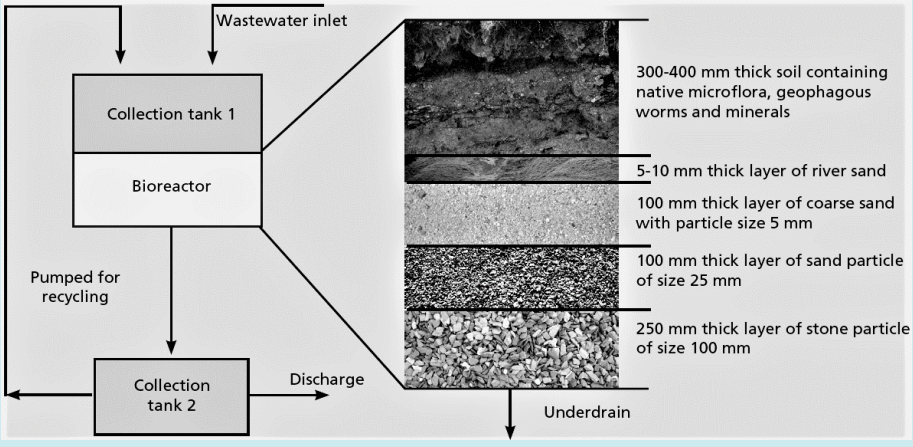
Natural processes-based wastewater treatment with a capacity to treat 50 KLD.

Minimal energy consumption (40–50 kWh per MLD to pump the wastewater for distribution over the reactor bed)

The DWWTs creates an alternate resource of water that is used to maintain the green area inside the residential premises (CSE, 2019).



Schematics of SBT and the bioreactor showing different layers of filter materials



6 Annexures

6.1 Legislative and regulatory provisions for FSSM

Policy	Existing key focus	Provision for FSSM
National Urban Sanitation Policy (NUSP), 2008	Prioritizes state-wide sanitation strategy and city sanitation plans (CSP) with a focus on service-level benchmarks. The policy envisages a city sanitation task force	Provision for septage management exists but is not captured in service-level benchmarks
National Urban Faecal Sludge and Septage Management Policy, 2017	Recognition of FSSM as a sanitation solution	The focus is non-sewered areas; equal emphasis needs to be put on onsite and offsite sanitation systems
Plan, scheme and mission	Existing key focus	Provision for FSSM
National Mission for Clean Ganga, 2011	Pollution abatement and rejuvenation of River Ganga; and maintaining minimum ecological flow to ensure water quality	20th Executive Committee Meeting of NMCG sanctioned a model Faecal Sludge and Septage Management Project for Chunar, Mirzapur
National Urban Livelihood Mission, 2013	Reduce poverty and vulnerability of the urban poor by providing them self-employment and skilled wage employment opportunities, resulting in an appreciable improvement in their livelihoods on a sustainable basis	Provision for training of manual emptiers and promoting innovative techniques and business models for desludgers.
Swachh Bharat Mission, 2014	Prioritizes open defecation-free India, and also emphasizes on provisions for containment systems with specified dimensions	Focus on ending open defecation with safe management of FSS and wastewater being secondary
Pradhan Mantri Awas Yojna, 2015	Provision of houses with a toilet (along with containment systems and wastewater management through sewers), with no focus on other components of the FSSM value chain	Refers to the SBM Guidelines for design integration of containment systems
Guidelines	Existing key focus	Provision for FSSM
Environment Impact Assessment (EIA), 2006	Clearance for scheduled development projects that are likely to result in significant environmental effects	Environmental factors are not considered; e.g., consumption of water, wastewater generation and septage management
Advisory Note on Septage Management, 2013	Development of a septage management sub-plan as part of a city sanitation plan	Recommends septage management as an essential component for citywide sanitation
Urban and Regional Development Plans Formulation and Implementation (URDPFI) Guidelines, 2014	Propose how land will be used for different purposes in urban centres	Provides a relatively wide scope under the city sanitation plans by talking about septage management and wastewater
Model building bye-laws, 2016	Tools used for construction and design aspects of buildings in a development area	Clearance by ULBs, with standard reference to the BIS codes
Septage Management: A Practitioner's Guide, 2017	Guideline for effective FSSM; integrating it into city sanitation planning	Explains all stages of the sanitation chain for urban centres dependent on onsite sanitation systems, along with innovative tools that can be used to assess and plan for improving each stage

Policy	Existing key focus	Provision for FSSM
Draft Guidelines for faecal sludge and septage management, Uttar Pradesh, 2018	Prioritizes CSPs with a focus on service-level benchmarks. The guideline envisages a city sanitation task force	Captures FSSM in a persuasive manner describing in detail the technology options, FSSM approach as well as the milestone and timeline which needs to be followed.
Standard Operating Procedures for Cleaning of Sewers and Septic Tanks, 2018	Aims to eliminate hazardous cleaning or at least to avoid accidents due to improper practice of cleaning of sewers and emptying of septic tanks, thereby, preventing human casualties	Provides information on procedures to be followed for safe emptying of containments and recommends scheduled desludging of all containment systems at a frequency of less than two years
Act	Existing key focus	Provision for FSSM
The Water (Prevention and Control of Pollution) Act, 1974 and Environmental Protection Act, 1986	Provide provisions for prevention and control of water pollution and for the maintaining or restoring of wholesomeness of water in the country	No dedicated mention of FSSM
Uttar Pradesh Water Supply and Sewerage Act, 1975	Facilitates the establishment of corporations, authorities and organizations for the development and regulation of matters of water supply and sewerage services	Empowers ULBs to fine owner(s) of improperly designed and damaged onsite sanitation systems
The Prohibition of Employment as Manual Scavengers and their Rehabilitation Act, 2013	Prohibits the dehumanizing practice of manual scavenging by eliminating the dual evils of insanitary latrines and the highly iniquitous caste system	Focuses on conversion of insanitary toilets to sanitary toilets and providing training in livelihood skills and financial assistance to manual scavengers
Agency for defining standards	Existing key focus	Provision for FSSM
Bureau of Indian Standards (BIS)	Provides standards for building materials and components	Provides the standards for building of a septic tank along with user interface description
Central and Uttar Pradesh Pollution Control Boards	Advise the Central and state government on any matter concerning prevention and control of water and air pollution, and achieving improvement in the quality of air; as well as preparing manuals, codes and guidelines relating to treatment and disposal of treated effluents	No specific guidelines or norms for FSSM, but the effluent discharge norms for STPs can be followed for FSSTPs

Source: Compiled by CSE

6.2 Minutes of the CSTF meeting held on 1 June 2017 in Chunar

स्वच्छ गंगा मिशन योजनान्तर्गत सिटी सेनिटेशन प्लान (सी.एस.पी.) तैयार किये जाने हेतु आज दिनांक 01.06. 2017 को अपरान्ह 02.00 बजे टास्क फोर्स की बैठक मा0 श्रीमती हसीना बेगम अध्यक्ष नगर पालिका परिषद चुनार/अध्यक्ष टास्क फोर्स की अध्यक्षता में पालिका सभागार में सम्पन्न हुई। बैठक दिनांक 01.06.2017 की कार्यवृत्ति –

शहरी स्वच्छता कार्यबल की द्वितीय बैठक में आमंत्रित कार्यबल के सदस्यों के हस्ताक्षर कर अध्यक्ष महोदया की अनुमति से बैठक प्रारम्भ	सर्वप्रथम श्री शमशेर सिंह जलकल प्रभारी द्वारा समस्त उपस्थित सदस्यों का धन्यवाद करते हुए द्वितीय स्वछच्छता कार्यबल की बैठक में विस्तार से एफएसटीपी के संबंध में बताया गया, जिस पर उपस्थित सदस्यों द्वारा वार्ता की गई, गत बैठक दिनांक 21.3.2017 सहमति/अनुमोदन किया जाता है। अध्यक्ष महोदया द्वारा आज की सीएसटीएफ बैठक के लिए सहमति प्रदान किया गया।
बिन्दू सं0 1 – एफएसटीपी निर्माण हेतु भूमि उपलब्ध व कार्ययोजना पर विचार	सर्वप्रथम श्री शमशेर सिंह जलकल प्रभारी द्वारा एफएसटीपी के भूमि उपलब्धता एवं मौके का स्थल निरीक्षण के संबंध में बताया गया। सीएसई नई दिल्ली से आये, श्री राजरतन सरदार व श्री सुमित कुमार गौतम द्वारा उपस्थित सदस्यों के समक्ष विस्तार से एफएसटीपी के संबंध में बताया गया, जिस पर समस्त उपस्थित सदस्यों द्वारा चिन्हित भूमि पर एफएसटीपी बनाने हेतु आवश्यक कार्यवाही करने एवं भूमि की स्वीकृति हेतु अध्यक्ष द्वारा निर्णय लिया गया। इस संबंध में सीएसई ने चुनार में सर्वे की गई भूमि जिस पर एफएसटीपी योग्य भूमि के बारे में एक प्रजेन्टेशन दिया, विस्तार पूर्वक विचार विमर्श के पश्चात सीएसटीएफ सदस्यों द्वारा रामबाग के पास वार्ड नं0 11 में आराजी सं0 363, जो वर्तमान में बीहड़ भूमि में वर्गीकृत है, को सबसे उपयुक्त मानते हुए उस भूमि का सर्वे और टेक्निकल धरातरलीय अध्ययन करने के लिए सहमति प्रदान की जा रही है।
बिन्दू सं0 2 – स्टेटस रिपोर्ट	सिटी सेनिटेशन प्लान (सी.एस.पी.) तैयार किये जाने हेतु स्टेटस रिपोर्ट पर विचार विमर्श किया गया, जिस पर सभी सदस्यगण विचार करते हुए यह तय किया गया कि गंगाजी जो कि अब अत्यधिक प्रदूषित हो चुकी है, और कही कही नाले जैसी स्थिति हो गई है, व स्वच्छ बनाने हेतु स्वच्छ गंगा मिशन योजनान्तर्गत एक सेनिटेशन प्लान तैयार किया जाना चाहिए, जिससे नगर पालिका परिषद चुनार एक माडल सिटी कहलाये।

बिन्दू सं0 3 – सीएसई प्रतिनिधि के द्वारा सीएसई पर प्रस्तुतिकरण आदि किया जाना।	सी.एस.सी. प्रतिनिधि श्री राजरतन सरदार द्वारा प्रस्तुतिकरण किया गया कि उसमें दर्शाया गया कि शहर से निकलने वाला 89 प्रतिशत फीकल स्लज वातावरण को प्रदूषित करता है, जब कोई व्यक्ति अपना टायलेट खाली कराता है तो शहर के बाहर कही भी खुले स्थान या नाला में डाल देता है, जिससे वातावरण प्रदूषित होने के साथ साथ कई तरह की बीमारियां भी फेलती है, इससे बचने के लिए फीकल स्लज को ट्रीटमेंट किया जाना आवश्यक है।
बिन्दू सं0 4 – एफ.एस.एम. टेक्नोलाजी पर विचार।	एफ.एस.एम. टेक्नोलाजी के अन्तर्गत फीकल स्लज को ट्रीटमेंट प्लान में ले जाकर उससे खाद तैयार की जाएगी, तथा खाद्य का किसानों को बेच दिया जाएगा, तथा निकलने वाले पानी को ट्रीटमेंट करने के उपरान्त कृषि कार्य हेतु एवं बागवानी हेतु या गंगा जी में छोड़ दिया जाएगा।

अधिशासी अधिकारी
नगर पालिका परिषद चुनार

प्रतिलिपि– अध्यक्ष/सदस्य टास्क फोर्स के सदस्यगण को सूचनार्थ एंव आवश्यक कार्यवाही हेतु प्रेषित।

अधिशासी अधिकारी
नगर पालिका परिषद चुनार

6.3 Service-level benchmarks for sanitation

S. no.	Current SLB indicators (sewerage system)	Proposed sanitation benchmark (sewerage + onsite sanitation systems)
1	Coverage of sewerage network services	Coverage of adequate sanitation systems
	Total number of properties with individual connections to sewerage network as a percentage of total number of properties in the city	Percentage of households with individual or group toilets connected with adequate sanitation systems (sewer network, septic tank or double-pit system) among the total households in the city
2	Collection efficiency of sewerage networks	Collection efficiency of sanitation systems
	Quantum of sewage collected at the intake of the treatment plant to the quantity of sewage generated (as per CPHEEO, 80 per cent of water consumed is generated as sewage)	Weighted average collection efficiency of each sanitation system, weighted by share of households dependent on each sanitation system
3	Adequacy of sewage treatment capacity	Adequacy of treatment capacity of sanitation system
	Adequacy is expressed as secondary treatment capacity available as a percentage of normative wastewater generation	Weighted average of adequacy of treatment plant capacity available for each sanitation system, weighted by share of households dependent on each sanitation system
4	Quality of sewage treatment	Quality of treatment of sanitation system
	Quality of treatment is measured as a percentage of wastewater samples that pass the specified secondary treatment standards, that is, treated water samples from the outlet of STPs are equal to or better than the standards laid down by government of India agencies for secondary treatment of sewage	Weighted average of quality of treatment of each sanitation system, weighted by share of households dependent on each sanitation system
5	Extent of reuse and recycling of sewage	Extent of reuse and recycling in sanitation system
	Quantity of sewage that is recycled or reused after secondary treatment as a percentage of quantity of sewage received at the treatment plant	Weighted average of extent of reuse of treated wastewater and sludge after adequate treatment as a percentage of sewage and sludge received at the treatment plant, weighted by share of household dependent on each sanitation system

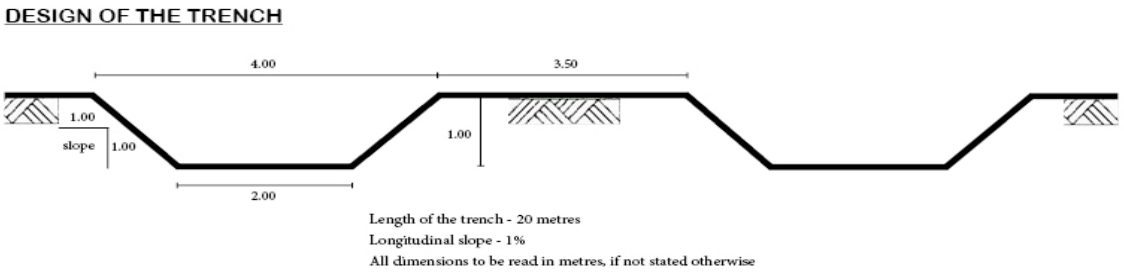
Source: MoUD, 2017

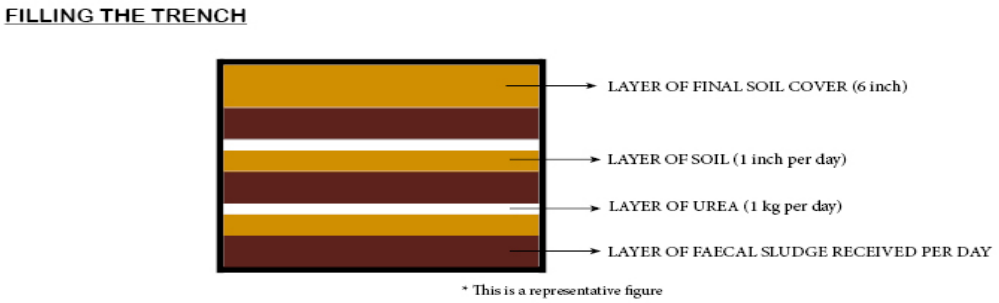
6.4 Trenching guidelines for site selection and monitoring

S. no.	Activity	Remarks
1	Site selection criteria	
	Identification of possible sites	
	Site above high flood level (HFL)	
	Site not prone to water-logging	
	Water table deeper than 15 ft from the bottom level of the trench	If not refer to point 2f
	Surfacewater body at a minimum distance of 45 ft	If not refer to point 2f and 2g
	Soil type: Porous	
	Site terrain: Flat	
	Distance between nearest habitation and site at least 200 m	
	All-weather road accessibility for cesspool emptier vehicles	
	Compatible to usage by adjacent and neighbouring properties	
	Distance of site from town centre at least 15 km	
	GPS tagging of the DRE site	
2	Design criteria	
	Top width of the trench: 3 m	
	Bottom width of the trench: 1.5 m	
	Height or depth of the trench: 1.5 m	
	Length of the trench: 10 m	
	Distance between two trenches: 3.5 m	
	Lining of trench bottom with 1 ft of sand	Only in case of non-compliance to points 1d and 1e
	Lining sides of trench with agri-film or thick PVC sheets	Only in case of non-compliance to point 1e

Source: Compiled by CSE, 2019

Design of a trench





Source: WASH Institute, 2019

6.5 Legal framework and site selection for FSSTP

Although not a single statute or regulation which is directly applicable for site selection of FSSTP exists, many laws are indirectly applicable to FSSTP, listed as follows:

- Solid Waste Management Rules, 2016
- Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016
- Need to obtain consent to establishment and consent to operate (CtE and CtO respectively) or no-objection certificate (NoC) from SPCB or CPCB
- Orders of National Green Tribunal issued till August 2019
- Acts and standards listed in *Annexure 6.1*; among others.

Scoring guide for the screening of sites for FSSTP

S. no.	Parameters	Maximum score	Scoring method for FSSTP
1	Ownership of land	10	ULB-owned land: 10; State government land: 8; private land: 4; under any dispute: 0
2	Availability of land	10	Immediately available: 10; available in one–three months: 6; available in more than three months: 3
3	Distance from residential area or habitat	10	Within 100 m: 0; within 100–500 m: 3; 0.5–1 km: 7; 1–3 km: 10; 3–5 km: 7; more than 5 km: 3
4	Approach road	5	No approach road: 0; wide approach road through the colony: 2; narrow road but not through the colony: 4; wide road: 5
5	Visibility and impact	15	At a prominent location where good public transportation is available up to the site: 15; good road with public transport and a display board that can enhance visibility: 10; good road but no visibility (interior area): 5; unreachable to common people for demonstration: 2
6	Reuse option for treated effluent and dried manure	15	Chance of reuse of effluent in agriculture: 15, partial reuse of effluent and demand of manure expected: 10; partial use (either effluent or manure): 5; no chance of reuse of effluent but only for disposal and reuse of manure: 2
7	Disposal of treated effluent	5	Under gravity: 5; partial under gravity and pumping: 3; entire pumping – 0
8	Social acceptability. Is there any chance of causing public nuisance?	10	No probability: 10; issues may arise but involvement of relevant stakeholders can address the issue: 5, likely chances of dispute: 0
9	Chances of flood in the area	10	No history of flood: 10; no flood in recent years: 7; occasionally flooded site: 5; flood prone: 0
10	Is there any water body adjacent to the site?	10	Water body nearby (within 100 m): 2; 100–200 m: 4; 200–500 m: 8; 0.5–1 km: 10
	Maximum total	100	

Source: Compiled by CSE

Selection of a suitable site for FSSTP warrants an integrated approach comprising of multiple social, economic, technical and regulatory criteria. The ownership status of the land is also an important parameter as it requires additional financial resources. Social factors like willingness of the local communities to have FSSTP in their backyard must also be considered during selection of the sites. Technical specifications like vicinity of agricultural fields and water bodies for the discharge of treated wastewater or sludge, depth of groundwater, and geological formations also need to be considered.
In view of the these, a detailed 10 point checklist covering key aspects has been prepared. Each site should be physically visited and discussions should be held with local communities residing in nearby areas and with CSTF members. Based on the compilation of the aforementioned information, a matrix should be filled by giving score to each of the site against predetermined key parameters (with a maximum score: 100) as shown in *Table 6*.

Scores accrued against each point should be tabulated for each site. Sites having the highest score should be selected as the first choice.

6.6 Tendering process for FSSTPs

6.6.1 List of activities and steps for tendering of an FSSTP

1. Expression of interest (optional)
The implementing agency expresses its desire for implementing a project and asks potential players in the market to send tentative proposal, including details related to work experience, company credentials, etc. This helps the implementing agency to assess the existing market scenario regarding such projects and fine-tune its detailed tender document.

2. Finalization of the tender approach
- In-house design, item rate contract and O&M service contract.
- Turnkey and EPC contract upto commission and combined or separate O&M contract (normally five years)
- PPP contract (user fee- or annuity-based) with 10–15 years O&M

3. Technical sanction from competent authority
Depending on the department code, state PWD code, or state municipal statute, the power to sanction a project up to a particular cost and type of contract lies with an officer or engineer of various ranks. The scrutiny of the project design, cost and tender approach is done at this stage.

4. Administrative sanction from competent authority
Depending on who the implementing agency is and the project cost, the power to give administrative approval lies either with the executive officer or municipal commissioner, or the relevant state department (Director, municipal administration or local bodies). Alternatively, it may require cabinet approval (beyond a certain cost). A PPP project normally requires approval from the Empowered Committee for Infrastructure (ECI). During the administrative sanction of a project, issues related to the availability of funds for its capex and opex are examined. The structure of the tender is also scrutinized.

5. Issue of tender notice
The project implementation authority issues notice or advertisement in relevant state or national newspapers (statutory requirement) regarding the intent to implement the project with a brief about the project, key dates, including the

availability of the detailed tender document (DNIT, DTCN), request for proposal or draft concession agreement, pre-bid meeting date, etc.

6. Issue of detailed tender conditions notice (DTCN) or detailed notice inviting tender (DNIT) or request for proposal (RFP) with draft concession agreement (CA)

As per the date mentioned in the tender notice, the document is either uploaded in the e-procurement website or website of implementing agency or sale of hard copy in case of a paper tender. This document contains detailed information relating to the eligibility criteria, scope of work, documents to be submitted in the bid, contractual conditions, technical specification etc.

7. Pre-bid meeting

Potential bidders put forward any clarifications required or suggestions related to the tender. The authority normally has the right to accept or reject suggestions.

8. Corrigendum and addendum

In case of any corrections or additions related to any dates, eligibility criteria, scope of work, documents to be submitted in the bid, contractual conditions, technical specification, etc., a corrigendum or addendum is issued.

9. Bid due date or bid submission date

This is the last date for submission of the bid. The bid normally includes a technical bid which includes a company's credentials related to eligibility of the project and a financial bid which includes the quote (i.e., the price at which the company wishes to undertake the project).

- In case of e-tendering, the same has to be uploaded to the website. Certain documents like a demand draft for document fees, bank guarantee for EMD, company credentials, etc., need to be sent as a hard copy.
- In case of paper tender (following the two-envelope system), two separate sealed envelopes with technical and financial bids respectively are to be submitted.

10. Technical bid opening

The authority opens the technical bid and checks for completeness related to the submission of all documents (i.e., responsiveness of the bid). Incomplete bids are rejected.

11. Pre-qualification (optional, depending upon statutory requirement)

In some cases, companies are pre-qualified based on certain key conditions. Technical evaluation is only done for qualified companies.

12. Technical evaluation

The company credentials are checked vis-a-vis the eligibility of the tender. In some cases, marking is done based on criteria set in the tender document where minimum marks are needed to qualify. The companies meeting the criteria are invited for financial bid opening.

13. Financial bid opening

Financial bids are opened and made public. The L1 bid is assessed to check if it is too high or low, and if it is acceptable as per the procurement guidelines of the authority.

14. Bid negotiation (not allowed in certain cases)
In case the bid of a successful bidder is very high, negotiation can take place with the L1 bidder to reduce the price. No change in the scope is allowed at this stage.

15. Tender or bid approval
Depending on who the implementing agency is and the project cost, the power to give tender or bid approval lies either with the executive officer, the municipal commissioner (Mayor in some cases) or the state department (Director, municipal administration or local bodies) or might require cabinet approval (beyond certain cost). A PPP project normally require approval from ECI. During this stage, assessment is done whether the tendered cost is within the budget, and whether the tendering process was done as per the necessary rules and regulations.

16. Letter of award to the successful bidder by the authority or project implementing agency.

17. Submission of performance guarantee by the successful bidder
A performance bond, also known as a contract bond, is a surety bond issued by an insurance company or a bank to guarantee satisfactory completion of a project by a contractor. The term is also used to denote a collateral deposit of good faith money, intended to secure a future contract, commonly known as margin.

18. Signing of the contract.

6.7 Business models for FSSM

In the present scenario, the FSSM is majorly in the hands of private operators. The operators charge for emptying service provided to different stakeholders. Emptying points can be from individual households, residential colonies, commercial establishments, institutions, toilet complexes, offices, etc. Generally, operators are called for emptying only when the containment is full. The fee for emptying varies widely. Due to absence of dedicated disposal sites, private emptiers practice illegal dumping of FSS into water bodies, utterly disregarding the threat posed to human health and environment. They run their business without paying any fees to government authorities which means that despite high charges collected from customers, no revenue is generated by government authorities from the emptying business. Farmers in whose fields the collected FSS is disposed of also pay the private operators (in some cases).

6.7.1 Generic business model for FSSM

A business model not only depicts the financial spending of an institution towards a better FSSM, but reflects a return on investment. A business model consists of four interlocking elements:

- *Customer value proposition (CVP):* Products that create value for a target customer
- *Cost structure:* All costs incurred to operate the business model
- *Profit formula:* Revenue streams from each component of the sanitation
- *Key resources:* Most critical activities required for the business

For a business model of any institution working in the spectre of FSSM, the four elements should create and provide value to customers. The value propositions

can be divided into multiple segments, but in this guideline, we have restricted them to five types as listed below:

Value proposition 1: Access to toilets and treatment for end-use—providing an improved sanitation service to communities through access to toilets, and recovery of nutrients or energy through treatment of FSS.

Value proposition 2: Emptying and transportation of faecal sludge—providing a timely sanitation service for emptying pits and septic tanks at an appropriate frequency.

Value proposition 3: Treatment of FSS for disposal—a healthier and safe environment through appropriate treatment of FSS.

Value proposition 4: End-use through nutrient recovery—producing high quality compost as a soil conditioner.

Value proposition 5: End-use through energy recovery—improving access to energy.

Depending on the value proposition offered by the business, its customer segment will vary. For a business providing emptying and transportation services, the customer segment is individual households, community toilet and institutions. A generic business model canvas is described in *Table 7*. Government could charge for following activities by private operators and septic tank owners to generate revenue in order to sustainably run the FSSM programme:

- Permits and their renewal for private operator through registration process
- Charges to repair faulty design through registered masons and plumbers
- Fine against defaulters (private operator or containment owners) for not following instructions given by government agencies

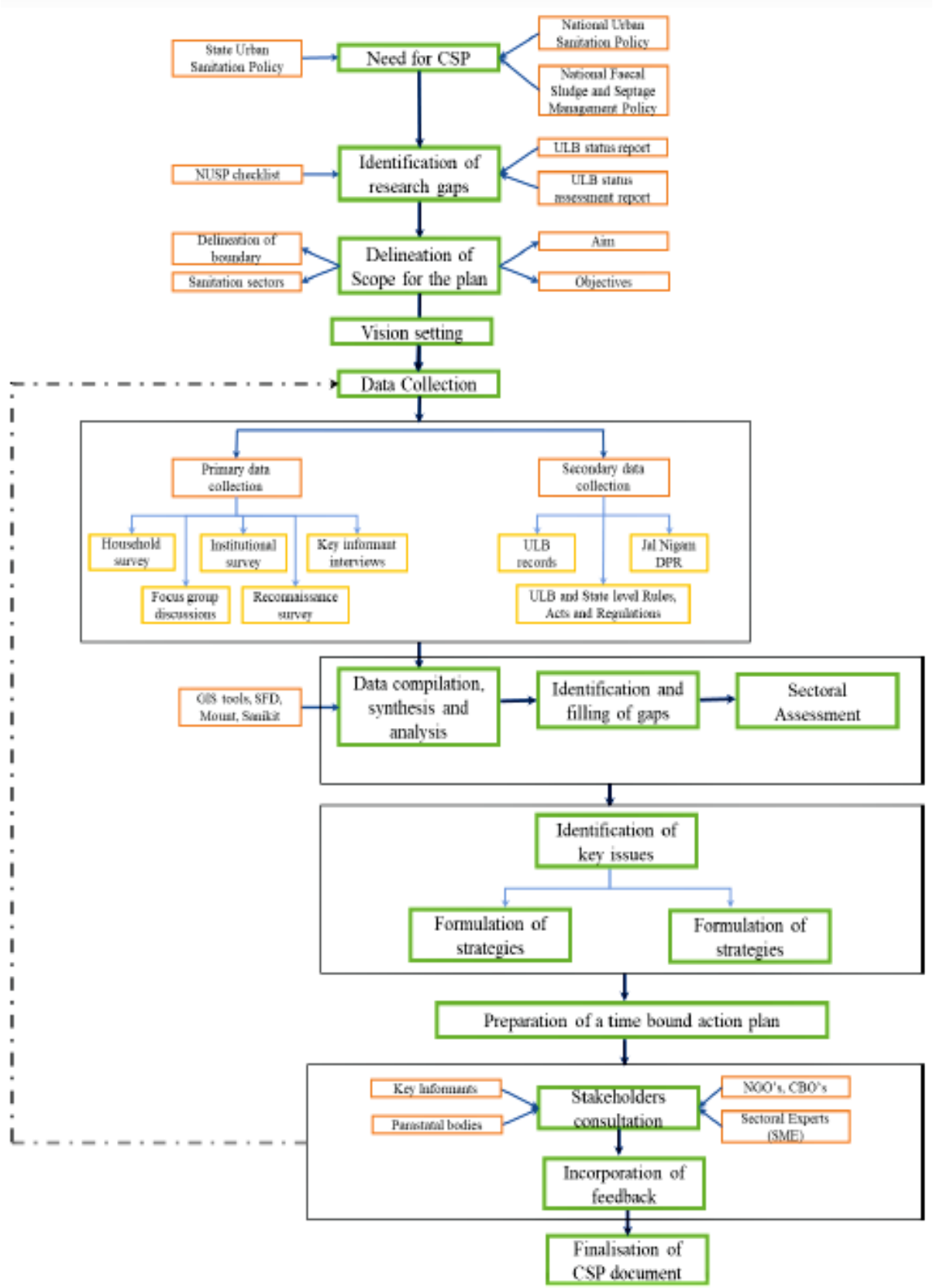
Generic business model canvas for FSSM

<table>
<tr><th>Key partners</th><th>Key activities</th><th>Value propositions</th><th>Customer relationships</th><th>Customer segments</th></tr>
<tr><td rowspan="10">• Municipal corporation and local authorities
• Technology suppliers
• Financial institutions
• Community-based organizations
• Research and development institutions (e.g., local university)</td><td>• Toilet provision
• Waste collection</td><td>VP1: Access to toilets and increased revenue from end use</td><td>• Direct sale of toilets</td><td>• Community
• Businesses</td></tr>
<tr><td>• FS collection</td><td>VP2: Timely emptying and transportation of FS</td><td>• One-on-one service provision
• Contracts with municipality
• Direct or through contracts</td><td>• Households
• Businesses</td></tr>
<tr><td>• FS treatment</td><td>VP3: FS treatment for healthy and safe environment</td><td>• Direct compost sales</td><td>• Municipality</td></tr>
<tr><td>• Organic waste and FS collection
• Compost production
• Compost: Sales and marketing</td><td>VP4: High-quality compost (soil ameliorant)</td><td>• Distributors
• Direct energy sale</td><td>• Farmers
• Municipal park department
• Agriculture department
• Agroforestry
• Fertilizer industry</td></tr>
<tr><td>• Biogas production
• Biogas sale</td><td>VP5: Reliable and renewable energy service</td><td>• Power purchase agreement</td><td>• Households
• Community
• Small businesses</td></tr>
<tr><td>• Customer relation-ship management</td><td rowspan="4"></td><td></td><td>• Public sector (e.g., municipality, ministry, etc.)
• Institutions</td></tr>
<tr><td>Key resources</td><td>Channels</td><td rowspan="3"></td></tr>
<tr><td>• Appropriate technology and equipment
• Labour
• Finance
• License and contracts for collecting waste</td><td>• Direct
• Municipality
• Word-of-mouth
• Brochures and other media communications</td></tr>
<tr><td></td><td>• Distributors and extension agents</td></tr>
<tr><td colspan="3">Cost structure</td><td colspan="2">Revenue streams</td></tr>
<tr><td colspan="3" rowspan="2">• Fixed investment cost (construction, trucks, equipment, etc.)
• Operation and maintenance cost (labour, raw material input, utilities, sales and marketing, licence, etc.)
• Interest payments</td><td>• Sale of toilet and end use products</td><td>• FS disposal fees, sanitation charge and O&M budget support</td></tr>
<tr><td>• Emptying fees and, in some instances, FS delivery fees</td><td>• Sale of compost
• Sale of Energy</td></tr>
<tr><td colspan="3">Social and environmental costs</td><td colspan="2">Social and environmental benefits</td></tr>
<tr><td colspan="3" rowspan="2">• Potential health risk for those in direct contact with FS (can be mitigated with the use of protective equipment)
• Improper FS treatment and disposal causing environmental and health risks for citizens</td><td rowspan="2">• Reduced pollution of water bodies and soils
• Reduced human exposure to untreated FSS
• Job creation</td><td>• Improved soil and agricultural productivity</td></tr>
<tr><td>• Improved energy security</td></tr>
</table>

Note: Colours indicate relevance to corresponding value proposition (VP). Beige is applicable to all VPs

Source: Rao, et al., 2016

6.8 Approach and methodology for CSP preparation



6.9 Application form for a licence to collect, transport and dispose of FSS

Application form for license for collection, transportation and disposal of Faecal Sludge & Septage in Chunar Nagar Palika Parishad

Paste Self Attested Recent Passport Size Photograph

1. Name(s) of the applicant: (Mr / Ms) _____

_____

2. Nationality: (Indian / Other) _____

3. Address of correspondence: _____

_____

4. Address of Head Office/Regd. Office: _____

_____

5. Telephone Numbers: (O) _____ (M) _____

6. Email ID: _____

7. Registration No. of vehicle(s):

(i) _____ (ii) _____

(iii) _____ (iv) _____

8. Fitness certificate of the vehicle(s) valid upto:

(i) _____ (ii) _____

(iii) _____ (iv) _____

9. Insurance of the vehicle(s) valid upto:

(i) _____ (ii) _____

(iii) _____ (iv) _____

10. Pollution certificate of the vehicle(s) valid upto:

(i) _____ (ii) _____

(iii) _____ (iv) _____

11. Vehicle(s) whether fitted with GPS tracker (Yes/No): _____

12. Details of payment of processing fee for license

D.D. No.: _____ Date: _____ Bank: _____

13. List of attached documents (self-attested copy) (*tick √*):

☐ Identity Proof ☐ Registration Certificate(s) ☐ Pollution Certificate(s) ☐ Address Proof

☐ Fitness Certificate(s) ☐ Driving License ☐ Certificate(s) of Insurance & Policy Schedule

☐ Passport size photographs ☐ List of employees

Total number of attachments: _____

I/We certify that information given by me/us in column 1 to 13 are true to the best of my knowledge and belief. I also certify that I have read and understood the attached terms & conditions and agree to abide by them. I agree that if any information given by me is found wrong the application for license will be liable for cancellation at any time.

Signature of applicant(s)

Date: _____

Terms and conditions:

I. Faecal sludge and septage (FSS) shall be collected and transported only by an agency having a valid licence for this purpose issued by the Chunar Nagar Palika Parishad (CNPP).

II. The fee for collection and transportation of FSS to the faecal sludge and septage treatment plant (FSSTP) shall be as prescribed by CNPP from time to time. No licencee shall charge any amount from the OSS owner in excess of the prescribed fee.

III. FSS shall be transported only in vehicles approved for this purpose by an officer authorized for this purpose by CNPP.

IV. The licencee shall ensure that there is no leakage of FSS during transportation from the collection point to the FSSTP.

V. The vehicle carrying FSS shall be fitted with prescribed equipment to take care of threat of pollution due to any accident during transportation from desludging point to the FSSTP.

VI. Each vehicle used for transportation of FSS shall be fitted with a GPS device and access rights of the same shall be given to CNPP and the agency notified by CNPP for tracking of such vehicles.

VII. The licencee shall be fully and completely liable for any damage to any person, vehicles, property and environment in case of any accident or disaster.

VIII. A copy of the licence shall be prominently displayed on the vehicle used for transportation of FSS.

IX. The vehicle or tanker shall be painted with yellow colour duly marked with the precaution in red colour 'SEPTIC TANK WASTE' (in English) and "मलकुंड अपशष्टि" (in Hindi).

X. The licencee shall dispose of FSS only at notified locations.

XI. FSS will be received at an FSSTP on all days from 7 a.m. to 7 p.m. The licencee shall plan the trip in such a way that the decanting can be done within the given time slot.

XII. The licencee shall be responsible for regular training of the staff deployed to provide effective services of collection, transportation and disposal of FSS, and use of protective equipment for taking measures to minimize the damage to the environment in case of an accident.

XIII. The licencee shall be responsible for ensuring that every staff member undergoes a health check-up at least once every year and submit record of the same to CNPP at the time of the renewal of licence.

XIV. Staff deployed by the licencee shall be insured for accidents during the process of cleaning, transportation and disposal of FSS.

XV. In case of violation of any provisions of these regulations, the licence shall be liable to be cancelled, security of the licencee shall be forfeited and he shall also be liable to pay penalty as prescribed for violation of these regulations.

6.10 Award of licence to collect, transport and dispose of FSS

License for collection, transportation and disposal of Faecal Sludge & Septage in Chunar Nagar Palika Parishad

Paste Passport Size Photograph with stamp of Chunar Nagar Palika Parishad

In accordance with all the terms and conditions of the By-laws/ Regulations, Municipal Corporation Act rules, the special license conditions accompanying this license and applicable rules and laws of Government of Uttar Pradesh, the permission is hereby granted to:

1. Name(s) of the applicant: (Mr / Ms) _____

_____

2. Address of Head Office/Regd. Office: _____

_____

For the collection, transportation & disposal of faecal sludge & septage from onsite containments in Chunar Nagar Palika Parishad.

This license is based on information provided in the FSS Collection, Transportation and Disposal License Application Form. This license is effective for a period of one year from date of issue, set forth below.

3. License No.: _____

4. Effective Date: _____

5. Expiration Date: _____

The license may be suspended or revoked for Condition of Non – Compliance and is not transferable. The original license shall be kept on file in the licensee's office. A copy of this license shall be carried in every registered vehicle used by the licensee.

6. Signatures:

Executive Officer **Emptier / operator / owner**

6.11 Procedure for emptying onsite sanitation systems

1) Check vehicle (vacuum truck) and equipment
   a. Check engine oil
   b. Check air pressure in tyres
   c. Check pumping equipment

2) Check PPE
   All employees should carry PPE (as listed in *Annexure 6.14*). Use of bare hands should be strictly prohibited by CNPP.

3) Have the service requester take the crew to the OSS. Open the access covers and inspect the interior and exterior of the tank and check:
   a. The level of water or sludge up to the flow line of the outlet pipe—a water level below the flow line of the outlet pipe indicates leaks.
   b. Tank construction to look for cracks in the concrete. Use of a mirror on a long rod can help inspect the interior of the tank.
   c. If there is more than one compartment, locate and remove lids from all compartments. Each compartment will require pumping out.
   d. Seek information from local sources about the water table. Be cautious when pumping out material from tanks because if the water table is high, a tank that has not been secured may crack.

4) Position the truck near the building with safety cones, stoppers and hand-breaks to avoid any friction during pumping pressure. The maximum distance is determined by the length of the hose and elevation rise from the bottom of the pit or septic tank to the vacuum truck. This should typically be not more than 25 meters in linear distance and four meters in elevation gain. In case the length and elevation is more than the specified number, intermediate pumping may be required.

5) Check hoses for cracks and wear and tear
   Proper fitting is required for operations, therefore twine, tyre tube and plastic should not be used for hose connections as they may cause leaks. Hoses, clamps and fittings should be used to connect the main hose to the tanker and the hoses to each other are critical for proper suction and pressure operation.

6) Check the depth of the tank with the help of the hose. This will provide a fair indication on the volume of the sludge and the time it will take to empty it. This can be done by slowly lowering the hose in the tank; as it moves down, and it becomes harder to push it further, the sludge viscosity can be estimated.

7) Connect the hose to the truck tank. In case of hardened sludge, back pressure may be required to break the sludge mass. Clamp fittings should be screwed in such cases. The fitting might come off due to high pressure, and expose the workers to safety hazards.

8) Engage the pump or vacuum equipment. The operator will:
   a. Make sure there is suction and that the pump is operating.
   b. Use the hose to break up sludge and scum masses as much as possible.
   c. The operator should closely monitor the level gauge on the vehicle. In case, there is not enough space, the operator should monitor the level gauge closely.

d. Check for water flowing back from the outlet pipe, this is indicative of a clogging problem and should be reported to the building owner or requester.

9) Upon completion of emptying through the suction system, the operator should check if there are rocks or clogged mass that need to be broken or can be pumped out. This can be done by pumping 200–300 litres of septage back into the tank. Fresh water can also be pumped in instead of septage.

10) Never pump out the entire contents of a tank during periods when the water table is high. If the groundwater is higher than the bottom of the tank, the tank may float out of the ground. In such conditions, leave enough contents in the tank to serve as a stabilizer.

11) Upon completion of emptying, wash the pipes with water directed to the OSS.

12) Replace clean hoses back in the truck toolbox and place lids over the tank.

13) After each desludging operation, the area shall be properly cleaned and disinfected with relevant cleaning agents such as bleaching powder, lime, etc. The workers shall also follow proper hygienic practices such as washing hands with soap, etc. [Robbins, 2007].

6.12 Form for record of collection, transport and disposal of FSS

From to maintain record of collection, transportation and disposal of Faecal Sludge & Septage in Chunar Nagar Palika Parishad

Date: _____ **Time:** _____

I. Onsite System Owner Details

1. Name: _____
2. Address: _____
3. Telephone No.: _____
4. Nature of establishment: _____

II. Containment

1. Year of construction: _____ 2. Previous desludging (DD/MM/YYYY): _____
3. Outlet present (Yes/No): _____ 4. If yes, connected to: _____
5. Shape of containment: _____
6. Lining (Yes/No): Walls _____ Bottom _____
7. No. of chambers: _____ 8. No of openings in each baffle wall: _____
9. Dimension (feet): Length _____ Breadth _____ Depth _____
   Diameter _____ Depth _____
10. GPS coordinates: Latitude _____ Longitude _____
11. Location of containment within the property: _____

_____

III. Desludging

1. Volume of FSS (cu.m): _____ 2. Time in desludging (hrs.): _____
3. Trip length (km): _____ 4. Time in commuting (hrs.): _____

IV. Details of desludging service provider

1. Name of operator: _____
2. Vehicle Registration No: _____ 3. CNPP License No.: _____

V. Signatures:

Emptier staff on duty **Emptier/operator/owner** **OSS owner**

VI. Decanting

1. Time (hh:mm): _____ 2. Volume of FSS (cu.m): _____
3. Name of the emptier staff: _____
4. Name of the FSSTP operator: _____

VII. Signatures:

Emptier staff on duty **Emptier/operator/owner** **FSSTP operator**

6.13 Structure of FSSM bye-laws

1. Management and disposal of wastewater
   - There shall be a clause to the effect that enforcing safe management and disposal of wastewater generated by a property shall be a responsibility of the property's owner.

2. Design, construction and maintenance of onsite sanitation systems
   - There shall be a clause making it mandatory to design and build OSSs in accordance with notified standards.

3. Effective and safe desludging and transportation of FSS
   - This shall include bye-laws for registration and licencing of private desludging service providers including the criteria for issue of a licence; the process to apply for a licence; the application fee for the licence; and the performance guarantee.
   - This shall also cover regulations for publicity of the licenced operator(s) and awareness campaigns for the residents regarding the same.
   - This section shall also bring to light regulations on OSS owners to engage only licenced service providers, fee for desludging and transportation of FSS, vehicles to be deployed for safe transportation of FSS; precautions to be taken during transportation; preventive measure in case of accidents; liability of licenced operator in the eventuality of accident; safety measure(s) to be taken by worker(s) deployed; disposal of FSS; training of worker(s); health check-up and insurance of worker(s); and a clause for cancellation of licence in case of non-compliance.

4. Treatment and reuse or disposal of FSS
   - This shall include clauses for identification and notification of treatment and disposal site(s); creation of infrastructure to receive the FSS; deployment of staff to receive the FSS by plant operators and timing to receive the FSS at plants

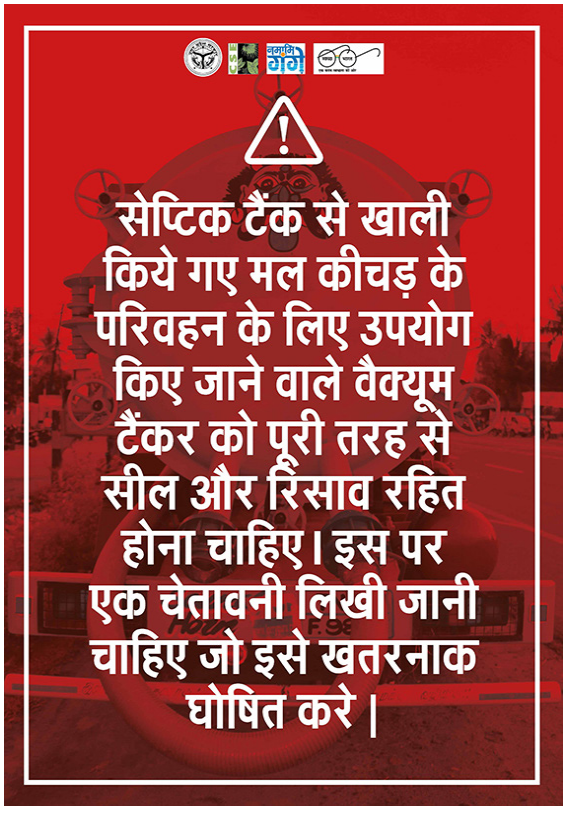
5. Administration and enforcement of bye-laws
   - This section shall state that powers of administration and enforcement of these regulations lie with the CNPP; CNPP may levy user fees for rendering services of desludging, transportation or treatment, for ensuring the cost recovery and the users shall be required to pay it.
   - A clause which provides special power for inspection to CNPP; clauses for violations and penalties; to whom and how a stakeholder shall appeal against any action taken by CNPP; and a dispute resolution clause.

6.14 List of protective gear and safety equipment

The following protective gear and safety equipment shall be available at the work site:

(i). Safety body clothing predominantly made of polyester which is reflective and offers chemical splash resistance
(ii). Safety body harness and safety belt
(iii). Surgical face mask, and respirators that protect against dust, fumes, mist and microorganisms
(iv). Safety torch
(v). Heavy chemical-resistant hand gloves made of butyl, with added advantage of mechanical protection and hazardous material spills
(vi). Safety goggles with the ability to withstand chemical splash to avoid infectious substances from reaching the eyes
(vii). Safety helmet (corded) fitted with a torch helpful in dark working conditions
(viii). Reusable earplugs, preferably connected to a flexible band that can be worn around the neck when not needed. These should be made out of silicon and helpful around the vacuum tankers where average sound levels exceed 85 dBa
(ix). Emergency medical oxygen resuscitator kits
(x). Gas monitors
(xi). Head lamp
(xii). Guide pipe set
(xiii). Safety tripod set
(xiv). Wader boots
(xv). Air compressor and blower
(xvi). Modular airlines supply trolley system
(xvii). Raincoat

6.15 Examples of FSSM communication initiatives



6.16 FSS treatment technologies

6.16.1 Bangalore method of composting

Dr Acharya developed this method for the utilization of town residues and night soil. It is a hot fermentation method and the compost production depot should preferably be located on the outskirts of the city.

Preparation
Trenches or pits about one metre deep are dug; the breadth and length of the trenches depends on the availability of land and the type of material to be composted. The trenches should preferably have sloping walls and a floor of 90 cm slope to prevent water logging.

Filling the pit
First, refuse is filled in the trenches to about 15 cm height. Night soil is spread over this to a layer of 5 cm. After filling the pit with refuse and night soil in alternate layers, the pit is filled to about 15 cm above the ground level with a final layer of 15 cm on the top. This may be made dome-shaped and converted with thin layer of soil with red earth or mud to prevent the loss of moisture breeding of flies. The material is allowed to remain as such without any turning and pot watering for about three months.

During this period, the material settles down due to reduction in volume of the biomass and additional night soil and refuse are placed on top in alternate layers and plastered or covered with mud or earth to prevent loss of moisture and breeding of flies. After the initial aerobic composting, which takes place over eight to ten days, the material undergoes anaerobic decomposition at a very slow rate and it takes about six to eight months to obtain the finished product [Misra & Roy, n.d.]. Compost obtained by this method contains 1.5 per cent N, 1.0 per cent P_2O and 1.5 per cent K_2O [IASRI, 2011].

6.16.2 Co-treatment with sewage

This is a better option because most STPs have land for sludge drying and dewatering. Sludge dewatering sites needs to be improved a bit by designing proper sludge drying beds. Geobags to dewater the septage or sludge can be used as an alternative option to sludge drying bed. The liquid fraction from sludge or septage can be directed to the STPs. This is a much better option than directly mixing septage into the liquid stream of STPs. Septage, after dewatering, and sludge from STPs can be treated together through co-composting, pyrolysis, etc. This solution is feasible only in STPs in the vicinity of the target city, otherwise, sludge transportation cost will be prohibitive.

6.16.3 Co-composting with solid waste

Co-composting is composting of septage along with the organic fraction of municipal solid waste. The organic fraction includes food waste, paper, yard waste (e.g., leaves and branches) cut or removed during landscaping. Co-composting is done in batches. Septage and other organic material are placed in piles or rows. Various parameters need to be controlled to ensure an optimal composting process, including temperature, moisture, carbon–nitrogen ratio and oxygen concentration. Co-composting takes several months and needs low amounts of energy. The process produces compost, a dark, rich soil-like material which can be used as a soil conditioner [Strande, et al, 2014].

6.16.4 Dedicated FSS treatment systems

The first step for the treatment of FSS essentially comprises of solid–liquid separation where the total suspended solids are separated from the FSS. The methods generally deployed for separation include centrifuge, mechanical thickener, geobags and sludge drying beds. Separated wastewater or effluent can be treated using aerobic and anaerobic principles similar to sewage treatment (up-flow anaerobic sludge blanket reactors, anaerobic filters, sequential batch reactors, membrane bioreactors, activated sludge processes, oxidation ponds, etc.). This can be followed by nutrient removal in planted horizontal or vertical gravel filter beds. Treated wastewater, depending upon the designated end-use, can be further treated using tertiary methods like chlorination, UV, ozonation or simply in a maturation pond, etc.

The next step for separation of total solids is pathogen removal. Sludge can be further dried (with or without the use of energy) to kill pathogens. Pathogen removal can also be achieved through co-composting with municipal solid waste. Depending on various criteria like availability of land, availability of financial resources and extent of the treatment, a number of combinations of the above-mentioned technologies could be used for FSS treatment. A brief of such combinations and their specifications are listed in *Table 8*.

Review of technologies

System (combination)	Operation type	System life	Applicability	Land requirement	Performance of the system (reduction in key pollutants)	Energy requirement	CAPEX (in ₹)	OPEX (in ₹)
Unplanted drying bed (UDB) + waste stabilization pond (WSP) + co-composting followed by chlorination, if deemed necessary	Decentralized	UDB/WSP: 50 years	Ward-, city- or cluster-level	UDB depending upon the FSS load and WSP: 6,000 m^2/MLD of FSS	• BOD: 75–85 per cent • COD: 74–78 per cent • TSS: 75–80 per cent • Coliform: 60–99.9 per cent	WSP: 5.7 kWh/D/MLD	UDB: 30,000,000/MLD WSP: 2,300,000/MLD	UDB: 5,000,000/MLD/year WSP: 2,00,000/MLD/year
Anaerobic digestion (AD) + co-composting followed by chlorination	Decentralized	AD: 50 years	Ward-, city- or cluster-level	AD: 600 m^2/MLD	• BOD: 60–90 per cent • COD: 60–80 per cent • TSS: 60–85 per cent	AD: 60 kWh/d/MLD	AD: 50,000,000/MLD	AD: 3,000,000/MLD/year
Centrifugation + activated sludge process (ASP) + vermi-composting followed by ozonation	Decentralized	ASP: 50 years	Ward-, city- or cluster-level	ASP: 900 m^2/MLD	• BOD: 85–92 per cent • COD: 93–94 per cent • TSS: 75–80 per cent • Coliform by 60– 90 per cent	• ASP: 185.7 kWh/D/MLD • Centrifugation 20–300 kWh per metric ton of solid	ASP: 6,800,000/MLD	ASP: 700,000/MLD/year
Centrifugation + sequential batch reactor + Cco-composting followed by chlorination	Decentralized	SBR: 50 years	Ward-, city- or cluster-level	SBR: 450 m^2/MLD	• BOD: 95 per cent • COD: 90 per cent • TSS: 95 per cent	• SBR: 153.7 kWh/D/ MLD • Centrifugation 20–300 kWh per metric ton of solid	SBR: 7,500,000/MLD	SBR: 600,000/MLD/year
Centrifugation + membrane bioreactor (MBR) + co-composting followed by ozonation	Decentralized	MBR: 50 years	Ward-, city- or cluster-level	MBR: 450 m^2/MLD	• BOD: 95 per cent • COD: >90 per cent • TSS: > 90 per cent	• MBR: 302.5 kWh/D/ MLD • Centrifugation 20–300 kWh per metric ton of solid	MBR: 30,000,000 / MLD	MBR: 900,000 / MLD/year
ASP + reed bed + sludge drying bed + co-composting	Networked	Sewer and treatment plant life: 50 year	Ward-, city- or cluster-level	ASP: 900 m^2/MLD	• BOD: 90–95 per cent • COD: 85–90 per cent • TSS: >90 per cent • TN: > 60 per cent • Coliform: 90–99.9 per cent	ASP: 185.7 kWh/d/MLD	ASP: 6,800,000/MLD	ASP: 700,000/MLD/year
ABR+ sludge drying bed + co-composting	Networked	Treatment plant life: 50 years	Ward-, city- or cluster-level	ABR: 1,000 m^2/MLD	• BOD: 70–95 per cent • TSS: 80–90 per cent • Coliform: 20–30 per cent	ABR: 34 kWh/d/MLD	ABR: 50,000,000/MLD	ABR: 3,000,000/MLD/year
AF+ sludge drying bed + co-composting	Networked	Treatment plant: 50 years	Ward-, city- or cluster-level	-----	• BOD: 50–90 per cent • TSS: 50–80 per cent	AF: 34 kWh/d/MLD	AF: 35,000 per KL (for 10 KLD plant)	---------
UASB+ sludge drying bed + co-composting	Networked	>50 years	Ward-, city- or cluster-level	UASB: 1,000 m^2/MLD	• BOD: 75–85 per cent • COD: 60–80 per cent • TSS: 75–80 per cent • TN: 10–20 per cent	UASB: 34 kWh/d/MLD	UASB: 6,800,000 / MLD	UASB: 600,000/MLD/year

System (combination)	Operation type	System life	Applicability	Land requirement	Performance of the system (reduction in key pollutants)	Energy requirement	CAPEX (in ₹)	OPEX (in ₹)
MD + WSP + solar drying + chlorination	Decentralized	ST: 50 years; WSP: 50 years	Ward-, city- or cluster-level	WSP: 6,000m^2/MLD	• BOD: 75–85% • COD: 74–78% • TSS: 75–80% • TN: 70–90% • TP: 30–45% • Coliform: 60–99.9%	WSP: 5.7 kWh/d/MLD	WSP: 2,300,000/ MLD	WSP: 200,000/ MLD/year
Geo-bags + WSP+ chlorination	Decentralized	Geobag: 6–12 months	Ward-, city- or cluster-level	WSP: 6,000m^2/MLD	• BOD: 75–85% • COD: 74–78% • TSS: 75–80% • TN, 70–90% • TP:30–45% • Coliform: 60–99.9%	WSP: 5.7 kWh/d/MLD	WSP: 200,000/ MLD	WSP: 200,000/ MLD/year
ABR + CW + Ssudge drying bed + co-composting + chlorination	Decentralized	>50 years	Ward-, city- or cluster-level	ABR: 1,000 m^2/MLD	• BOD: 70–95 per cent • TSS: 80–90 per cent • Coliform: 20–30 cent	ABR: 34 kWh/d/MLD	ABR: 50,000,000 / MLD	ABR: 3,000,000/ MLD/year

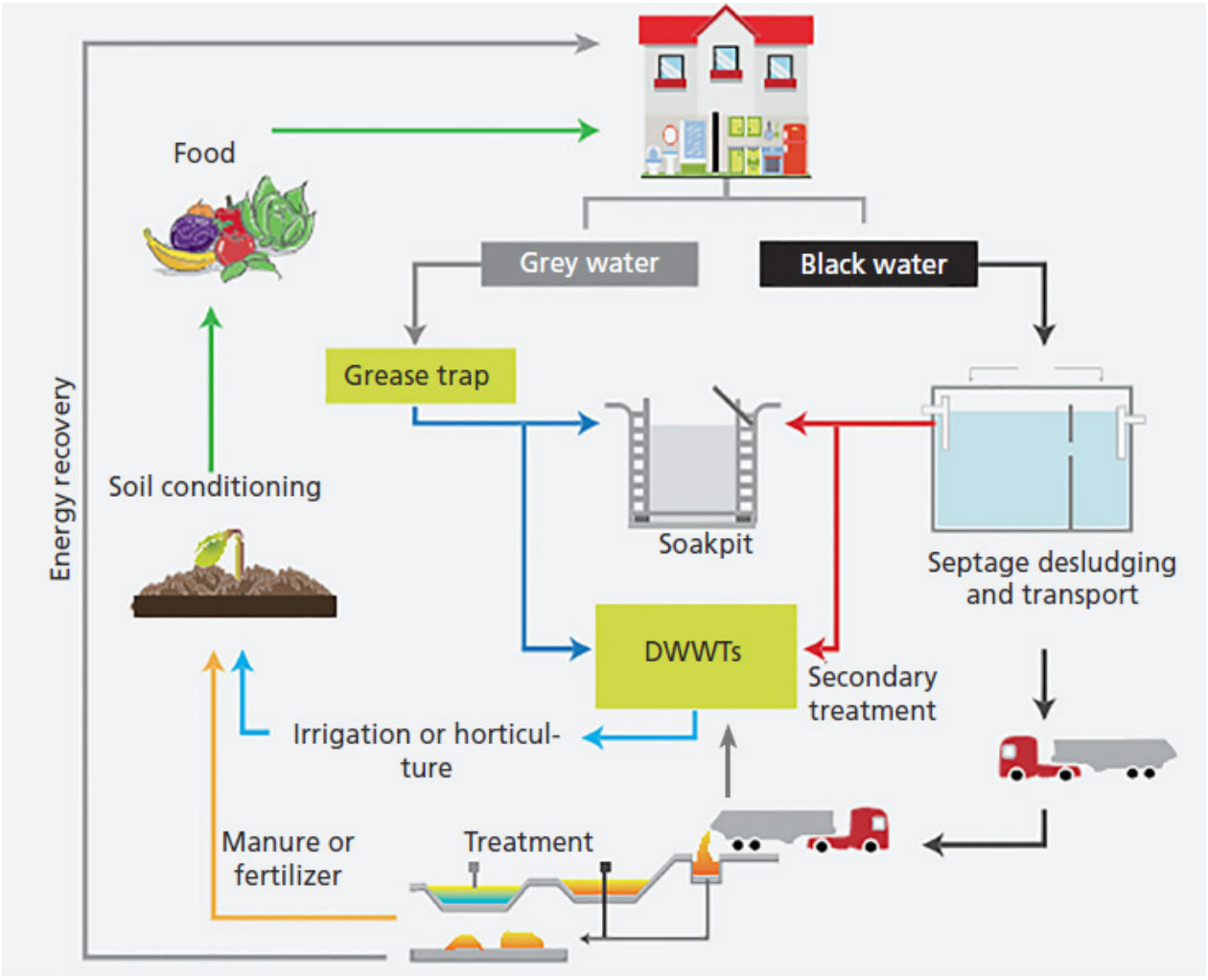
Source: Compiled by CSE, 2017

6.17 Base map features

S. no.	Class of feature	Features to be marked
1	Administrative boundaries	Ward boundary Zone boundary Slum boundary Cadastral boundary
2	Road	Major and minor road network Road intersections Carriage way Footpaths
3	Water pipelines	Pipeline distribution network Pumping stations Overhead tanks Water treatment plant Reservoir overhead or underground Bore holes Water supply office locations Location of valves Fire hydrant locations Consumer indexing with property number Public taps
4	Stormwater drains	Stormwater drain network (both natural and constructed) Width of drains Slope of drains
5	Solid waste	Location of bins Location of landfill sites Location of parking spots of SWM vehicles
6	Traffic management	Traffic control room Traffic light network Traffic signal post Public parking Bus stop and taxi stands Traffic congestion areas Petrol pump Ambulance service locations
7	Healthcare	Hospital location Dispensaries PHCs Chemist shop location
8	Settlement	Buildings at the city level
9	Contours	Five-meter interval at the city level

6.18 End-use and resource recovery

End-use of FSS refers to the safe and beneficial use of human excreta, i.e., faeces and the wastewater from OSSs. The type of end-use should decide the level of treatment. Considering the nutrients, organic matter and energy contained in FSS, it can be used as soil conditioner or fertilizer in agriculture, aquaculture or horticultural activities. It can also be used as a fuel source, building material or for protein food production. Closing the loop would not only help in reducing freshwater and chemical fertilizer demand, but also prove to be a source of revenue, in other words, can help improve the business model.



Source: CSE, 2018

End-use of dried sludge

Composting is the stabilization of organic waste through aerobic biological decomposition. Different types of composting include two open-area methods—windrow and static pile composting—and in-vessel mechanical composting. Composting is a feasible option where bulking agents are easily available. Humus produced through composting can be used as a soil conditioner. Operational parameters for septage composting are presented in *Table 9*. Compost products can be sold or given away.

Operational parameters for dewatered FSS composting

Parameters	Optimum range	Control mechanisms
Moisture content of compost mixture	40–60 per cent	Dewatering of septage to be 10–20 per cent solids followed by bulking material (amendments such as sawdust and woodchips); 3:1 by volume amendment: dewatered septage
Oxygen	5–15 per cent	Periodic turning (windrow), forced aeration (static pile), mechanical agitation with compressed air (mechanical)
Temperature (compost must reach)	55–65°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
C/N ratio	20:1–30:1	Addition of bulking material

Source: (CPHEEO, 2013)

For dewatered FSS agriculture applications, it should satisfy the criteria given in *Table 10*.

Recommended pathogen requirements for bio-solids reuse as per WHO and USEPA

Organization	Guideline requirements	Source
World Health Organization	Helminth egg count: ≤1 egg per gram of total solids	WHO, 2006
	E. coli: ≤1,000 count per gram of total solids	
US Environmental Protection Agency (Part 503 Biosolids Rule)	Faecal Coliform density of less than 1000 MPN/g total dry solids	US EPA, 1994
	Salmonella subspecies (spp) density of less than 3 MPN per 4 g of total dry solids (3 MPN/4 g TS)	

Source: Tayler, 2018

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

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

Sludge with a solid content of 30 per cent or more can be handled with conventional end-loading equipment, and applied with agricultural manure

spreaders. Liquid sludge, typically with solid content of less than 6 per cent, is managed and handled by normal hydraulic equipment.
Agricultural use of sludge matches best with priorities in waste management as FSS contains nutrients in considerable amounts.

End-use of treated wastewater
Wastewater contains valuable nutrients (nitrogen, phosphorus and potassium), which may either be recovered as a resource or recycled when treated wastewater is reused for irrigation or other applications. When using treated wastewater for irrigation, these nutrients aid crop growth and could reduce the need for synthetic fertilizers in India by up to 40 per cent [Minhas, 2002]. While farmers in India rarely pay any significant amount for the provision or use of this resource, it is important to understand its economic benefits. The standards, issued by Ministry of Environment, Forest and Climate Change, applicable to discharge of treated wastewater into water bodies as well as for land disposal and application are presented in *Table 11*.

Effluent discharge standards (applicable to all modes of disposal)

Industry	Parameters	Standards (concentration not to exceed)
Sewage treatment plants	pH	5.5–9
	Biochemical oxygen demand (BOD)	10
	Chemical oxygen demand (COD)	50
	Total suspended solids (TSS)	20
	Total phosphorus	1
	Fecal Coliform (FC) (most probable number per 100 milliliter, MPN/100ml)	Desirable: 100 Permissible: 230

Note:

All values in mg/l except for pH and faecal Coliform.

These standards shall be applicable for discharge into water bodies as well as for land disposal and applications.

The standards for faecal Coliform shall not apply with respect to use of treated effluent for industrial purposes.

These standards shall apply to STPs yet to be commissioned as well as existing STPs.

In case of discharge of treated effluent into a sea, it shall be through a proper marine outfall and the existing shore discharge shall be converted to marine outfalls, and in cases where the marine outfall provides a minimum initial dilution of 150 times at the point of discharge and a minimum dilution of 1,500 times at a point 100 meters away from the discharge point, the existing norms shall apply as specified in the general discharge standards.

Reuse and recycling of treated effluent shall be encouraged and in cases where part of the treated effluent is reused and recycled involving possibility of human contact, standards as specified above shall apply.

Central Pollution Control Board or state Pollution Control Boards or Pollution Control Committees may issue more stringent norms taking account to local condition under Section 5 of the Environment (Protection) Act, 1986".

Source: MoEF&CC, 2017; NGT, 2019

6.19 Monitoring an FSSM programme

Stage	Monitoring
Containment	• Construction is as per standards prescribed by BIS or CPHEEO • Construction of the containment is done by licenced masons and plumbers • Overflow from containment is not diverted into open areas and drains • Census of the OSS and retrofitting of faulty containment is carried out. If not done within the timeline, defaulters should be penalized
Emptying	• Safety standards are followed • Provisions of statutes like Manual Scavenging Act, 2013 are followed • Fixed charges are collected by private or government operators
Transportation	• Vehicles are registered and licenced by ULB with transparency • Vehicles are well-maintained • All vehicles are GIS enabled, so that disposal can be monitored • FSS is disposed of in designated disposal and treatment sites
Treatment	• FSS characteristics are determined to design the treatment system • In case of co-treatment at an STP, design parameters to take additional FSS load is checked • Effluent resulting from dewatering is treated to discharge standards • The independent FSS treatment plant has adequate provisions for parking vehicles without causing disturbance in the surroundings • Sludge drying beds are emptied regularly
Disposal / End - use	• Provisions of statutes like Water Act and Environment Protection Act are followed • Defaulters are charged and fined as per the law • Quality checks of end products is done before reuse • Rates of end products are affordable • Treated wastewater overflowing from containments meets prescribed standards of reuse for designated purposes

Source: Compiled by CSE

6.20 Capacity building and IEC or BCC strategies

Sector	Type of worker	Training need	Training timeline	Topics for IEC or BCC campaign (for all)
Access to sanitary toilets	Junior engineer (maintenance)	• MoHUA bye-laws (design consideration of toilets), water and energy efficient fixtures	Once a year (compulsory) Remaining trainings as and when required (such as induction of new staff, invitation from CoE, Centre or State under programmes like SBM, AMRUT)	• Campaigns for school faculties on the importance of sanitary education • For students (different age-groups) on how they can contribute in making the region clean and healthy • Menstrual hygiene education campaign • Use and maintenance of community toilets by locals and how it can prevent open urination or defecation • Campaign on why open defecation is not an acceptable practice, by children or adults • Campaign highlighting the acceptance of open urination and why it is harmful for citizens • Campaign for greater civic involvement in maintaining public sanitation services
	Sub-sanitary inspector	• Estimation of floating population, homeless, disabled, method to identify open urination or defecation hotspots, bye-laws, assessment of functional status of public or community toilets	One training in first year, then refresher training every year	
	Field officer	• Qualitative and quantitative research	Once a year (compulsory) Remaining trainings as and when required (such as induction of new staff, invitation from CoE, centre or state under programmes like SBM and AMRUT)	
	Field assistant	• Data collection, data entry, public interaction	Once a year (compulsory) Remaining trainings as and when required (such as induction of new staff, invitation from CoE, centre or state under programmes like SBM and AMRUT)	
	Safai karmchari (training programme open to institutional safai karmchari as well)	• Use of PPE, use of cleaning agents, public interaction, data management, awareness of labour laws, social welfare schemes, scientific handling of toilet waste like menstrual products	Once a year (compulsory) Remaining trainings as and when required (such as induction of new staff, invitation from CoE, centre or state under programmes like SBM and AMRUT)	

<table>
<tr><th>Sector</th><th>Type of worker</th><th>Training need</th><th>Training timeline</th><th>Topics for IEC or BCC campaign (for all)</th></tr>
<tr><td rowspan="4">Faecal Sludge and Septage Management (FSSM)</td><td>Assistant Engineer</td><td rowspan="2">• Planning and designing of sustainable and decentralized solutions for FSSM
• Policies, programmes and guidelines for FSSM
• Use of mapping and spatial data and IT in O&M and for data analysis
• Data generation for FSSM for CNPP
• Innovative approaches to implement scheduled desludging and regulated emptying in CNPP
• Setting up a call centre and MIS for better management and implementation of scheduled desludging</td><td rowspan="2">Once a year (compulsory)
Remaining trainings as and when required (such as induction of new staff, invitation from CoE, centre or state under programmes like SBM and AMRUT)</td><td rowspan="4">Public participation and awareness on:
• Scheduled desludging
• Ill-effects of an unclean city—impact on public health and environment
• Ill-effects of using untreated FS and wastewater in agriculture. It can be a resource if used wisely
• Stencil signs on road (no dumping of FS or wastewater) for water bodies and drains
• Slogans and interactive programmes or events on beautiful landscape or water bodies and clean environment
• Brochures and workshops on how to do DWWTs for properties with green area more than 100 sq m
• Brochures on use of native plants and landscaping on smaller or individual scale (native plant kits on sale)
• Biodiversity: Noticeboard near green areas and water bodies stating details of existing flora and fauna
• Workshop at schools and colleges with dummy models to be prepared by students on above topics (RWH, landscaping, save water bodies, species surrounding us)</td></tr>
<tr><td>Junior Engineer</td></tr>
<tr><td>Truck operators</td><td rowspan="2">• Use of PPE
• Role of field staff in effective FSSM
• Use of cleaning agents
• Public interaction
• Data management
• Use of technology to choose their routes efficiently
• Maintenance of their vehicles
• Awareness of labour laws, social welfare schemes
• Reporting process—complaints, innovations, issues pertaining to human resource management</td><td rowspan="2">Once a year (compulsory)
Remaining trainings as and when required (such as induction of new staff, invitation from CoE, centre or state under programmes like SBM and AMRUT)</td></tr>
<tr><td>Faecal sludge & septage treatment plant operators</td></tr>
</table>

Source: Compiled by CSE, 2019

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