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TAMIL NADU URBAN SANITATION SUPPORT PROGRAMME

REPORT

TAMIL NADU STATE BASELINE STUDY: TECHNICAL ASSESSMENT OF SANITATION CHAIN

January 2017

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In Association With:

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Tamil Nadu State Baseline Study: Technical Assessment of Sanitation Chain

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Abbreviations

AC	Asbestos Cement
BNR	Biological Nutrient Reduction
CDD	Consortium for DEWATS Dissemination
CDZ	Cauvery Delta Zone
CT	Census Town
GoTN	Government of Tamil Nadu
HH	Household
HRZ	High Rainfall Zone
HSC	Household Service Connection
HZ	Hilly Zone
NEZ	North Eastern Zone
NNP	Narasimhanaicken-palayam
NWZ	North Western Zone
O & M	Operations and Maintenance
PNP	Periyanaicken-palayam
PPE	Personal Protective Equipment
PSI	Pound-force per Square Inch
RCC	Reinforced concrete
Sq.m	Square meter
STP	Sewage Treatment Plant
SZ	Southern Zone
TCC	Tiruchirappalli City Corporation
TNPCB	Tamil Nadu Pollution Control Board
TNUSSP	Tamil Nadu Urban Sanitation Support Programme
TP	Town Panchayat
UGD	Underground Drainage System
UGSS	Underground Sewerage Scheme
ULB	Urban Local Body
WZ	Western Zone

Executive Summary

Executive Summary

The Tamil Nadu Urban Sanitation Support Programme (TNUSSP) carried out a study in 21 Urban Local Bodies (ULBs) across seven different agro-climatic zones to understand the state of sanitation across various regions in Tamil Nadu. The study covered various stakeholders and assessed infrastructure across the sanitation chain to draw a detailed account of the prevailing situation. The classification of the state according to various agro-climatic zones proved useful, as there were significant differences in infrastructure patterns across these regions.

E1.1. Objectives

The broad objectives of the study was:

i. To understand the current status of sanitation infrastructure across the chain in different regions of Tamil Nadu, including construction practices, operational and maintenance practices for containment, desludging and transportation of fecal sludge, as well as treatment and re-use, regionally.
ii. To understand and analyse the variations in sanitation arrangements and practices across regions.
iii. To map the current enabling conditions for infrastructure development such as supply chains, skill sets/capacities available and other factors that play a role in moulding the plan and operations of sanitation infrastructure and related services.
iv. To build an extensive report of the systems and practices followed across the state of Tamil Nadu.

E1.2. Methods

Tamil Nadu is broadly classified into seven different agro-climatic zones as per the classification made by the government. These are: Cauvery Delta Zone (CDZ), High Rainfall Zone (HRZ), Hilly Zone (HZ), North Eastern Zone (NEZ), North Western Zone (NWZ), Southern Zone (SZ), and Western Zone (WZ). From each of these seven zones, three urban local bodies (ULBs) were sampled based on representation of different areas and population of ULBs. Purposive sampling was also carried out to represent varied geographies and climatic conditions, and as a result, 21 ULBs were selected from these seven zones.

The study used both quantitative and qualitative data collection methods to document information from various stakeholders including household members, masons, public toilet and community toilet operators, desludging operators, treatment facility operators and farmers. Both semi (or/and) structured interviews with stakeholders as well as unobstructed observations were carried out. In each of the seven zones, 90 household interviews were carried out. Further, across zones, interviews were done with a total of 84 masons, 47 desludging operators/workers (39 unobstructed observations), four facility managers of sewage treatment plants and 49 farmers who use fecal sludge as manure. Also, 41 public toilets were surveyed, and unobstructed observations were carried out at 52 public toilet facilities.

E1.3. Findings at the Household Level

E1.3.1. Water Supply

Most households across all seven zones were found to depend on municipal piped water supply as the source for potable water, while a few depended on household tube wells. In CDZ and NEZ, few households relied on borewells. Water for non-potable use such as washing, flushing, cleaning and others was sourced primarily from tube wells and bore wells by households that had access to them. In terms of frequency of water supply, most households in CDZ, HRZ, NEZ and WZ reported everyday supply.

It was found that only 12 out of 270 households in three zones had a metered arrangement for water supply - HRZ, NWZ and SZ. Nevertheless, all households paid a fixed annual fee to the ULB which ranged from Rs.60 to Rs.150 per household.

E1.3.2. Wastewater Arrangements

Kitchen gardens and stormwater drains were two commonly reported arrangements for disposal of kitchen and bath water, although inter-zone variability remains. In CDZ zone, both kitchen and bath water was mainly (around 80 per cent) disposed into kitchen garden, while in WZ, it was disposed into stormwater drains.

E1.3.3. Toilets

The prerequisite for households to be selected for the study was the presence of a toilet. Further analysis indicated that most households (60 per cent) across all seven zones had only one toilet. The location of toilets, irrespective of the number of toilets per household, was found to be mainly at the back of the houses. A high number of households attributed space availability as the prime factor that determined the location of the toilet. Of the 630 households, only 89 had not constructed toilets at the time of construction of their houses. Most of the households that constructed toilets at a later point, initiated construction after 2014, and this can be attributed to the introduction of government sanitation schemes.

The superstructure of the toilets in all zones was found to have walls which were mainly made of bricks (95 per cent), with RCC slabs (65 per cent) or tin sheets (27 per cent). Majority of the households had a pour flush system, while about a third had cistern flush. The most commonly reported toilet was the Indian type (86 per cent) while the rest reported having western toilets. 72 per cent of households had a tap within the toilet, while six per cent had it outside the toilet. An average of 87 percent of households across zones had squatting pans with water seals and the P trap was found to be the plumbing fixture used in most households.

E1.3.4. Containment

Seventy per cent of households interviewed reported that their toilets were connected to septic tanks. There were vast inter-regional variations in terms of the characteristics of a septic tank but one similarity observed across zones was that all septic tanks had their overflow discharge into stormwater drains.

The presence of partition wall is a major differentiator between a holding tank and septic tank. At most places throughout the state, it was found that containment systems resembled a septic tank in shape but not all aspects of the design – such as partition wall, manhole, vent pipes – were used at most study sites. The households that had connections between septic tanks and soak pits were found to be negligible. The greywater and, at times, overflow of blackwater from containment systems drained into open drains outside the house, which conveyed it further to low-lying lands or waterbodies. The presence of manholes was noted in 21 per cent of septic tanks across households and 85 per cent of

septic tanks were reported to be lined at the bottom. Notably, a high number of septic tanks were found provisioned with a vent pipe (86 per cent).

Single pits were reported to be the next most commonly used containment system across the seven zones (29 per cent of households). High rainfall and hilly zones reported a high number of single pits in comparison to septic tanks.

Containment systems varied widely with respect to the surrounding soil and groundwater conditions. Masons have developed skills in adapting containment units for storage of black water based on their understanding of these geographical conditions and household requirements. At places where desludging services were limited, containment systems were largely built with the option for percolation through its walls. Overall, the mean size of septic tank was found to be 2.6 m^3. At the zone level, the mean ranged between 2.4 m^3 in SZ and 3.5 m^3 in HRZ.

E1.3.5. Collection

Despite 90 percent of containment systems having been constructed more than 10 years before the study, only 36 per cent of households stated that the containment unit ever filled up completely and that it was desludged. The reasons for desludging were mainly attributed to backflow (102 households) and overflow of blackwater (93 households).

Majority of households (58 per cent) reported that their containment systems had never filled up till date, while 16 per cent said it took more than five years. However, the reported data on septic tank lining indicates that nearly 50 per cent households had their containment systems lined at the bottom. Further analysis highlighted that even in most households with lined septic tanks, the containment had never filled up. This may be due to the depth of septic tank (the mean depth recorded across zones is 2.6 metres) or because of percolation through its walls.

In terms of desludging, while 28 per cent claimed to have never desludged, another 30 per cent of all households reported desludging as recently as one month ago to seven years back. Of this, the HZ reported having the maximum numbers of households that had never desludged while the HRZ reported more regular desludging. The responses regarding the frequency of desludging was also skewed towards more than a five-year period or never done. Private desludging operators were most commonly used by households which reported desludging, followed by those operated by ULBs.

Wider road access facilitates easy access to containment structures for desludging vehicles. In the sample, 211 households had a road width of 3-5 metres, while 202 households had width of only 0-3 metres.

E1.4. Desludging Services

A total of 47 operators were surveyed to understand desludging practices across the seven zones. Most of them reported the tank capacity to be between 4,500-7,000 litres and 2,000-4,500 litres each. The CDZ and the NEZ reported the maximum number of operators traversing 6-20 kms, while the HRZ, NWZ and WZ had the maximum number of operators plying 20-50 kms. Operators in the HZ and WZ claimed to travel distances over 50 kms but this is very negligible at six per cent. The cost of desludging largely falls within the range of Rs 1,000 to 3,000 irrespective of the number of private players in operation. Nine out of 47 operators stated to also de-sludge chemical waste from industries such as leather, needle, clothes, oil, rubber, steel, communication and soft drink companies.

Desludging services for onsite containment units were prevalent throughout the state, with access more easily available in bigger cities or towns in proximity to such cities. Many private operators were found

to provide these services at competitive rates thereby making up for the gap left by government services. In places such as hill stations, it was found that there was a dearth of private operators and they usually charged high rates for their services, forcing households to adopt other means to prevent sludge build up in the containment units. Such techniques usually involved using some form of biological or chemical agent to digest the sludge in such containment units.

Private operators usually use new vehicles, typically not older than 10 years, to keep the running cost low. When they get older and more used, these vehicles are sold at rural markets. Private operators enter this business after seeing that there is tremendous opportunity from others in it. It was very common to see friends and family members of the operators also getting involved. Operators, on gaining profits from their business, invest in additional vehicles and start providing more services. Thus, at many places across the state, operators had close relationships with one another which helped them build a nexus to keep away new entrants and maintain healthy competition.

The data also showed that most operators ply less than 20 kms to the discharge point. Contrary to other zones, in the NEZ, maximum number of operators stated procedures as the chief reason for not discharging in the treatment plant; distance and time were not listed as pressing factors here.

E1.5. Treatment and Reuse

E1.5.1. Treatment

Most of the towns covered in this study had no treatment plants within their jurisdiction. There were a few private treatment units, however, but these operated within closed premises to which entry was not easy. Hence, this study does not have data on such treatment units. In some cities, such as Kancheepuram, Thanjavur, Vedaranyam, and Ooty, there were treatment plants, which could be accessed. However, no dedicated operator was available during the study to provide details on these assets.

Fecal sludge collected by desludging operators, at almost all places, was disposed at vacant lands or water bodies. Even though there is a state-wide policy on use of clustered sewage treatment plants for disposal, it is not a common practice in smaller cities and towns where STPs are far from the catchment area or where there is no strict enforcement of the law. The most commonly-cited reason for not dumping at designated sites was the time taken to travel to these sites which resulted in lost opportunities and higher fuel costs.

Moreover, it was observed at a lot of places that this sludge was considered a resource, rich in nutrients and minerals required for farming. The sludge conditioned the soil and increased its moisture retaining capability.

E1.5.2. Reuse

To understand reuse of fecal sludge, interviews were conducted with farmers across the seven zones. Out of the 43 farmers interviewed, 17 farmers said they used wastewater for irrigation, because of its high nutrient value and the lack of freshwater availability, and 13 farmers reported use of fecal sludge as soil conditioner. The use of wastewater for irrigation purposes was practiced in five zones, excluding HZ and WZ; 13 farmers, across all zones, claimed to use fecal sludge as soil conditioner. Among them, seven farmers used dried sludge and five farmers used fresh sludge from the cesspool.

Only one of the farmers said that he pays Rs.50 for availing fecal sludge, while the others said that they neither pay for the sludge nor are they paid by the disposer. When enquired on the willingness to pay for such products, they seemed reluctant to buy it from a market. A few farmers did hint at getting the end product certified by an agricultural university to endorse its benefits.

None of the farmers reported the incidence of any water-borne diseases except one farmer in the NEZ who claimed that one of his family members suffered from cholera.

To conclude, the study captured both qualitative insights and representative quantitative status of the current situation across the state. It is recommended that the study be understood after carefully analysing its perspective of covering only a selected few towns and cities across the state. To detail or design region/city/town-specific interventions, detailed local information needs to be captured and analysed.

1 Findings from the Technical Assessment

1. Findings from the Technical Assessment

1.1. Introduction and Methodology

The Government of Tamil Nadu (GoTN) has been a pioneer in recognising the importance of securing the full sanitation chain as vital for improving public health outcomes for all citizens. To help GoTN achieve its sanitation goals (Muzhu sughadhara Tamizhagam) through the Tamil Nadu Urban Sanitation Support Programme (TNUSSP), the Bill and Melinda Gates Foundation has set up a Technical Support Unit within the Municipal Administration and Water Supply (MAWS) Department. TNUSSP aims at making improvements along the sanitation chain in the of Tamil Nadu and demonstrating innovations in two model urban locations: Tiruchirappalli City Corporation (TCC), and Periyanaicken- palayam (PNP) and Narasimhanaicken-palayam (NNP) Town Panchayats, Coimbatore district.

In both locations, the programme is implementing projects and interventions along the full cycle of sanitation in consultation with key stakeholders and working closely with the TCC and PNP-NNP Town Panchayats.

The baseline study thereby intents to satisfy the objective of mapping current sanitation situation across the various agro climatic zones in the state of Tamil Nadu. The study aimed at framing state specific overview of sanitation situation across the full cycle chain. Accordingly, the sanitation situation was assessed for components across the fecal sludge chain. The study was conducted post a pilot study carried out by CDD Society at Periyanaicken-palayam, Narasimhanaicken-palayam and Tiruchirappalli.

1.1.1. Objectives of the Study

The baseline study intends to create an understanding of the sanitation situation across the various region in the State of Tamil Nadu.

The broad objectives of the study are as follows:

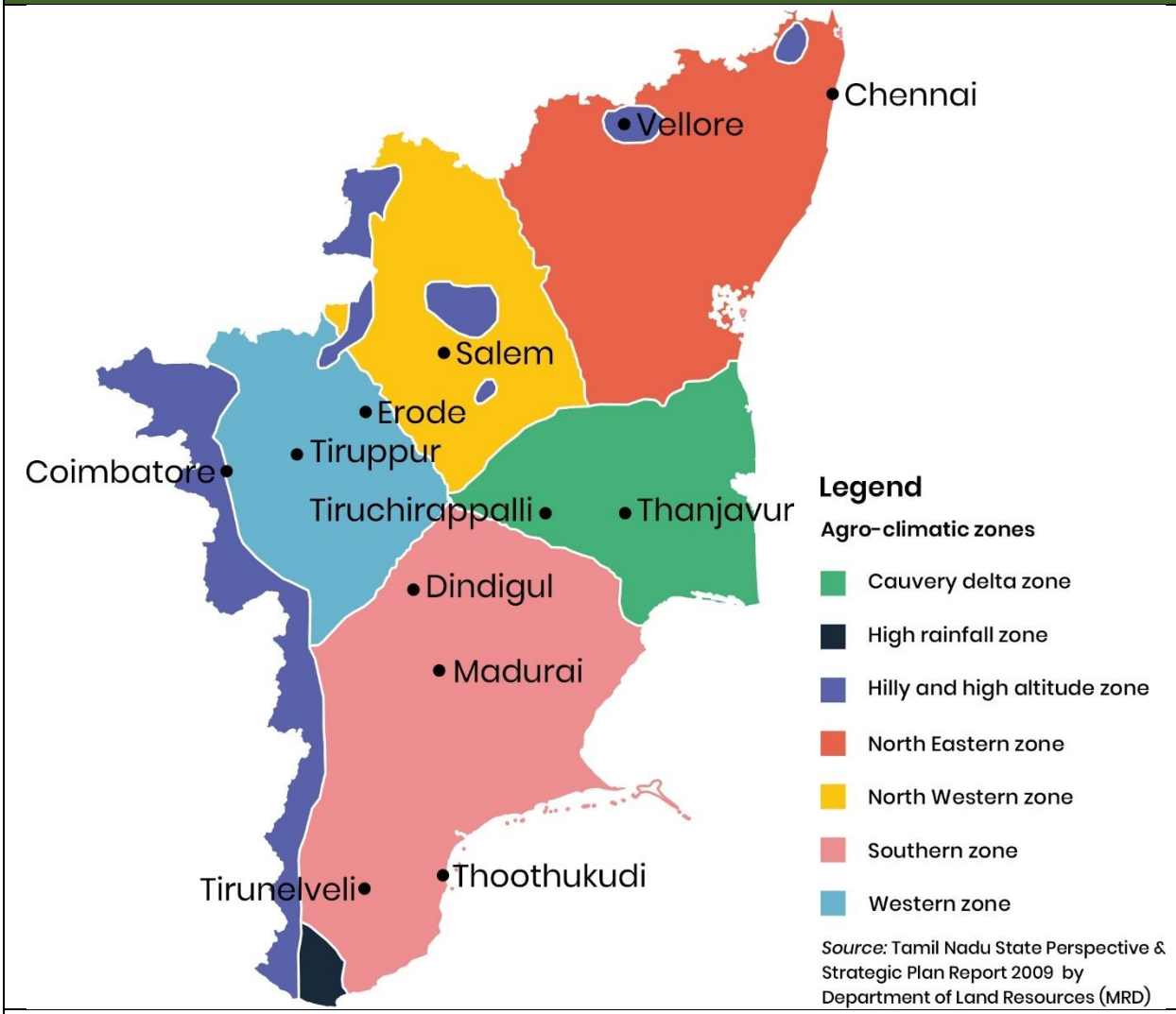
i. To understand the current status of sanitation infrastructure across the chain in different regions of Tamil Nadu, including the current construction practices, operational and maintenance practices for containment, desludging and transportation of fecal sludge, treatment and re-use, regionally.
ii. To understand and analyse the variations in sanitation arrangements and practices across regions.
iii. To map the current enabling conditions for infrastructure development such as supply chain, skill sets/capacities and others, which play a role in moulding the plan and operations of the infrastructure and related services.
iv. The outcome of the study is to have an extensive understanding of the systems and practices followed across the state of Tamil Nadu.

1.1.2. Scope of the Study

1.1.2.1. Study Locations

The State is broadly classified under seven different agro climatic zones as per the classification made by the Government of Tamil Nadu. For the purpose of this study, three urban local bodies were sampled from each of these agro climatic zones. The Figure 1.1 and Table 1.1 represents the various agro-climatic zones and the regions they cover. Details of the agro-climatic characterisation of the zones along with water table, water quality and soil type information in each zone is presented in Annexure 1.

Figure 1.1: **Agro-climatic Map of Tamil Nadu**



Source: TNUSSP, 2016

Table 1.1: **Agro Climatic Zones**[1]

S.No.	Agro climatic zone	Regions (districts) covered in the zone
1	Cauvery delta zone (CDZ)	Thanjavur, Nagapattinam, Tiruvarur, Trichy and parts of Karur, Ariyalur, Pudukkottai and Cuddalore
2	High rainfall zone (HRZ)	Kanyakumari
3	Hilly zone (HZ)	The Nilgiris and Kodaikanal (Dindigul)
4	North eastern zone (NEZ)	Kancheepuram, Tiruvallur, Cuddalore, Vellore, Villupuram and Tiruvannamalai

[1] For Demography – Namakkal under North western zone, Cuddalore under North eastern zone, Karur under western zone, Ariyalur under Cauvery delta zone

Table 1.1: **Agro Climatic Zones**[1]		
S.No.	**Agro climatic zone**	**Regions (districts) covered in the zone**
5	North western zone (NWZ)	Dharmapuri, Krishnagiri, Salem and Namakkal (Part)
6	Southern zone (SZ)	Madurai, Sivagangai, Ramanathapuram, Virudhunagar, Tirunelveli and Thoothukudi
7	Western zone (NZ)	Erode, Coimbatore, Tiruppur, Theni, Karur (part), Namakkal (part), Dindigul, Perambalur and Ariyalur (part)
Source: TNUSSP, 2016		

The demographics of seven zones is presented in Table 1.2.

Table 1.2: **Demographics of Seven Zones in Tamil Nadu**						
S.No.	**Zone**	**Total Population**	**Urban Population**	**% of Urban Population**	**Urban Area (sq.km)**	**Density (People/sq.Km)**
1	Cauvery Delta Zone	10,405,302	3,235,115	31.1	19,127	169
2	High Rainfall zone	1,899,392	1,568,820	82.6	1,732	906
3	Hilly Zone	735,394	435,655	59.2	2,621	166
4	North Eastern zone	21,017,195	9,392,786	44.7	30,487	308
5	North western Zone	8,723,842	3,288,055	37.7	18,326	179
6	Southern Zone	13,158,209	6,705,316	51.0	27,494	244
7	Western Zone	14,677,737	8,761,734	59.7	29,232	300
Source: Census, 2011						

From the above regions, three urban local bodies were sampled based on the following rationale.

i. Representation of different sizes and population of ULBs.
ii. Purposive sampling to represent varied conditions of geography and climatic conditions.

Table 1.3 presents the details of the ULBs selected within each zone based on the above two rationales.

Table 1.3: **ULBs Selected for the Study**				
S.No	**Agro climatic zone**	**Corporation**	**Municipality**	**Town panchayat (TP)/ Census town (CT)**
1	Cauvery delta zone (CDZ)	Thanjavur	Vedaranyam	Tharangambadi (TP)
2	High rainfall zone (HRZ)		Nagercoil	Villukuri (TP) and Agasteeswaram (CT)
3	Hilly zone (HZ)		Udhagamandalam	Kotagiri (TP) and Naduvattam (CT)
4	North eastern zone (NEZ)	Vellore	Kancheepuram	Sriperumbudur (TP)
5	North western zone (NWZ)	Salem	Edappadi	Sankagiri (TP)
6	Southern zone (SZ)	Thoothukudi	Kovilpatti	Ettayapuram (TP)
7	Western zone (NZ)	Erode	Bhavani	Jambai (TP)
Source: TNUSSP, 2016				

1.1.2.2. Stakeholders

Stakeholders who contribute to the setting up of infrastructure along the sanitation chain were interacted with to understand and analyse the variations in sanitation arrangements and practices across regions. Table 1.4 represents the targeted stakeholder groups identified as part of this study and their participation.

Table 1.4**: Stakeholders Associated with Infrastructure Creation**			
S.No.	**Component**	**Stakeholder**	**Participation**
1	User interface and containment structures-	Household members	• Primary custodian of the system • User of the infrastructure • Operates and maintains the system
		Mason	• Construct (and sometimes even design) systems such as toilets and containment units
		Public toilet operators	• Provision and O&M of common infrastructure
		Community toilet operators	• Provision and O&M of shared infrastructure
2	Desludging and transportation	Household members	• Customers
		Cesspool operator study (Owners, operator and cleaner)	• Service provider and custodian of desludging and transporting infrastructure.
3	Treatment	Facility manager/Operator, Treatment providers	• O&M of treatment system

Table 1.4: **Stakeholders Associated with Infrastructure Creation**			
S.No.	**Component**	**Stakeholder**	**Participation**
4	Reuse	Farmers	• Recipient of fecal sludge for reuse at farmlands
Source: TNUSSP, 2016			

1.1.3. Sampling

Table 1.5 shows the number of respondents that were sampled per ULB.

Table 1.5: **Planned Sample Size of Various Study Categories within a ULB**		
S.No.	**Study Category OR Response group**	**Number of Samples/ Observation per ULB**
1	Household survey	30 households
2	Household sanitation infrastructure observation- Toilet and containment	30 households, same sample set as above survey
3	Under-construction containment units – Observation	3 structures
4	Masons – toilet builders	3 masons
5	Public toilets/ community toilets survey	2 toilet complexes
6	Public toilets/ community toilets - observation	2 toilet complexes, sample set same as above
7	Cesspool operator – survey	2 Interviews
8	Cesspool operation observation	2 observations
9	Facility manager – wastewater treatment plant	1 interview
10	Wastewater treatment plant observation	1 observation
11	Farm owners	2 interviews
12	Fecal sludge sampling	2 sample
Source: TNUSSP, 2016		

A total of 630 households with toilets were sampled across seven zones, details of which are presented in Annexure 2. Further, 84 masons, 47 desludging operators/workers (39 unobstructed observations),

four facility managers of sewage treatment plants, 49 farmers using fecal sludge as manure were interviewed. Further, 41 Public Toilets were surveyed and in 52 public toilets unobstructed observations were carried out.

1.1.4. Data Collection

The study involves qualitative assessment of the sanitation chain. Table 1.6 represents the objective of enquiry and type of data collection instrument for each stakeholder group. The study consists of semi (or/and) structured interviews of stakeholders as well as direct observations by study team members.

Both structured and semi-structured questionnaires were used to elicit information. Data collection checklist was used by the surveyor to note down their observation. Observations were carried out to assess the procedures related to sanitation services (such as desludging, transportation of fecal sludge, etc.) and compare them with standard operating procedures to determine the current levels of service delivery and hazard mapping. Independent observation of the infrastructure was carried out to understand the condition of these systems and the threats they pose to environment and health.

Table 1.6**: Data Collection Tools**

S.No.	Data Points	Objective	Data Collection Method
1	Household Toilet	• Document the current infrastructure related to user interface and containment • Assess current design and procedures and operational practices that lead to negative impacts of improper sanitation	• Structured interview with the household member • Direct observations of the infrastructure
2	Public toilet Community toilet	• Document the condition of existing infrastructure and O&M practices	• Structured interviews with Public toilet operator / Community toilet representative • Direct observations
3	Containment	• Determine the skill and knowledge level in building toilets and containment units	• Structured interviews with masons and Observations
4	Emptying	• Determine the existing infrastructure present for desludging and transportation of fecal sludge.	• Structured interviews with Cesspool Operator Direct observations of the operation (Desludging, transportation and disposal)
5	Treatment	• Determine the current conditions of decentralised wastewater treatment units and their O&M	• Structured interview with Facility manager • Direct observations of the infrastructure
6	Reuse	• Map the current practice of sludge disposal and reuse and their implication on health and ecosystem	• Semi structured interviews with farmers

Source: TNUSSP, 2016

Table 1.7 details out the sampling procedure involved in selecting the respondents of the study.

Table 1.7: **Sampling Plan for Various Study Categories within a ULB**			
S.No.	**Study category or Response Group**	**Sampling**	**Method/ technique**
1	Household	Purposive	Households were selected based on the judgement of the enumerator.[2] One of the necessary criteria for participation in the study was presence of a household toilet.
2	Under-construction structures	Purposive	Samples were selected during the reconnaissance visit to these towns. Only those which have access to the under-construction containment units and which are not in operation were considered. This also includes interviews with masons/workers available on site.
3	Masons	Snowballing	A list of masons was populated during interaction with local community. Subsequent masons were identified or sampled from the network of masons in this list.
4	Cesspool operators	Snowballing	A list of cesspool operators was identified during interaction with the local community, subsequent operators were identified for interview from the network or linkages from the list.
5	Cesspool observation	Purposive	Observations were made for different desludging operators across subsequent days of study
6	Facility manager	Purposive	Treatment units providing access for the study were sampled. The same sample set was used for direct observation
7	Farm owners	Purposive	Farmers identified during disposal of fecal sludge during the cesspool operation observation were sampled
8	Fecal sludge sampling	Purposive	Samples were collected at the end of cesspool observation data collection module. The methodology used is further detailed out under the document “Faecal sludge Sampling and Analysis Protocol” by CDD Society under the TNUSSP
Source: TNUSSP, 2016			

[2] The sample space was stratified based on the Household wall structure; this is a proxy indicator of the sanitation infrastructure. The stratified samples were selected during a recce undertaken before the start of study. The intention was to have a representative sample of the entire town, while also being able to access the data such as septic tank dimensions, toilet conditions, etc. Hence, during the study, the enumerator visited the selected sample sets and asked a set of pre-requisite questions to the household, which when answered in affirmative enlisted the household as a sample under the study, otherwise households in the immediate vicinity were selected and the same protocol was followed.

1.1.5. Limitations of the Study

The baseline study was conducted with the objective to assess the sanitation situation across the state of Tamil Nadu. Though sufficient steps were taken to reduce the errors and biases, there were a few inherent constraints of the study which are mentioned below.

i. The study is qualitative in nature and hence cannot provide a representative assessment of the sanitation chain existing in the pilot towns.
ii. The sample size of the study is not statistically significant to draw quantitative results.
iii. The desired number of respondents as mentioned in Table 5 could not be achieved due to the inherent nature of the respondents and their availability, at a few urban local bodies.

The research methodology is designed to represent the situation of the state, but nevertheless, to get a detailed understanding of any specific region, a further study with statistically appropriate number of sample must be carried out.

1.2. Study Findings

This section presents the analysis of data collected or observed from primary and secondary research carried out under this study.

Each zone had its own specific regional characteristics like Cauvery zone mainly comprised of deltaic area due to Cauvery river flowing through the area. North eastern zone had six geographical tracts; coastal plains, hilly and mountainous area undulated with hillocks, eastern ghats, central plateau, backwater, western ghats adjoining the plateau. Western zone and north western zone had mostly undulating topography. The high-altitude zone was mostly hilly comprising Nilgiris, the Yelagiri, the Anamalai and the Palani hills. The southern zone had flat plains and intermittent hills and the high rainfall zone had no specific geographic characteristics. Hence, detailed zone level analysis was done to understand the specific characteristics of each zone and is presented in Annexures 3 to 8.

This chapter presents the comparative analysis across the zones of environmental services and components of sanitation chain.

1.2.1. Profile of the Urban Local Bodies

Table 1.8 presents the demographic details of the 21 pilot towns covered under this study as per Census 2011. As can be seen there is a high degree of variability in access to toilets in hilly, southern and north western zone. In terms of connecting toilet to containment structures, variability was noted as per census data in North Eastern zone.

Table 1.8: **Demographics of 21 Pilot Towns in Tamil Nadu**

S. No.	Zone/ Name of the ULB	Total Population	Number households	% of households with xtoilets	% of toilets connected to OSS
Cauvery Delta Zone					
1	Thanjavur (Corporation)	2,22,943	56,836	84.1%	70.6%
2	Vedaranyam (Municipality)	47,064	12,108	41.7%	99.5%
3	Tharangambadi (Town panchayat)	23,191	5,482	72.8%	99.9%
High Rainfall zone					
1	Nagercoil (municipality)	2,24,849	59,997	93.7%	100 %

Table 1.8: **Demographics of 21 Pilot Towns in Tamil Nadu**					
S. No.	**Zone/ Name of the ULB**	**Total Population**	**Number households**	**% of households with xtoilets**	**% of toilets connected to OSS**
2	Villukuri (Town panchayat)	15,304	4,037	82%	99.9 %
3	Agasteeswaram (Census town)	9,717	2,620	85.2%	99.9 %
Hilly Zone					
1	Udhagamandalam (Municipality)	88,430	23,235	65.5%	63.8%
2	Kotagiri (Town panchayat)	28,207	7,860	57.7%	99.8%
3	Naduvattam (Census town)	8,505	2,340	15.3%	99.3%
North Eastern zone					
1	Vellore (Corporation)	1,85,803	42,598	83.8%	46.1%
2	Kancheepuram (Municipality)	1,64,384	41,807	88.6%	87.7%
3	Sriperumbudur (Town Panchayat)	24,864	6,318	71.6%	99.9%
North western Zone					
1	Salem (Corporation)	8,29,267	2,15,747	75.1%	100%
2	Edappadi (Municipality)	54,823	14,560	25.8%	99.6%
3	Sankagiri (Town panchayat)	29,467	8,122	52%	100%
Southern Zone					
1	Thoothukudi (Corporation)	2,37,830	60,714	92.5%	99.8%
2	Kovilpatti (municipality)	95,057	25,099	71.6%	100%
3	Ettayapuram (Town panchayat)	12,772	3,646	40%	99.8 %
Western Zone					
1	Erode (Corporation)	1,57,101	43,184	87.5%	100%
2	Bhavani (Municipality)	39,225	11,147	67.4%	99.7%
3	Jambai (Town Panchayat)	16,522	4,789	24.3%	100%
Source: Census, 2011					

1.2.2. Household Water Supply

In each of the seven zone, for each of the 3 ULBs selected, 30 households were interviewed. This section presents the findings from households, in terms of water supply, wastewater management and sanitation arrangements.

1.2.2.1. Source of Water

Most of the households in all the seven zones depend upon municipal piped water supply for potable water. Few households in the zones depend upon household tube wells. In NEZ and CDZ few households depend upon bore well. Households also have access to groundwater through tube, bore and open wells when the groundwater table is high. The other sources of potable water include can

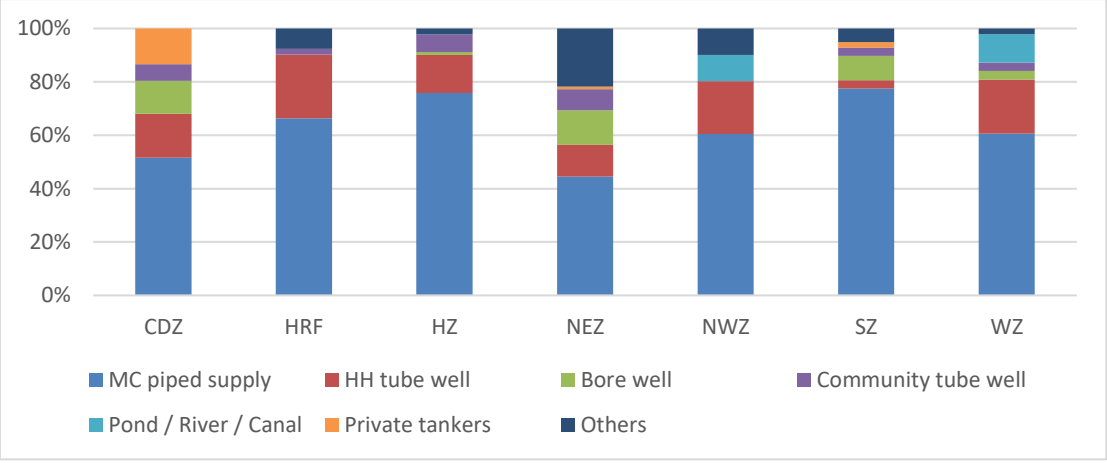
water, purifiers, RO water, aqua guard and pumps. Table 1.9 and Figure 1.2 summarise the sources of potable sources of water.

Table 1.9: **Primary sources of Potable Water for Households**

Sl. No.	Sources	MC piped supply	HH tube well	Bore well	Community tube well	Pond / River / Canal	Private tankers	Others	Total*
1	Cauvery Delta Zone	50	16	12	6	0	13	0	97
2	High Rainfall Zone	61	22	0	2	0	0	7	92
3	Hilly Zone	69	13	1	6	0	0	2	91
4	North Eastern Zone	45	12	13	8	0	1	22	101
5	North Western Zone	55	18	0	0	9	0	9	91
6	Southern Zone	76	3	9	3	0	2	5	98
7	Western Zone	57	19	3	3	10	0	2	94

Source: TNUSSP Primary Study, 2016 * Multiple response indicating number of households and hence total may not add up to 90

Figure 1.2: **Sources of Water Supply in Seven Agro Climatic Zones for Potable uses**

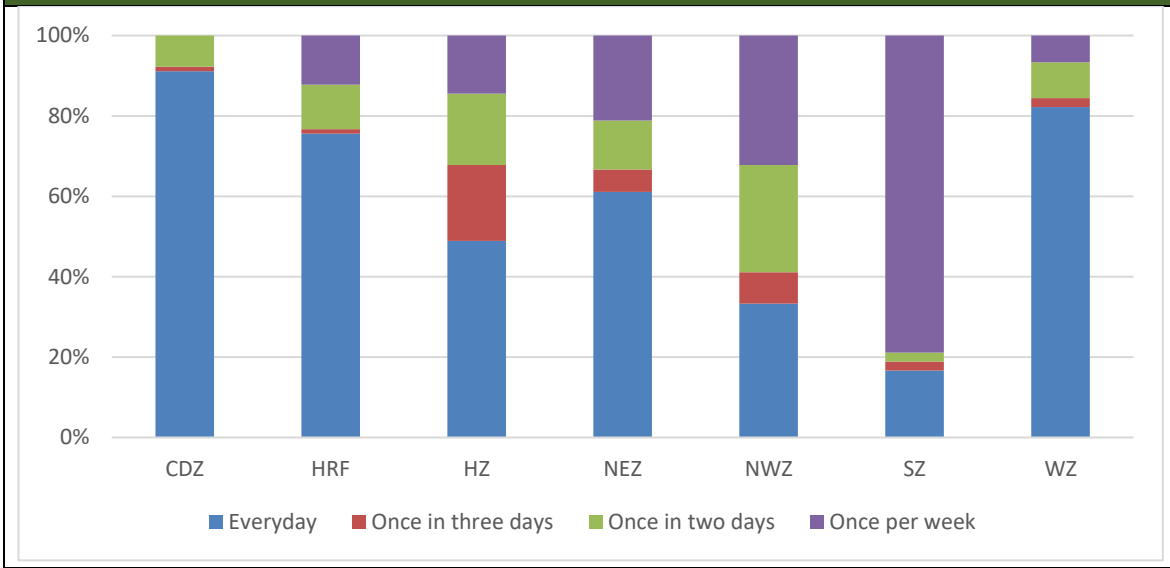


Source: TNUSSP Primary Study, 2016 Multiple response

1.2.2.2. Frequency of Water Supply

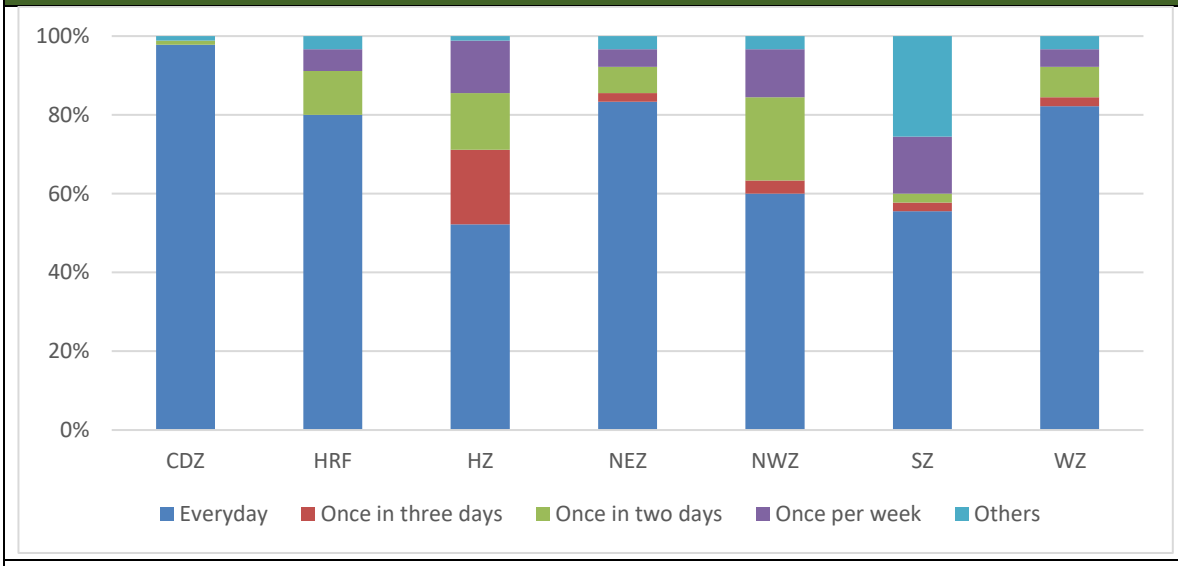
Figure 1.3 shows the frequency of water supply across zones for portable uses. When it comes to frequency of water supply, most of the households in CDZ, WZ, HRZ and NEZ get everyday water supply. Water for non-potable use came primarily from tube wells and bore wells. In such cases frequency of water supply is as per one's need and majority of the households across zones draw water every day except in Hilly Zone (Figure 1.4).

Figure 1.3: **Frequency of Water Supply for Potable uses**



Source: TNUSSP Primary Study, 2016 Base: HHs [n=90]

Figure 1.4: **Frequency of Water Supply for Non-Potable uses**



Source: TNUSSP Primary Study, 2016 Base: HHs [n=90]

1.2.2.3. Piped Water Supply

Most households covered had access to municipal piped water supply; they use this water primarily for potable purpose, while a few households had access to bore wells within their premises and the water from this was mostly used for non-potable purposes such as washing, flushing, cleaning and others. 10

out of 30 households had a metered arrangement for water supply, but nevertheless all the households paid a fixed annual fee to the municipality.

1.2.2.4. Water Supply Charge

The water supply charges across the zones were collected and analysed. For 29 per cent of the households this question was not applicable. Three fourths of the households reported having a fixed billing, while 10 per cent paid no charge, 3 per cent had a metered connection and about 11 per cent of the respondents did not know. The fee ranged from Rs.60 – Rs.150 per household and no basis for this variation could be observed in the study.

1.2.3. Household Greywater Disposal Arrangement

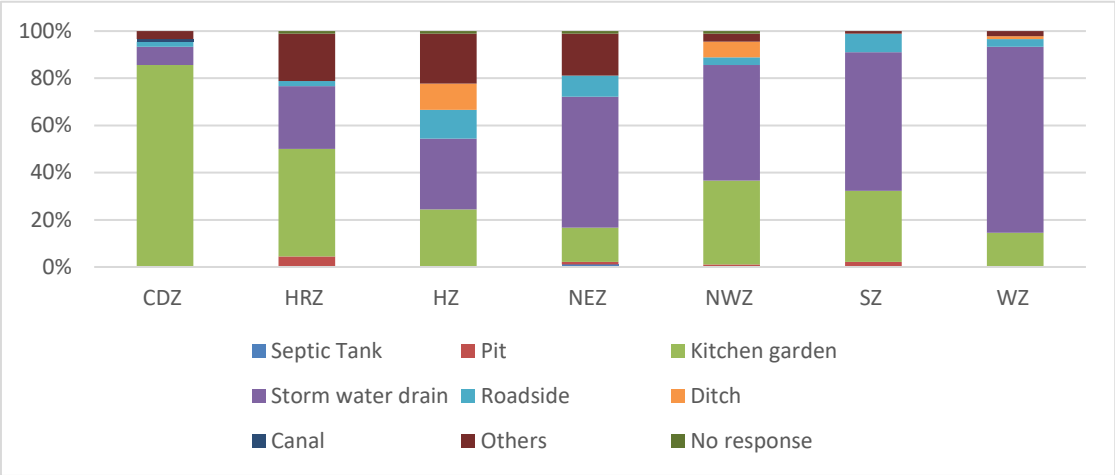
This section captures the infrastructure and arrangement at the household level set up to manage wastewater generated from other sources such as washing, bathing, kitchen, washing utensils etc. The Table 1.10 along with Figure 1.5 and Table 1.11 along with Figure 1.6 provide the various sources and the disposal point for kitchen and bathing. Kitchen garden and stormwater drain are two commonly reported arrangements for disposal of kitchen and bathing water, although inter-zone variability remains. For instance, in CDZ zone, both kitchen and bathroom water is mainly (around 80 per) disposed into kitchen garden, while in WZ, it is mainly disposed into stormwater drains.

Table 1.10: **Arrangement for Disposal of Wastewater from Kitchen**

Sl. No.	Zones	Septic Tank	Pit	Kitchen garden	Storm water drain	Roadside	Ditch	Canal	Others	Total*
1	Cauvery Delta Zone			77	7	2		1	3	90
2	High Rainfall Zone		4	41	24	2			18	89
3	Hilly Zone			22	27	11	10		19	89
4	North Eastern Zone	1	1	13	50	8			16	89
5	North Western Zone		1	32	44	3	6		3	89
6	Southern Zone		2	27	53	7			1	90
7	Western Zone			13	71	3	1		2	90

Source: TNUSSP Primary Study, 2016 *Number of households, may not add up to 90 due to non-response

Figure 1.5: **Arrangement for Disposal of Wastewater from Kitchen**



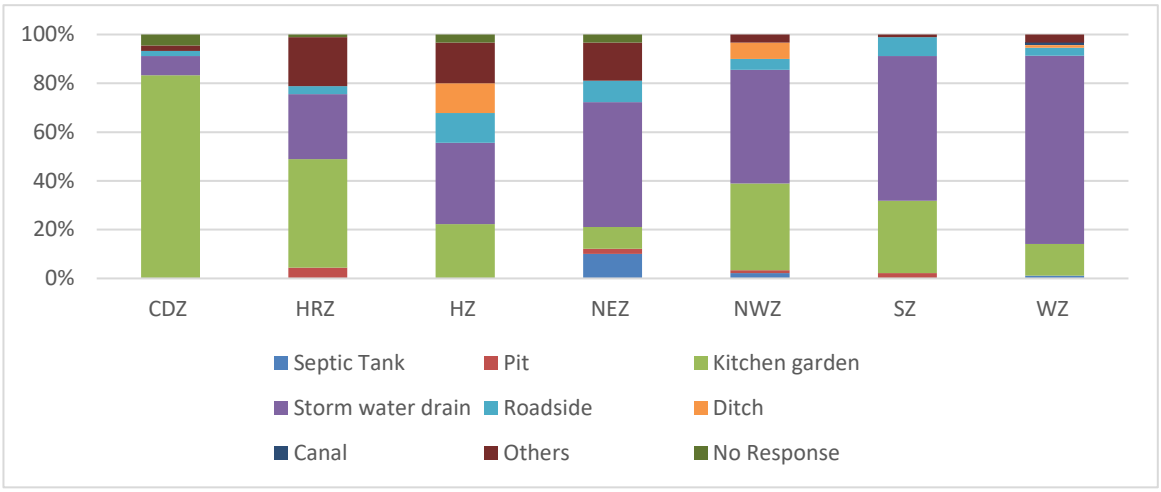
Source: TNUSSP Primary Study, 2016 Base: HHs [n=90]

Table 1.11 **Arrangement for Disposal of Wastewater from Bathing**

Sl. No.	Zones	Septic Tank	Pit	Kitchen garden	Storm water drain	Roadside	Ditch	Canal	Others	Total
1	Cauvery Delta Zone			75	7	2			2	86
2	High Rainfall Zone		4	40	24	3			18	89
3	Hilly Zone			20	30	11	11		15	87
4	North Eastern Zone	9	2	8	46	8			14	87
5	North Western Zone	2	1	32	42	4	6		2	89
6	Southern Zone		2	27	54	7			1	91
7	Western Zone	1		12	71	3	1	1	3	92

Source: TNUSSP Primary Study, 2016 *Data represents number of households, may not add up to 90 due to non-response, multiple response

Figure 1.6: **Arrangement for Disposal of Wastewater from Bathing**



Source: TNUSSP Primary Study, 2016 Multiple response Base: HHs [n=90]

1.2.4. Household Sanitation Arrangement

1.2.4.1. Number and Location of Household Toilets

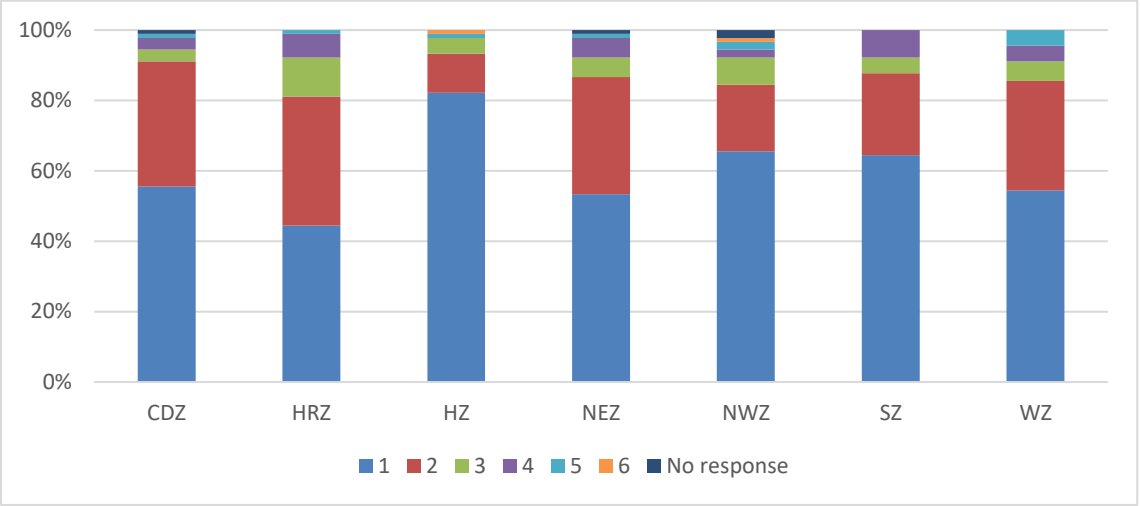
Households were purposively sampled to have at least one toilet. In the sample of 630 households across the seven zones, 60 per cent of the households have at least 1 toilet in the house while around 27 per cent households have 2 toilets.

Table 1.12: **Number of Toilets in the House**

S.No	Zones	1	2	3	4	5	6	No response	Total
1	Cauvery Delta Zone	50	32	3	3	1	0	1	90
2	High Rainfall Zone	40	33	10	6	1	0	0	90
3	Hilly Zone	74	10	4	0	1	1	0	90
4	North Eastern Zone	48	30	5	5	1	0	1	90
5	North Western Zone	59	17	7	2	2	1	2	90
6	Southern Zone	58	21	4	7	0	0	0	90
7	Western Zone	49	28	5	4	4	0	0	90

Source: TNUSSP Primary Study, 2016 Base: HHs [n=90]

Figure 1.7: **Number of Household Toilets**



Source: TNUSSP Primary Study, 2016 Base: HHs [n=90]

The toilet in the covered households is mostly located at the rear of the house (41 per cent) followed by 27 per cent households having the toilets within the house (Table 1.13 and Figure 1.8). Southern zone has the highest number of households with toilets on the rear side. In the high rainfall zones, in addition to high number of toilets being constructed on the rear side a high number of toilets are also constructed within the house. In all the zones it has been uniformly reported that a very less number of 7.8 per cent of toilets are constructed outside the house.

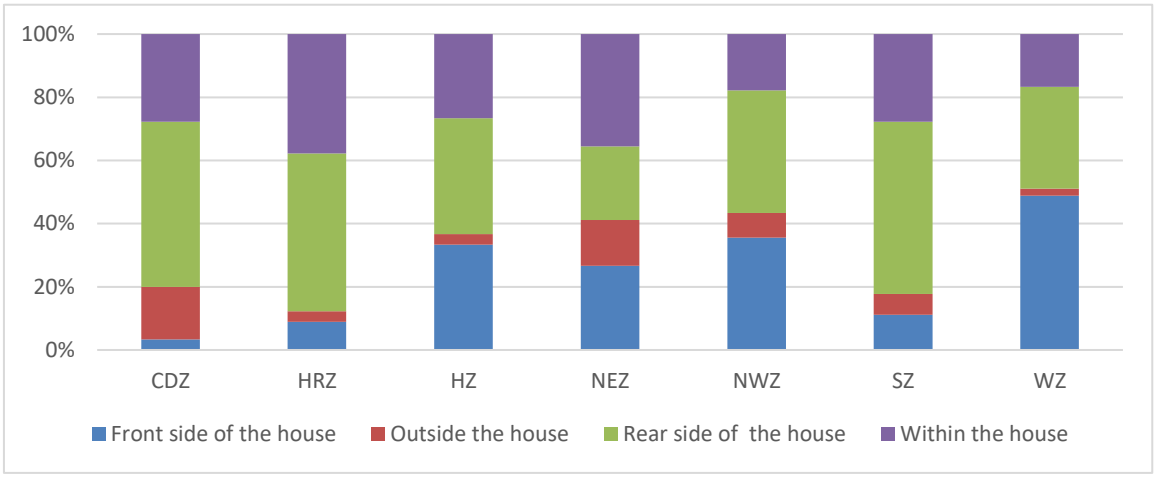
Table 1.13: **Location of Household Toilet**

Sl. No.	Zones	Front side of the house	Outside the house	Rear side of the house	Within the house	Total
1	Cauvery delta zone	3	15	47	25	90
2	High rainfall zone	8	3	45	34	90
3	Hilly Zone	30	3	33	24	90
4	North eastern zone	24	13	21	32	90
5	North western zone	32	7	35	16	90
6	Southern zone	10	6	49	25	90
7	Western zone	44	2	29	15	90

Source: TNUSSP Primary Study, 2016 Base: HHs [n=90]

A majority 85 per cent of households have attributed space availability as the prime factor for locating the toilet in the particular area while a small 13 per cent of households have reported *Vaastu* (religious customs in designing a house) as the influencing factor.

Figure 1.8: **Location of Household Toilets**



Source: TNUSSP Primary Study, 2016 Base: HHs [n=90]

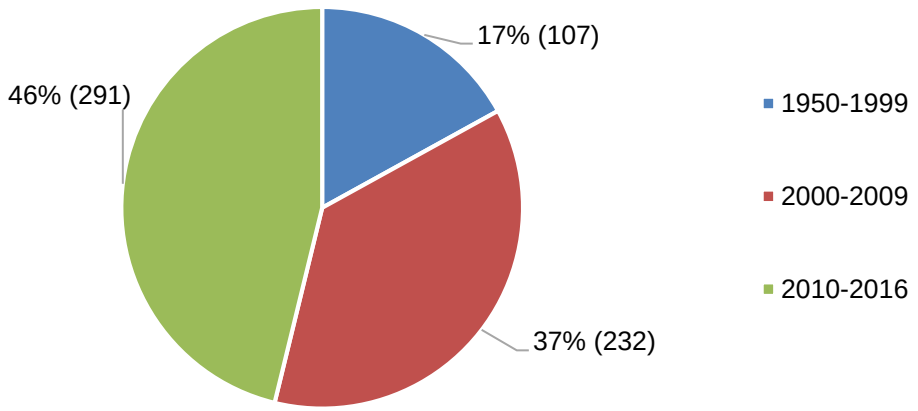
1.2.4.2. Period of Toilet Construction

Households were asked about the reasons for initiating toilet construction. The number of responses stating factors relating to people for toilet construction have been limited. However, in many cases it has been stated that the owner of the house was responsible for construction of toilets. Additionally, reasons such as government schemes and personal and women safety have also been recorded as reasons for initiating construction of toilets.

The toilets in all the seven zones have mostly (85 per cent) been constructed around the same time as the construction of the houses. Overall, 92 per cent from three zone High Rainfall Zone (HRZ), North East Zone (NEZ) and West Zone (WZ) had toilets constructed same time as house construction. A total of 89 of the 630 sampled households across the zones reported that the toilet was not constructed during the time of constructing the house.

It was observed that post 2000 the number of households constructing toilet had increased. A majority 46 per cent of the households have constructed their toilets between 2010 and 2016. More than half of the households had constructed the toilets from 2014 onwards. This trend is observed in the hilly zone, southern zone and in the north western zone. The increase in take up for individual household toilets maybe due to the various and level programmes that promoted construction of individual household toilets across the state. About 36 per cent households constructed toilets between 2000 and 2009. Only a small 17 per cent households have constructed their toilets between 1950 and1999 (Figure 1.9).

Figure 1.9: **Period of Toilet Construction**



Source: TNUSSP Primary Study, 2016 Cumulative percentages across zones

1.2.4.3. Characteristics of Household Toilet

Superstructure of the toilets in all the zones has walls mainly made of bricks (95 per cent) and few with tin/metal/AC sheets, RCC, bamboo/wood, and stone/cement mortar. The roofing materials used were either RCC slab (65 per cent) or tin/metal/AC sheets (27 per cent), while few had brick, bamboo/wood, and stone/cement mortar. Majority of the households had a pour flush system, while about a third had cistern flush. Indian toilet was the commonly reported toilet type (86 per cent) while the rest reported western toilet.

Toilets built in these seven cluster zones varied widely in size ranging from 1.3 to 2.8 sq.m. In the sample, 72 per cent of the households had a tap within the toilet, while 6 per cent had it outside the toilet and the rest stored water in buckets and tanks. The tap connectivity outside toilets in all the seven zones was in the average range of 1-3 m distance from the toilet. An average of 87 percent of the households across the zones had squatting pan with water seal and P trap was the major plumbing fixture for most of the households. Across the zone an average of 85 per cent of households had ventilation and lighting provision inside the toilet. Table 1.14 provides an overall view of toilet physical infrastructure across zones.

Table 1.14: **Physical Infrastructure of Household Toilets**

Sl. No	Zones	Squatting pan*		Type of trap*		Tap connection*		Ventilation*		Lighting provision inside toilet*	
		With water seal	Without water seal	S trap	P trap	Inside toilet	Outside toilet	Yes	No	Yes	No
1	Cauvery delta zone	87	0	2	88	73	4	72	18	83	7
2	High rainfall zone	64	1	15	75	62	11	81	9	78	12

Table 1.14: **Physical Infrastructure of Household Toilets**											
Sl. No	**Zones**	**Squatting pan***		**Type of trap***		**Tap connection***		**Ventilation***		**Lighting provision inside toilet***	
		With water seal	**Without water seal**	**S trap**	**P trap**	**Inside toilet**	**Outside toilet**	**Yes**	**No**	**Yes**	**No**
3	Hilly Zone	83	1			43	5	77	13	73	17
4	North eastern zone	84	0	1	89	68	7	74	16	72	18
5	North western zone	69	0	11	79	72	5	79	11	80	10
6	Southern zone	87	0	0	90	68	3	69	21	68	18
7	Western zone	75	0	12	78	68	5	83	7	83	7
	Total	**549**	**2**	**41**	**499**	**454**	**40**	**535**	**95**	**537**	**89**

Source: TNUSSP Primary Study, 2016 * Data represents number of households, which may not add up to 90 in each zone on account of non-response

Figure 1.10: **User interface in one of the household in hilly zone**

Source: TNUSSP Primary Study, 2016

1.2.4.4. Household Containment Structures

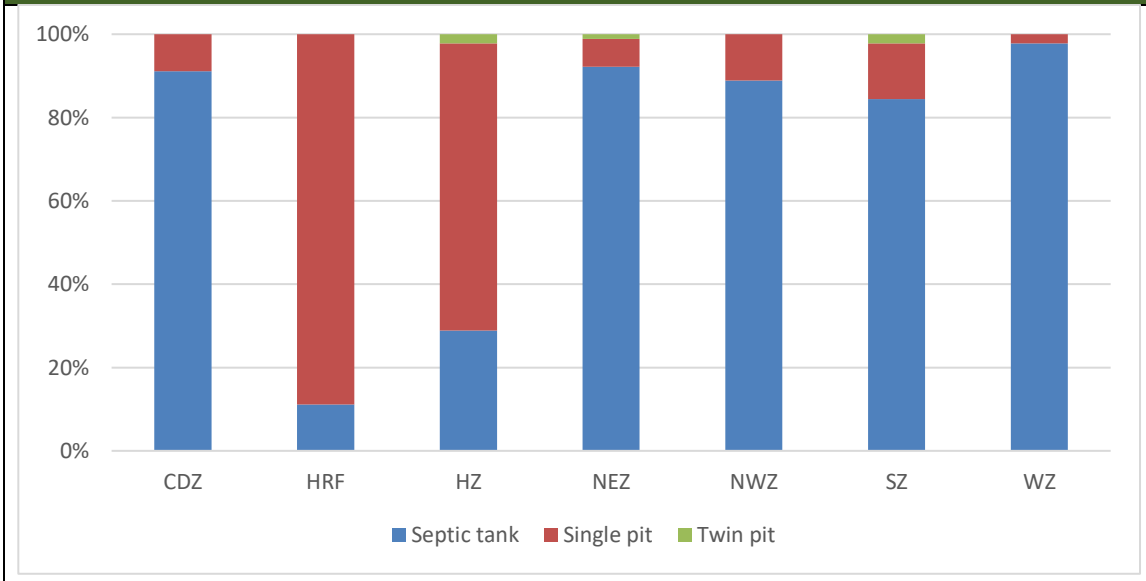
Of the 630 households covered across the state, a majority 444 households (70 per cent) have reported presence of septic tanks in the households, while 29 per of the households had single pits (Table 1.15 and Figure 1.11). Households in five of the seven zones depend heavily on septic tanks. High rainfall zone (88 per cent) and Hilly Zone (69 per cent) have high dependency on single pit disposal system. One similarity observed in all the zones is that all the septic tanks have their overflow discharge into stormwater drains.

Table 1.15: Types of **Containment Systems reported by Households**

S.No.	Zone	Septic tank	Single pit	Twin pit	Total
1	Cauvery Delta Zone	82	8	0	90
2	High Rainfall Zone	10	80	0	90
3	Hilly Zone	26	62	2	90
4	North Eastern Zone	83	6	1	90
5	North Western Zone	80	10	0	90
6	Southern Zone	76	12	2	90
7	Western Zone	88	2	0	90
8	Total	445	189	5	630

Source: TNUSSP Primary Study, 2016 Base: HHs [n=90]

Figure 1.11: **Types of Containment Systems by Zones**



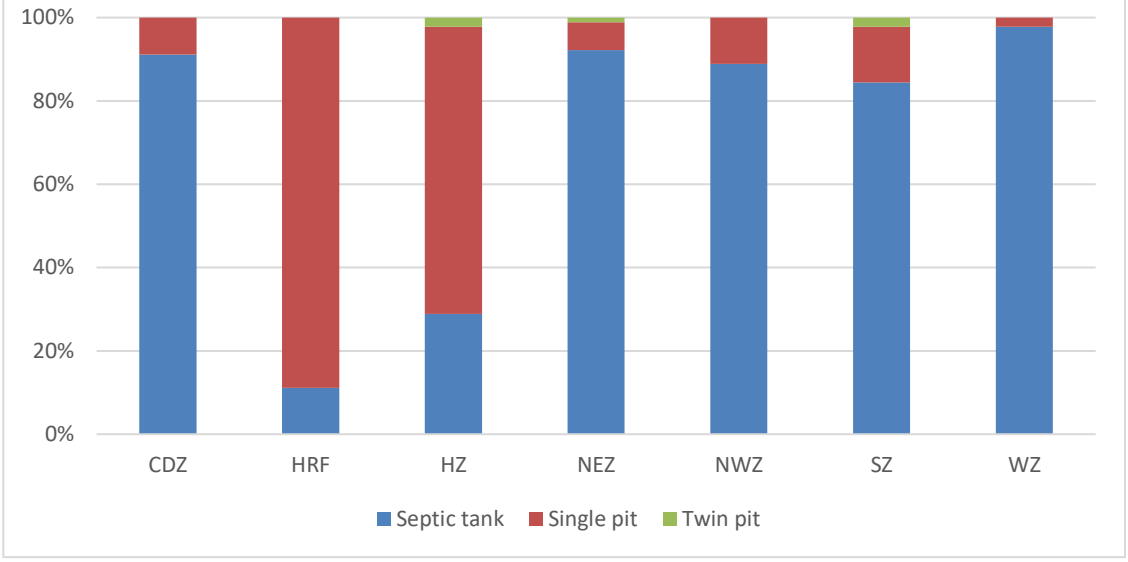
Source: TNUSSP Primary Study, 2016 Base: HHs [n=90]

a. Septic Tanks

While majority containment units reported by households are septic tanks, to check if the containment units reported as septic tanks meet the design standards certain observations were conducted during the baseline study.

The presence of partition wall is a major differentiator between a holding tank and septic tank. Of the 445 households with septic tanks, only in 170 HHs (38 per cent) the presence of partition walls was observed while a higher number of 220 HHs (50 per cent) did not have partition walls in the containment units. Of the 170 households which report partition wall, just 70 reported on the number of partition walls. Of these, two thirds of the households report having one partition while the rest largely comprises of two partition walls.

Figure 1.12: **Presence of Partition Wall in Septic Tanks**



Source: TNUSSP Primary Study, 2016

Table 1.16: **Septic Tank Characteristics across Zones**

			Characteristics of Septic Tanks								
			Vent Pipe*		Lined Bottom*		Manhole*		Connection to Soak Pit*		
S. No.	Zone	Septic tank	Yes	No	Yes	No	Yes	No	Yes	No	Others
1	Cauvery Delta Zone	82	69	8	36	39	14	63	6	62	1
2	High Rainfall Zone	10	7	1	6	3	5	5	1	7	0
3	Hilly Zone	26	23	3	18	7	13	7	1	22	3
4	North Eastern Zone	83	75	7	51	27	25	57	1	70	0

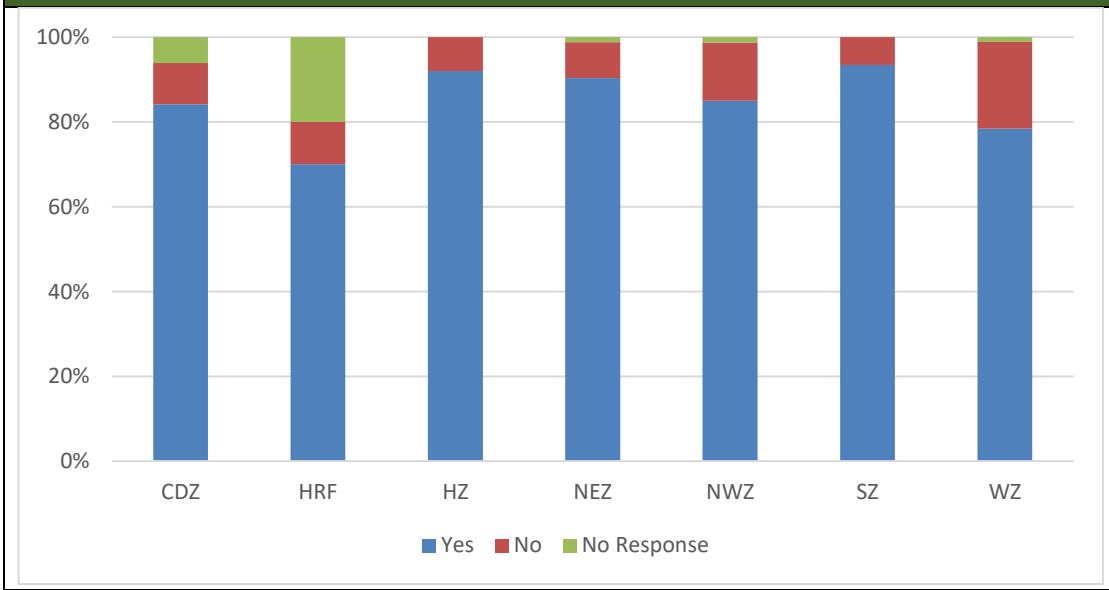
Table 1.16: **Septic Tank Characteristics across Zones**

			Characteristics of Septic Tanks								
			Vent Pipe*		Lined Bottom*		Manhole*		Connection to Soak Pit*		
S. No.	Zone	Septic tank	Yes	No	Yes	No	Yes	No	Yes	No	Others
5	North Western Zone	80	68	11	73	6	19	61	2	45	11
6	Southern Zone	76	71	5	71	5	8	68	4	68	2
7	Western Zone	88	69	18	82	5	10	76	1	76	4
8	**Total**	**444**	**382**	**53**	**337**	**92**	**94**	**337**	**16**	**350**	**20**

Source: TNUSSP Primary Study, 2016
*Data represents number of households. If total no. of responses in characteristics of septic tank do not add to no. of households with septic tank, it is on account of non-response

Information on vent pipe is available for 435 of the 444 septic tanks. Notably a high number of septic tanks are provisioned with a vent pipe (Figure 1.13). In the north eastern zone (75 HHs) and southern zone (71 HHs), the highest presence of vent pipes have been observed while the least number of vent pipes are observed in the high rainfall zone (7 HHs).

Figure 1.13: **Presence of Vent Pipes in Septic Tanks**

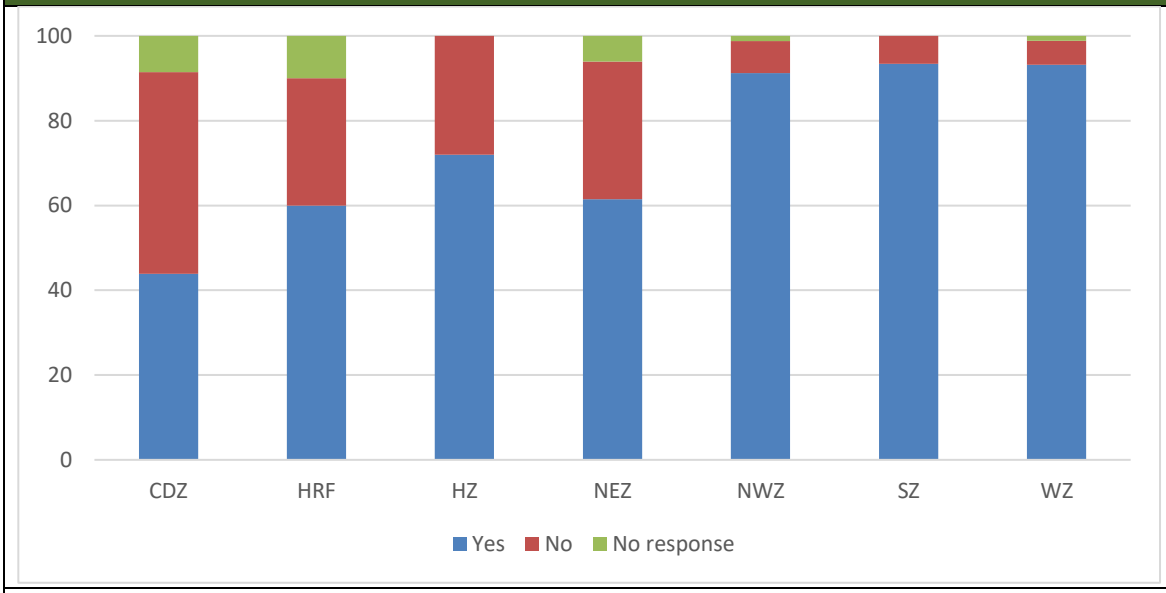


Source: TNUSSP Primary Study, 2016

Information on tank lining was available for 429 of the 444 septic tanks (Figure 1.14). The data from the observations revealed that in a considerable number of households of the western zone (93 per cent), north western zone (91 per cent) and southern zone (93 per cent) septic tanks are lined at the bottom.

It has also been observed that in the Cauvery delta zone, of the total 82 households, 44 per cent have septic tanks with lined bottom while 48 per cent are not lined at the bottom.

Figure 1.14: **Septic Tank Lining**



Source: TNUSSP Primary Study, 2016

The presence of a manhole was noted in 21 per cent of the septic tanks across households. Again, in the high rainfall zone, lesser households had manholes in septic tanks, while north east zone had higher number of households reporting presence of manholes in septic tanks. The number of manholes provisioned in the septic tank is majorly restricted to 1.

The trend from the above indicators clearly highlights that a majority of the septic tanks in the north eastern zone, north western and southern zone align with the design standards of standard septic tanks. There have also been observations to check if the septic tank is connected to a soak pit corresponding to the design standards. The data received explain that a majority of the households (90 per cent) do not have their septic tanks connected to a soak pit, while in 16 households it is connected and 20 households have other arrangements.

The measurement of a septic tank as observed are presented in terms of length, width and depth according to their respective zones in Table 1.17. The average range for length, width and depth of a septic tank is between 1 and 3 metre.

Table 1.17: **Dimensions of Septic Tank**

S.No	Zones					
	Length of Septic Tank (Metres)					
		1<	1-3	3-5	6-7	Total
1	Cauvery Delta Zone	0	63	15	0	78
2	High Rainfall Zone	1	7	1	0	9
3	Hilly Zone	0	24	2	0	26
4	North Eastern Zone	1	60	20	1	82
5	North Western Zone	0	68	12	0	80

Table 1.17: **Dimensions of Septic Tank**						
S.No	**Zones**					
6	Southern Zone	1	65	10	0	76
7	Western Zone	0	84	2	2	88
	Total	**3**	**371**	**62**	**3**	**439**
	Width of Septic Tank (Metres)					
		1<	**1-3**	**3-6**	**Total**	
1	Cauvery Delta Zone	3	71	4	78	
2	High Rainfall Zone	1	7	1	9	
3	Hilly Zone	0	26	0	26	
4	North Eastern Zone	5	73	4	82	
5	North Western Zone	3	73	4	80	
6	Southern Zone	4	72	0	76	
7	Western Zone	5	83	0	88	
	Total	**21**	**405**	**13**	**439**	
	Depth of Septic Tank (Metres)					
		1-3	3-5	5-10	**Total**	
1	Cauvery Delta Zone	60	14	0	**74**	
2	High Rainfall Zone	7	1	1	**9**	
3	Hilly Zone	23	3	0	**26**	
4	North Eastern Zone	50	29	0	**79**	
5	North Western Zone	64	16	0	**80**	
6	Southern Zone	71	4	0	**75**	
7	Western Zone	74	7	2	**83**	
	Total	**349**	**74**	**3**	**426**	

Source: TNUSSP Primary Study, 2016
Data represents number of households, total data may not add up to 444, which is number of households with septic tank on account of non-response

Overall, the mean size of septic tank is 2.6 m^3. At the zone level, the mean ranges between 2.4 m^3 in SZ and 3.5 m^3 in HRZ. The median is 2.4 m^3 across WZ, CDZ, SZ, HZ and slightly higher in NEZ, NWZ and HRZ. The mode across zones is 3.0 m^3 except in HZ which is 2.4 m^3, indicating a depth which is slightly lower than the other zones.

Table 1.18: **Septic Tank Size (Metre cube)**				
S. No	**Zones**	**Mean**	**Median**	**Mode**
1	Cauvery Delta Zone	2.6	2.4	3.0
2	High Rainfall Zone	3.5	3.0	3.0
3	Hilly Zone	2.5	2.4	2.4
4	North Eastern Zone	2.6	2.7	3.0
5	North Western Zone	2.6	2.6	3.0
6	Southern Zone	2.4	2.4	3.0
7	Western Zone	2.6	2.4	3.0
	Total	**2.6**	**2.4**	**3.0**

Source: TNUSSP Primary Study, 2016

b. Single Pit

After septic tanks, single pits have reported to be the next common containment systems across the seven zones (20 per cent of the households). The covered data revealed that high rainfall and hilly zones have reported high number of single pits in comparison to septic tanks. To understand the design of single pits certain indicators were covered and observed across the zones. Analysis of number of rings in a single pit revealed that on an average 5-8 rings were observed in a single pit. Further the height of the ring was observed to be between 1 and 2 metre while the diameter was 3-4 feet. Number of rings in a single pit is shown in Table 1.19.

Table 1.19: **Number of Rings in Single Pits**

			No. of Rings in the Single Pit					
S.No.	**Zones**	**No. of Single pit**	**2-4**	**5-8**	**9-11**	**12-15**	**No response**	**Total of responses**
1	Cauvery Delta Zone	8	0	8	0	0	0	8
2	High Rainfall Zone	80	1	7	1	0	71	9
3	Hilly Zone	62	3	36	11	5	7	55
4	North Eastern Zone	6	2	3	1	0	0	6
5	North Western Zone	10	1	6	0	0	3	7
6	Southern Zone	12	1	9	2	0	0	12
7	Western Zone	2	1	1	0	0	0	2
	Total	**180**	**10**	**70**	**15**	**6**	**79**	

Source: TNUSSP Primary Study, 2016 Data represents number of households.

In the absence of information on the number and size of rings, data was collected on total depth of the single pit in feet. The high rainfall zone has reported a maximum of 33 households with single pits having a depth of 10 feet. On the question of presence of vent pipe, 72 per cent of the households responded affirmatively, while the rest offered no response. The high rainfall zone (66 per cent) and hilly zone (73 per cent) have given the highest positive responses for presence of vent pipes.

1.2.4.5. Desludging at the Household Level

It was reported that 90 per cent of the containment (septic tanks and pits) systems were constructed at the same time the toilet was constructed and the data revealed that majority of the toilets along with the containment systems were constructed after 2000. In spite of 90 percent of the fact that containment systems were reported to have existed longer than 10 year period, only 36 per cent of the households have stated that the containment unit ever filled up completely and that it was de-sludged. The reasons for desludging were mainly attributed to backflow into the toilet (102 HHs) and overflow of containment (93 HHs). About 58 percent of the households report that the containment has never filled up till date, especially in hilly zone (75 per cent), North West Zone (68 per cent), followed by nearly half the households in other zones. Cauvery delta zone has the most number of households which have containment units filling up within one-year and the Cauvery delta zone also has the most number of households with containment systems taking more than five years to fill.

Further, analysis was carried out to see if the lining of the containment had any implications on containment filling up rate. An analysis on time taken for lined containment systems to fill up reveals that even within lined containment systems it has been reported that 55 per cent of the tanks have not filled up till date, while 16 per cent take more than five years to fill up, and 9 per cent of the containments take anywhere between 3 to 5 years to fill up.

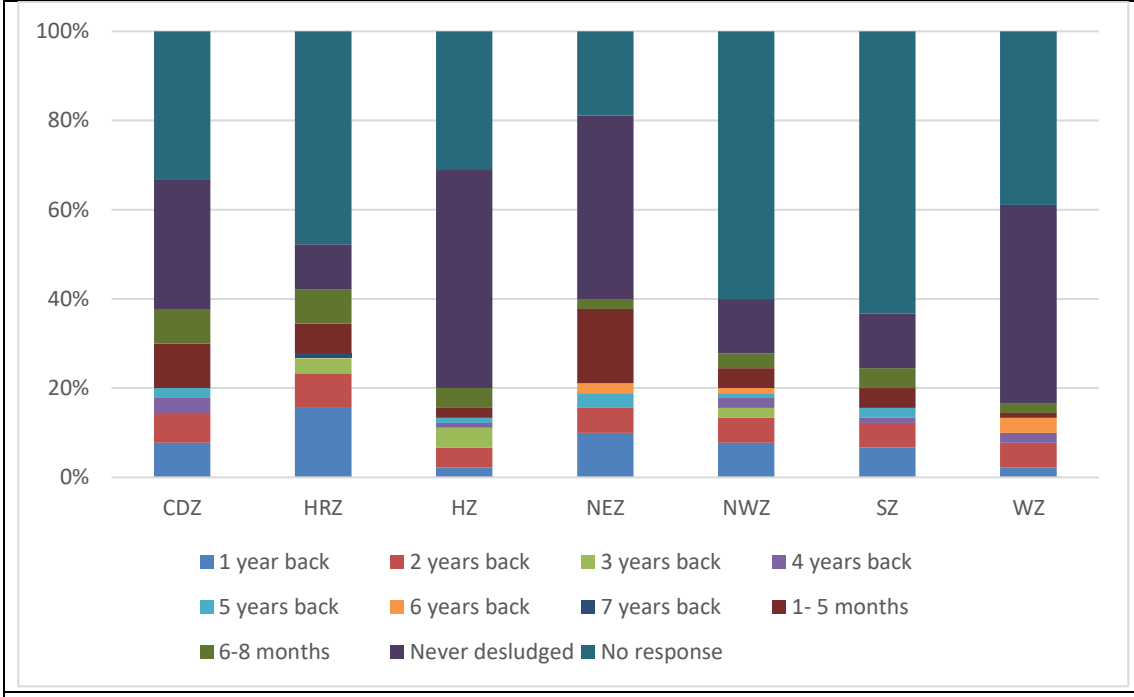
In terms of desludging, Table 1.20 and Figure 1.15 highlights that very few households have reported desludging while a majority 28 per cent claimed to have never de-sludged, of which Hilly Zone has the maximum number of households (50 per cent) who have never de-sludged. About 30 per cent of all households report desludging anywhere between 1 month and seven years ago. Of this, High Rainfall Zone, North East Zone and Cauvery Delta Zone report nearly 40 per cent of the households desludging anywhere between past one month and seven years since the last desludging.

Table 1.20: **Period when Septic Tank/Pit last De-sludged**

Sl. No.	Last-desludged	1 year back	2 years back	3 years back	4 years back	5 years back	6 years back	7 years back	1- 5 months	6-8 months	Never desludged	No response	Total
1	Cauvery delta zone	7	6	0	3	2	0	0	9	7	26	30	90
2	High rainfall zone	14	7	3	0	0	0	1	6	7	9	43	90
3	Hilly Zone	2	4	4	1	1	0	0	2	4	44	28	90
4	North eastern zone	9	5	0	0	3	2	0	15	2	37	17	90
5	North western zone	7	5	2	2	1	1	0	4	3	11	54	90
6	Southern zone	6	5	0	1	2	0	0	4	4	11	57	90
7	Western zone	2	5	0	2	0	3	0	1	2	40	35	90
	Total	**47**	**37**	**9**	**9**	**9**	**6**	**1**	**41**	**29**	**178**	**264**	**630**

Source: TNUSSP Primary Study, 2016 Base: HHs [n=90]

Figure 1.15: **Period when Septic Tank/ Pit last De-sludged**



Source: TNUSSP Primary Study, 2016

Asked on the frequency of desludging, a third of the households reported never having done it, of which a higher fraction of the households were from Western Zone and North West Zone. The responses on frequency of desludging are mostly skewed towards more than a five-year period, with the high rainfall zone reporting highest desludging frequency.

Wider road access facilitates easy access to containment structures for desludging vehicles. In the sample, 211 households have a road width between 3 and 5 metres, while 202 households report a road width of 0-3 metres.

Table 1.21: **Nearest Road Width for Households**

S.No	Zones	0-3m	3-5m	5-10m	10-20m	20-30m	30-50m	>50m	Total
1	Cauvery Delta Zone	36	34	2	3	5	1	0	81
2	High Rainfall Zone	2	6	66	10	5	0	0	89
3	Hilly Zone	17	9	16	8	6	5	25	86
4	North Eastern Zone	16	52	3	4	0	0	0	75
5	North Western Zone	42	38	5	3	0	1	1	90
6	Southern Zone	38	36	0	0	0	0	0	74
7	Western Zone	51	36	0	0	0	0	0	87
	Total	**202**	**211**	**92**	**28**	**16**	**7**	**26**	**582**

Source: TNUSSP Primary Study, 2016
Zone wise row totals may not add up to 90 on account of non-response
Base: HHs [n=90]

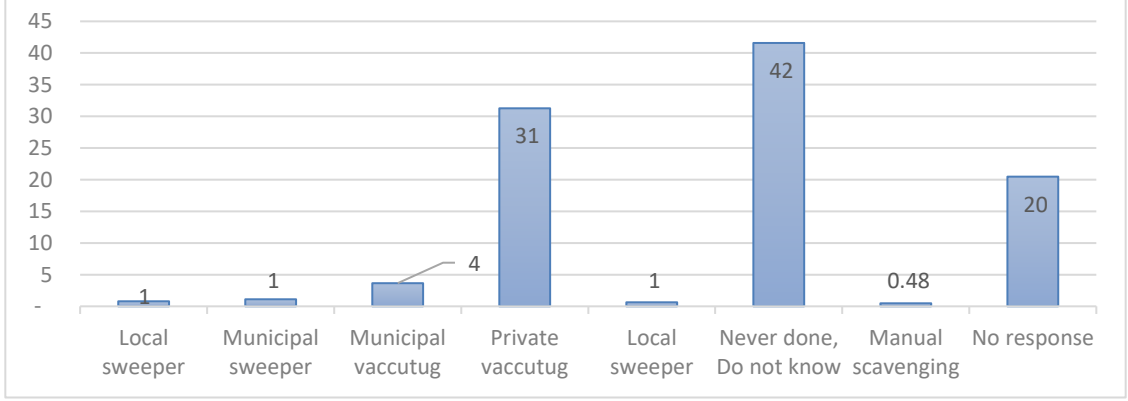
As regards the means of emptying, there is a clear consensus on private vacuutugs being the prominent option for desludging with 197 out of the 239 responding households using their services. About 23 households report using municipal desludging services, while 16 households use services of sweepers and three households use services of manual scavengers.

Table 1.22: **Types of Desludging Operators used by Households**

S. No	Desludging Operators	Local sweeper	Municipal sweeper	Municipal vaccutug	Private vaccutug	Never done, Do not know	Manual scavenging	No response	Total
1	Cauvery delta zone	0	0	9	35	27	0	19	90
2	High rainfall zone	0	2	3	44	25	2	14	90
3	Hilly Zone	0	1	4	14	54	0	17	90
4	North eastern zone	0	0	1	37	35	0	17	90
5	North western zone	2	0	2	25	51	1	9	90
6	Southern zone	2	4	4	31	20	0	29	90
7	Western zone	5	0	0	11	50	0	24	90
	Total	**9**	**7**	**23**	**197**	**262**	**3**	**129**	**630**

Source: TNUSSP Primary Study, 2016 Base: HHs [n=90]

Figure 1.16: **Types of Desludging Operators used by Households**



Source: TNUSSP Primary Study, 2016 Data in percentages, aggregate across Zones

Of the total 630 households covered, only 27 per cent (168 HHs) households have given information on desludging costs while the majority 73 per cent households have not responded or do not have

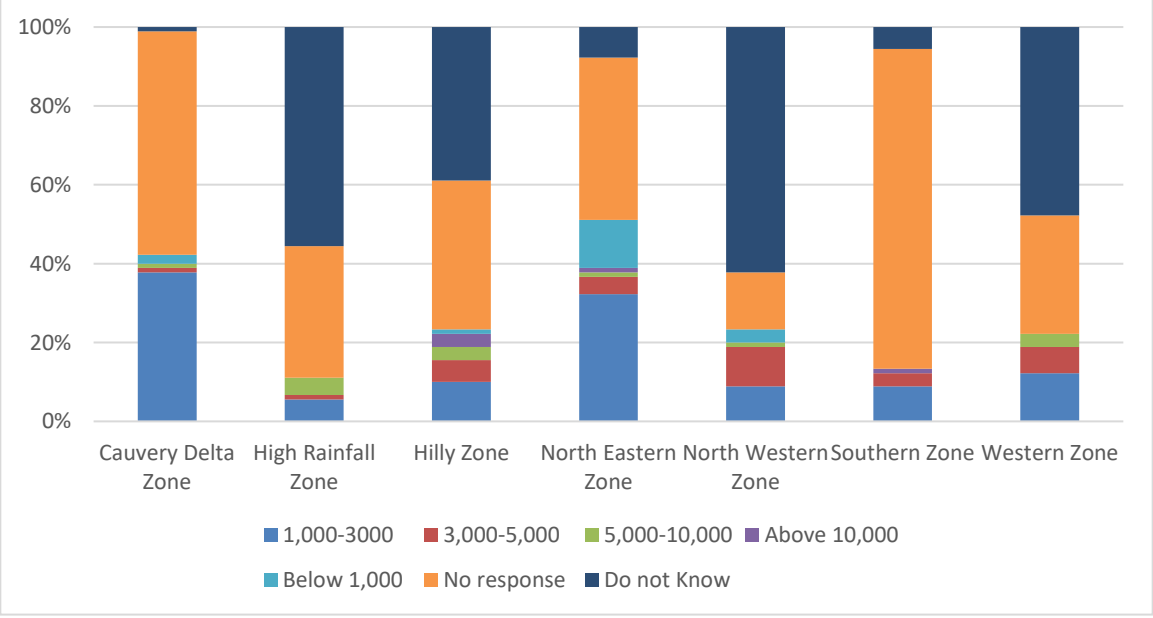
information on costs (Figure 1.17). Of the households who have responded, a majority of 104 households (17 per cent) have stated payments for desludging costs to be between Rs. 1,000 and 3,000 and this range applies for households across all zones (Table 1.23). A small 3 per cent of households have reported paying less than Rs. 1,000 for desludging. The Cauvery delta zone and north eastern zone have provided maximum responses on desludging costs and this again majorly falls in the 1,000-3,000 range. Irrespective of the number of private players in each zone the desludging costs ranges between 1,000 and 3,000 across zones.

Table 1.23: **Desludging costs**

S. No	Zones	1,000-3000	3,000-5,000	5,000-10,000	Above 10,000	Below 1,000	No response	Do not Know	Total
1	Cauvery delta zone	34	1	1	0	2	51	1	90
2	High rainfall zone	5	1	4	0	0	30	50	90
3	Hilly Zone	9	5	3	3	1	34	35	90
4	North eastern zone	29	4	1	1	11	37	7	90
5	North western zone	8	9	1	0	3	13	56	90
6	Southern zone	8	3	0	1	0	73	5	90
7	Western zone	11	6	3	0	0	27	43	90
	Total	**104**	**29**	**13**	**5**	**17**	**265**	**197**	**630**

Source: TNUSSP Primary Study, 2016 Base: HHs [n=90]

Figure 1.17: **Cost of Desludging reported by Households**



Source: TNUSSP Primary Study, 2016 Base: HHs [n=90]

1.2.5. Assessment of Public Toilets

In addition to the household survey, representatives from 41 public toilets were interviewed and unobstructed observations were carried out at 52 public toilets as part of this study. In terms of zones, SZ accounted for nine public toilets, CDZ had eight, NWZ had seven public toilet facilities each; HZ and WZ accounted for five each; NEZ had four and HRZ had three. Twenty two of these 41 facilities were found to be located within bus stand premises, five in marketplaces and nine in public spaces such as parks or tourist spots. Most commonly reported peak usage timings were 5-8 am (53 per cent) and 9-11 am (38 per cent). About 40 per cent of facilities reported daily usage by over 100 persons, while 27 per cent each reported 'more than 50 users' or 'between 50 and 100' users.

Over 90 per cent of these facilities had separate sections for men and women, over 85 per cent of the facilities surveyed had between 1 and 5 urinals and between 1 and 8 latrines each in both men's and women's sections. A third of the total facilities reported an average of five latrines. Seventeen facilities had bathing facilities for men, while 16 facilities had bathing facilities for women (ranging between 1 and 15 bathing cubicles). Indian closet was the main type of toilet found. Five facilities had western toilets in the men's section and 18 facilities had wash basins. For women, only four facilities had western toilets and 16 facilities had wash basins.

In terms of containment structures, 36 facilities were found connected to a septic tank, three were connected to sewer networks, one in Sriperumbudur bus stand was connected to an open drain while there was one non-response. Majority of containment structures were built along with the toilet structure. For 43 per cent of facilities, containment structures took up to one year to fill up, for 15 per cent, it took 1-2 years, while for 10 per cent of the facilities surveyed, it took up to five years for the containment to fill up. Accordingly, frequency of desludging varies from once a month (one facility), once in six months (eight), once a year (nine), to once in two years (eight) and over five years (four facilities). About 12 facilities reported needing between 2-3 trips to de-sludge their septic tanks, while one facility each reported requiring four, five and 10 trips to de-sludge septic tanks.

Seventy per cent of the public toilets were found to be operated by private parties, while 24 per cent were operated by an urban local body. Private parties were reported to have been recruited mainly by tendering process, while in a few cases, they were reportedly local contacts of ULBs or panchayats.
In over 90 per cent of cases surveyed, even when operated by a ULB, toilets were found to be maintained by a private agency or individual contracted by ULB. Nineteen facilities were reported to have one operator, 16 facilities had two operators, and three facilities had three operators. Only 18 facilities reported having female sections managed by a separate operator. Most commonly reported maintenance shifts were 8-hour shifts (29 per cent), followed by 6-hour shifts (51 per cent). Cleaning, supervision and fee collection were found to be the main responsibilities of an operator. Desludging services are sought from private operators and ULB and are paid mainly by private operators of public toilets.

In 70 per cent of the facilities, cleaning was found to be done by a sweeper, while in the rest, it was done by the operators themselves. In 70 per cent of the facilities, cleaning was done once every day; in 17 per cent, it was done thrice a day; and in 7 per cent, it was done twice a day. Bleaching powder (92 per cent of facilities), phenyl (68 per cent), acid (31 per cent), soap oil (31 per cent) were the commonly-used cleaning agents. These are purchased either by the operator (49 per cent) or the supervisor (44 per cent). Majority of the facilities have an inventory of cleaning products which are reportedly refilled on a weekly (73 per cent), bi-weekly (10 per cent) and monthly basis (12 per cent).

Water in these facilities was found to be mainly sourced from borewells (49 per cent), as well as tubewells/ handpumps (17 per cent), private tankers (15 per cent) and piped supply (12 per cent). Over 90 per cent of the facilities reported daily water supply, while three facilities reported water supply every alternate day. Of these, about 70 per cent reported continuous water supply, while in five facilities water

was found to be available only for one hour, and in four facilities, for two hours. While respondents were unaware of the exact value of the water bill, it was reported to be paid by the ULB in 20 per cent of cases, and in 54 per cent of the cases, it was paid by a supervisor/ private contractor.

Daily supervision was reported by 36 per cent of cases, weekly by 29 per cent, and monthly by 20 per cent. In 70 per cent of cases, inspection by government representatives was also reported.

1.2.6. Emptying and Transportation

A total of 47 operators were interviewed to understand the desludging practices across the seven zones. Of the 47 respondents, 26 per cent are owners of desludging services, while the rest are employees. Desludging services were reported to have started anywhere from 1 – 2 years up to 14 – 15 years, while the majority of 11 operators stated, the service have been started 4 – 5 years ago. 70 per cent of the owners own 1 truck, 15 per cent have 2 trucks, 9 per cent have 3 trucks and 1 service provider has 5. Mostly, desludging of septic tanks is the only service, while few also offer removal of cow dung. 79 per cent of the operators use business cards, which are distributed to households as a source of marketing, whereas pamphlets, mobile numbers on tankers or display boards at public places are rarely being used. The busiest times during the day are from 6 – 12 am in the months from October – December.

The data on characteristics of the desludging vehicle reveals that a majority 36 per cent operators reported tank capacity between 4,500-7,000 litres and 2,000-4,500 litres each. In the western zone and Cauvery delta zone, most number of operators have reported tank capacities between 2,000 and 4,500 litres while in the north western zone and high rainfall zone majority of the operators have reported tank capacities between 4500 and 7000 litres. Further, only in the north eastern zone and Cauvery delta zone the operators have reported tank capacities of more than 7,000 litres for desludging.

Table 1.24: **Tank Capacity (litres)**

S. No	Capacity (in litres)	2,000-4,500	4,500-9,500	Above 9,500	No response	Total
1	Cauvery delta zone	4	1	2	3	10
2	High rainfall zone	1	5	0	0	6
3	Hilly Zone	1	2	0	1	4
4	North eastern zone	3	0	7	0	10
5	North western zone	0	7	0	0	7
6	Southern zone	3	1	0	0	4
7	Western zone	5	1	0	0	6
	Total	**17**	**17**	**9**	**4**	**47**

Source: TNUSSP Primary Study, 2016 Data represents responses from 47 desludging vehicle operators

Maximum responses for question on distance travelled to households for desludging have been elicited from the operators in the Cauvery delta zone and north eastern zone. While majority 49 per cent operators have reported travelling between 6 and 20 kms to reach the households, a considerable 38 per cent operators have reported travelling up to 50 kms.

Table 1.25: **Distance to Households for De-sludging**						
S. No.	**Distance (in kms)**	**6-20**	**20-50**	**Above 100**	**Blanks**	**Total**
1	Cauvery Delta Zone	8	2	0	0	10
2	High Rainfall Zone	2	4	0	0	6
3	Hilly Zone	1	1	1	1	4
4	North Eastern Zone	7	1	0	2	10
5	North Western Zone	1	4	2	0	7
6	Southern Zone	2	2	0	0	4
7	Western Zone	2	4	0	0	6
	Total	**23**	**18**	**3**	**3**	**47**
Source: TNUSSP Primary Study, 2016 Data represents responses from 47 desludging vehicle operators						

The Cauvery delta zone and the north eastern zone have the maximum number of operators traversing between 6 and 20 kms. The high rainfall zone, north western zone and western zone have the maximum number of operators plying between 20 and 50 kms. Operators in the Hilly zone and North western zone have claimed to travel distances above 50 kms and this is very negligible at 6 per cent.

Nine out of 47 operators stated to also desludge chemical waste from industries such as leather, needle, clothes, oil, rubber, steel, communication and soft drink companies. Only in 2 cases, operators from Sriperumbudur and Nagercoil stated, all parts of the city would be accessible by the cesspool. Non-accessible locations are mentioned in the above sections. Containment units without openings are broken by the operator in most cases and sometimes by household members. A majority is using a steel rod and hammer for breaking the tank. This process can take a time of only 3 minutes or up to 2 hours and among all interviewed operators about 30 min on average. Independent of the time duration required for this, about 32 per cent of the operators charge Rs.100 – 600 extra for this service.

Table 1.26: **Distance to Discharge Point**						
S. No.	**Distance to discharge point (Km)**	**0-20**	**20-50**	**200**	**No response**	**Total**
1	Cauvery Delta Zone	9	1	0	0	10
2	High Rainfall Zone	4	2	0	0	6
3	Hilly Zone	1	0	1	2	4
4	North Eastern Zone	8	1	0	1	10
5	North Western Zone	6	1	0	0	7
6	Southern Zone	2	2	0	0	4
7	Western Zone	6	0	0	0	5
	Total	**36**	**7**	**1**	**3**	**47**
Source: TNUSSP Primary Study, 2016 Data represents responses from 47 desludging vehicle operators						

Majority of the operators (77 per cent) from all zones travel only between 0 and 20 kms distance to the discharge point. Operators were asked about the reasons for not disposing at the treatment plant. The reasons stated were primarily distance and time followed by procedures which is represented in Table 1.30. Contrary to other zones, in the north eastern zone maximum number of people have stated procedures as the chief reason for not discharging in the treatment plant while distance and time have not been a pressing factor for not emptying at the treatment plants in this zone.

Table 1.27: **Reasons for not Discharging in the Treatment Plant**					
S.No	**Zones**	**Procedures**	**Distance**	**Time**	**Total**
1	Cauvery delta zone	1	5	5	11
2	High rainfall zone	0	6	5	11
3	Hilly Zone	0	3	3	6
4	North eastern zone	6	1	2	9
5	North western zone	2	5	5	12
6	Southern zone	1	3	3	7
7	Western zone	0	6	6	12
	Total	**10**	**29**	**29**	**68**
Source: TNUSSP Primary Study, 2016 Data represents multiple responses from 47 desludging vehicle operators					

Out of the 47 operators interviewed, only 24 operators have revealed using personal protective equipment. The operators from the north western zone have reported highest usage of personal protective equipment and overall, masks are stated as the most used safety equipment across zones.

1.2.7. Treatment and Reuse

1.2.7.1. Treatment

As part of the study, wastewater treatment plants were assessed for their functionality and to understand the extent of wastewater management. Most of the towns covered had no treatment plants for the city/town level, though there were a few private treatment units, these were operated in closed boundaries and the entry to these were not easy and hence the study does not have data on such treatment units. In few of the cities such as Kancheepuram, Thanjavur, Vedaranyam and Ooty there were treatment plants, which could be assessed, however no dedicated operator was available during the study to provide details on these assets. The following are some information and observations made during the visit to the above-mentioned treatment plants.

a. Vedaranyam

A treatment plant, also called “Arakathu thurai sanitation system” was built for rehabilitating tsunami affected households. A simplified sewer system collects and transfers the sewage (both black and greywater) to the treatment plant, which works, on principles of moving bed bio-reactor (MBBR). The treatment plant is operational for the past 10 years and was funded by the World Bank. The treatment plant is operated by the urban local body, which also pays for the operational and maintenance requirement. It covers only certain wards of the town, only those which are rehabilitated tsunami structures, while the remaining households in the town have onsite sanitation systems for containing blackwater and their greywater is discharged into open drains.

b. Thanjavur

Thanjavur has an extensive area covered by underground drainage network. The wastewater from all the households connected to the network drain into a treatment plant working on the principles of aerated sludge process. The treatment plant has a provision for an operator room and laboratory, but during the study, neither operator nor any lab instruments were found. The treated wastewater still had turbidity and smell of ammonia; it was being discharged into a nearby lake. The sludge handling facility in the treatment plant is unutilised with several maintenance issues related to the drying bed, pumps and distribution channels. The treatment facility is also located in a remote setting making it difficult to locate and thereby limiting the changes of co-treating fecal sludge.

c. Ooty

The wastewater from entire Udhagamandalam is conveyed through pump to the treatment plant. The capacity of the treatment plant is about 5 million litres/day and wastewater is treated using activated sludge process. The treatment process includes primary, secondary and sludge treatment facilities. The wastewater goes through a screen chamber to remove all the larger floating particles such as plastics. The screened wastewater is then conveyed to primary treatment unit for grit removal. Then the wastewater is conveyed to the two aeration units where the organics undergo aerobic decomposition and then it is brought into secondary clarifier, where sufficient retention time is provided for the settling of sludge. The clarified water is then disposed of into the sewage farms. Some portion of sludge is re-circulated into the aeration units as activated sludge. Excess sludge is then sent into the sludge thickener and then undergoes membrane press for sludge dewatering and layer on sludge drying bed for drying.

Figure 1.18: **A) Aerobic Treatment Plant Unit at Thanjavur, b) Treated Effluent Foaming at the Outlet Point**

Source: TNUSSP Primary Study, 2016

Figure 1.19: **Aeration Treatment Module at Ooty**

Source: TNUSSP Primary Study, 2016

d. Kancheepuram

The first Under Ground Sewerage Scheme (UGSS) was commissioned in 1978 which covers a total of 85 km after which the new UGSS scheme was commissioned in 2014 which covers a collection length of 33.51 km. Total household connections to the UGSS as per DPR is 26,836 whereas only 18,643 connections are given as on date. The collected sewage is being treated by a Waste Stabilisation Pond (Figure 5.3) that covers an area of 25.46 acres and has a capacity of 14.71 MLD. It currently treats 9 MLD and the treated water is being discharged into a lake.

Figure 1.20: **Waste Stabilisation Pond at Kancheepuram**

Source: TNUSSP Primary Study, 2016

At a few treatment plants visited during the study, it was found that systems built years ago such as those in Salem, where the construction completed 5 years ago, the plants yet await commissioning, this is due to the fact that households are yet to be connected to sewer networks.

1.2.7.2. Reuse

The reuse part of the study was carried out by interviewing farmers from various agro climatic zones of Tamil Nadu. The below sections describe the characteristics and operational reuse modalities of these farmers across the various zones and also compare them at a state level. The use of wastewater for irrigation purpose was practiced in 5 zones except in hilly and western zone. Out of the total 43 farmers covered, 39 percent i.e.17 farmers reported using wastewater for irrigation and 30 percent i.e. 13 farmers reported use of fecal sludge as soil conditioner. Fecal sludge as soil conditioning was used to grow crops such as coconut, banana, leafy vegetables, potatoes, cabbage, and sugarcane. The reasons stated for use of wastewater was presence of high nutrient value and lack of freshwater availability. None of the farmers stated the occurrence of any water-borne diseases except for one farmer in north eastern zone who claimed that one of his family members suffered from cholera. However, to establish the exact linkage between wastewater use and disease requires further focused study. The zone wise details of wastewater irrigation and crops grown are given in Table 1.28.

Table 1.28: **Wastewater Reuse across Zones by Farmers**							
S. No	**Zones**	**No of farmers interviewed**	**Common source of irrigation**	**Wastewater used (No. of farmers)**		**Crops irrigated by wastewater**	**Fecal sludge used- (No. of farmers)**
				Yes	**No**		
1	Cauvery delta zone	7	Bore wells	5	2	Banana, Rice, Coconut, Bamboo	2
2	High rainfall zone	6	Canals, bore wells	2	4	Banana, Coconut, Leaves	1
3	Hilly Zone	8	Bore wells, open wells	0	8	-	1
4	North eastern zone	5	Lake, canal, open wells	4	1	Sugarcane, Groundnut, Rice	3
5	North western zone	6	Bore wells, Open wells	3	3	Rice, Corn, Leaves	2
6	Southern zone	4	Bore wells, Open wells	3	1	Banana, Rice	0
7	Western zone	7	Bore wells, Open wells	0	7	-	4
Source: TNUSSP Primary Study, 2016							

1.2.7.3. Aggregate Reuse across all Zones

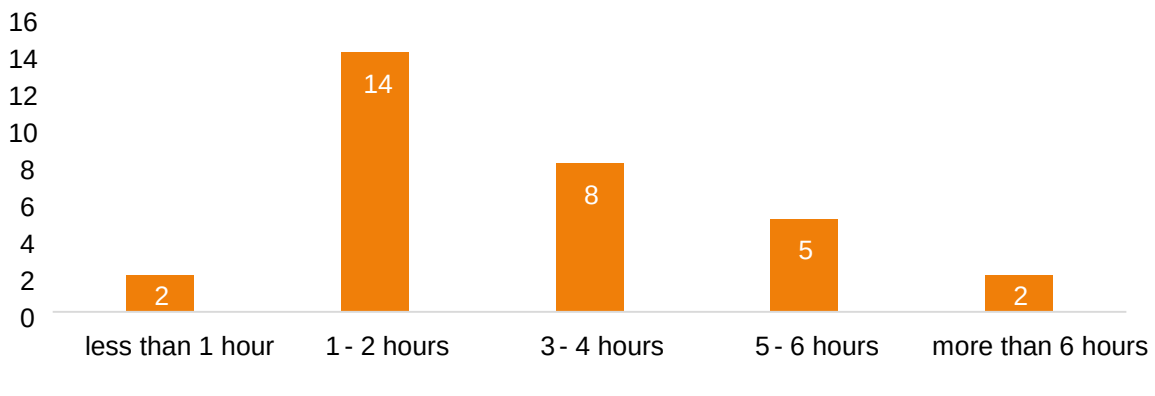
In this section the data collected across all 7 zones, as described in detail above is aggregated to give an overview of the overall characteristics and operational reuse modalities in Tamil Nadu. For irrigation purposes, the majority of the farmers use surface irrigation and only 3 farmers practice irrigation through sprinklers and 2 practice dripping irrigation. Freshwater is being used for the irrigation of the following crops and vegetables as shown in Table 1.29.

Table 1.29: **Crops Irrigated with Freshwater**									
S.No	**Crop/ Vegetable**	**Total number of farmers**	**Cauvery Delta Zone**	**High Rainfall Zone**	**Hilly Zone**	**North Eastern Zone**	**North Western Zone**	**Southern Zone**	**Western Zone**
1	Rice	14	2	2		4	3	3	
2	Banana	10	1	5				3	1
3	Corn	6					5		1
4	Carrots	6			6				
5	Coconut	5		4					1
6	Potatoes	3		3					
7	Sugarcane	4	1						3

Table 1.29: **Crops Irrigated with Freshwater**									
S.No	**Crop/ Vegetable**	**Total number of farmers**	**Cauvery Delta Zone**	**High Rainfall Zone**	**Hilly Zone**	**North Eastern Zone**	**North Western Zone**	**Southern Zone**	**Western Zone**
8	Groundnut	3				2	1		
9	Cabbage	4		4					
10	Tapioca	2							2
11	Mango	2		1				1	
12	Brinjal	1					1		
13	White onion	1		1					
14	Guava	1						1	
15	Beet root	1		1					
16	Ladyfinger	1		1					
17	Cauliflower	1		1					
18	Beans	1		1					
19	Radish	1		1					
Source: TNUSSP Primary Study, 2016							Responses represent number of farmers		

The sources of fresh water supply for irrigation are bore wells and open wells in most cases (35% respectively). Some farmers use water from canals or rainwater (14% respectively). A few farmers from the delta zone use saltwater. 63% of the farmers stated, freshwater would be available throughout the year, while the remaining 37% face seasonal problems, mostly during summer. 1 – 2 hours of daily water supply is most frequent as shown in Figure 1.20.

Figure 1.21: **Duration of Freshwater Supply**



Source: TNUSSP Primary Study, 2016 (Data represents number of responses)

68 per cent of the farmers stated pumping would be required for availing irrigation water but only 3 out of them specified the costs of electricity related to irrigation (Rs.100, Rs.300 & Rs.1,200). None of the interviewed farmers across all zones pays for water supply for irrigation and only 3 mentioned there would be a subsidy available for irrigation (all 3 from different zones and towns).

Most frequently used fertilisers are urea and potassium, while goat as well as cow dung are commonly used as well. Less frequently, M45, TAP and compost are being used. Usually, the fertiliser is manually mixed with soil and brought to the fields. The costs for fertilisers differ vastly across the farmers covered, starting from Rs.300 up to Rs.50,000. On average about 3,700 are being paid for fertilisers.

40% of the farmers stated to also use wastewater for irrigation, because of its high nutritious value (10 cases) or due to a lack of fresh water (6 cases). In the western zone, none of the farmers uses wastewater. Sources are either own septic tanks/ pits (10 cases) or STP outlets (3 cases), supplied by the farmer (7 cases), private truck operators (6 cases) or the municipality (3 cases). Usually, no transportation of wastewater is required and farmers do not pay for the supply. The types of crops irrigated with wastewater are listed in Table 1.30.

Table 1.30: **Crops Irrigated with Wastewater**

S. No	Crop/ vegetable	Number of total farmers	Cauvery Delta Zone	High Rainfall Zone	Hilly Zone	North Eastern Zone	North Western Zone	Southern Zone	Western Zone
1	Rice	9	4			3	1	1	
2	Banana	6	2	2				2	
3	Coconut	3	1	2					
4	Leaves	2		1			1		
5	Corn	2					2		
6	Groundnut	1				1			
7	Sugar cane	1				1			
8	Bamboo	1	1						

Source: TNUSSP Primary Study, 2016

Among all 47 covered farmers, only 1 mentioned, one of his family members suffered from cholera, whereas all remaining interviewed farmers did not report any cases of water-borne related diseases among their family members. Four of the farmers stated to receive complaints regarding the quality of crops/ vegetables. Restrictions from government bodies/ organisations towards the use of wastewater for irrigation are not known by any of the farmers.

28% of the farmers across all zones claim to use fecal sludge as soil conditioner. Out of these, 7 farmers use dried sludge and 5 farmers use fresh sludge from cesspool. The sludge is supplied to the fields during cultivation (7 cases) or 3 days to 3 months after the arrival of the sludge on the farm. Most farmers engage a private desludging operator for fecal sludge disposal. Only 1 of the farmers pays Rs.50 for availing fecal sludge, while the remaining ones neither pay for the sludge nor are paid by the disposer. Crops grown with the use of fecal sludge are listed in Table 1.31 below.

Table 1.31: **Crops grown using faecal sludge**									
S. No	**Crop/ vegetable**	**Number of total farmers**	**Cauvery Delta Zone**	**High Rainfall Zone**	**Hilly Zone**	**North Eastern Zone**	**North Western Zone**	**Southern Zone**	**Western Zone**
1	Sugarcane	4				2			2
2	Banana	3		1			1		1
3	Coconut	3		1			1		1
4	Leaves	2	1	1					
5	Rice	1	1						
6	Potato	1			1				
7	Cabbage	1			1				
8	Tapioca	1							1
9	Grass for cows	1	1						
10	Mango	1							1
Source: TNUSSP Primary Study, 2016									

Figure 1.22: **Farmers being Interviewed at Ooty and Erode**

Source: TNUSSP Primary Study, 2016

With 1 exception, none of the farmers using fecal sludge suffers from mosquitoes breeding due to fecal sludge and only 1 farmer uses pesticides (bleaching powder) against mosquitos and other pests. None of the farmers uses any equipment while handling fecal sludge. In 2 cases, farmers face problems when using fecal sludge as soil conditioner: one stated that the crops would not grow properly while another one mentioned it would affect other crops than the intended one as well. None of the farmers knew about any restrictions from government bodies/ organisations towards the use of fecal sludge for agricultural purpose.

Annexures

Annexure 1: Brief on Agro Climatic Zones

A1.1. Cauvery Delta Zone

It is spread across a total area of 24,943 sq. km and comprises of districts of Thanjavur, Tiruchirappalli, Pudukottai, Cuddalore and Villupuram districts. It is a deltaic area with Cauvery being a major river flowing through the region. The terrain is plain with the altitude varying between 6 and 250 m above MSL and a gentle slope towards the east. The region receives high rainfall of 1192 mm. Temperatures in the region vary between 38.6°C in summers and 21°C during winters. Table A1.1 below summaries the geological properties across this region:

Table A1.1: **Water Table, Water Quality and Soil Type in Cauvery Delta Zone**

Sl. No.		
1	**Water table level**	Winter: 1.6 – 2.6 m, below ground level (bgl) Summer: 4.7 – 5.8 m, bgl
2	**Water quality**	740 – 1340 micromhos/cm
3	**Soil**[3]	Red Loamy and Alluvium. The hydrological soil group 'B' with moderate infiltration and moderate runoff potential predominant in this block to the extent of 87%. The soil group 'C' with slow infiltration and moderate runoff potential covers about 12% area of the block. Hydrological soil group 'A' with high infiltration and low runoff potential constitute a very little area to the extent of 1%.

Source: Institute of Remote Sensing, Identification of Recharge areas Using Remote Sensing and GIS in Tamil Nadu, Anna University, Chennai, 1998 – 1999

A1.2. High Rainfall Zone

It covers 1,684 sq.km encompassing the entire district of Kanyakumari. The average rainfall is around 1,456 mm, with temperatures varying between 37°C in summers and 24°C in winters. The climate is sub-humid with heavy influences from southwest and northeast monsoons. A summary of the geological properties is depicted below in Table A1.2.

[3] Soils are classified by the Natural Resource Conservation Service into four Hydrologic Soil Groups based on the soil's runoff potential. The four Hydrologic Soils Groups are A, B, C and D.
Group A is sand, loamy sand or sandy loam types of soils. It has low runoff potential and high infiltration rates even when thoroughly wetted. They consist chiefly of deep, well to excessively drained sands or gravels and have a high rate of water transmission.
Group B is silt loam or loam. It has a moderate infiltration rate when thoroughly wetted and consists chiefly or moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures.
Group C soils are sandy clay loam. They have low infiltration rates when thoroughly wetted and consist chiefly of soils with a layer that impedes downward movement of water and soils with moderately fine to fine structure.
Group D soils are clay loam, silty clay loam, sandy clay, silty clay or clay. This HSG has the highest runoff potential. They have very low infiltration rates when thoroughly wetted and consist chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface and shallow soils over nearly impervious material.

Table A1.2: **Water Table, Water Quality and Soil Type in High Rainfall Areas of Tamil Nadu**		
Sl. No.		
1	**Water table level**	Summer: 19 – 36 m, bgl Winter: 19 – 35 m, bgl
2	**Water quality**	500 - 1000 micromhos/cm
3	**Soil**	Saline coastal alluvium, deep red loam.
		The hydrological soil group 'B' with moderate infiltration and moderate runoff potential covers 52% area of the block. The remaining 48% of the area is constituted by soil group 'C' with slow infiltration and moderate runoff potential.
Source: Institute of Remote Sensing, Identification of Recharge areas Using Remote Sensing and GIS in Tamil Nadu, Anna University, Chennai, 1998 – 1999		

A1.3. Hilly Zone

It comprises an area of 2,549 sq. km and covers the Nilgiris, the Yelagiri, the Anamalai and the Palani hills. The rainfall varies between 1000 and 5000 mm and the temperatures between 24°C in summers and 7°C in winters. A summary of the geological properties is tabulated below in Table A1.3.

Table A1.3: **Water Table, Water Quality and Soil Type in High Altitude Zones of Tamil Nadu**		
Sl. No.		
1	**Water table level**	Summer: 2 to 3 m, bgl Winter: 1.5 to 2.7 m, bgl
2	**Water quality**	170 – 660 micromhos/cm
3	**Soil**	Laterite
Source: Institute of Remote Sensing, Identification of Recharge areas Using Remote Sensing and GIS in Tamil Nadu, Anna University, Chennai, 1998 – 1999		

A1.1.1. North Eastern Zone

It covers a total area of 32,194 sq. km under districts of Chengalpattu, Tiruvallur, Kancheepuram, Vellore, Tiruvannamalai, Villupuram, Cuddalore and Perambalur districts. The region can be further sub-classified into six geographical tracts; coastal plains, hilly and mountainous area undulated with hillocks, eastern ghats, central plateau, backwater, and western ghats adjoining the plateau. The region receives an average rainfall of 989 mm in a year, with temperatures varying between 40°C in summers and 21°C in winters. A summary of the geological properties is tabulated below in Table A1.4

Table A1.4: **Water Table, Water Quality and Soil Type in North Eastern Zone of Tamil Nadu**		
Sl. No.		
1	**Water table level**	Summer: 10.3 to 16.6 m, bgl Winter: 7.03 to 15.64 m, bgl

Table A1.4: **Water Table, Water Quality and Soil Type in North Eastern Zone of Tamil Nadu**		
2	**Water quality**[4]	1500 – 4000 micromhos/cm
3	**Soil**	Red sandy loam, clay loam and saline coastal alluvium. Hydrological soil group 'B' with moderate infiltration and moderate runoff potential constitute about more than half of the area of the block. The hydrological soil group 'C' with slow infiltration and moderate runoff potential covers a little more than one-third area of the block. Hydrological soil group 'A' with high infiltration and low runoff potential covers the rest of the area.
Source: Institute of Remote Sensing, Identification of Recharge areas Using Remote Sensing and GIS in Tamil Nadu, Anna University, Chennai, 1998 – 1999		

A1.1.2. North Western Zone

It constitutes an area of 16,150 sq. km under Dharmapuri, Salem and Namakkal districts. This zone experiences frequent drought with climate varying between semi-arid and sub-humid. The annual rainfall ranges between 560 and 1,080 mm and temperatures between 42°C in summers and 10°C in winters. The region has undulating topography with peaks ranging between 600 and 1,000 m above MSL. A summary of the geological properties is tabulated below in Table A1.5.

Table A1.5: **Water Table, Water Quality And Soil Type In North Western Zone Of Tamil Nadu**		
Sl. No.		
1	**Water table level**	Summer: 4.4 to 19 m, bgl Winter: 2.9 to 9.5 m, bgl
2	**Water quality**	930 – 1375 micromhos/cm
3	**Soil**	Non calcareous red, non-calcareous brown, calcareous black. The hydrological soil group 'D' with very slow rate of infiltration covers more than half of the block area. The hydrological soil group 'C' with slow rate of infiltration covers about one third of the area. The hydrological soil groups 'B' and 'A' with moderate and high rate of infiltration cover the remaining portion of the area respectively.
Source: Institute of Remote Sensing, Identification of Recharge areas Using Remote Sensing and GIS in Tamil Nadu, Anna University, Chennai, 1998 – 1999		

A1.1.3. Southern Zone

It constitutes an area of 36,655 sq. km in the districts of Ramanathapuram, Tuticorin, Tirunelveli, Virudunagar, Sivagangai, Madurai and Pudukkottai. The zone comprises flat plains and intermittent hills with peaks of 700 m high. The average rainfall in the zone is 876 mm with temperatures varying between 37.5°C in summers and 20°C in winters. A summary of the geological properties is tabulated below in Table A1.6.

[4] Water Quality is tested for presence for nitrate and phosphate which indicates wastewater

Table A1.6: **Water Table, Water Quality and Soil Type in Southern Zone of Tamil Nadu**		
Sl. No.		
1	**Water table level**	Summer: Around 7.75 m, bgl Winter: 1.39 m, bgl
2	**Water quality**	540 - 11000 micromhos/cm
3	**Soil**	Coastal alluvium, black, red sandy soil, deep red soil. Hydrological soil group 'A' covers an area up to 86.33 sq.km that is 29.91 % of total area. Hydrological soil group 'B' covers an area up to 50.84 sq.km that is 17.62 % of total area. Hydrological soil group 'C' covers an area up to 54.13 sq.km which is 18.75 % of total area and Hydrological soil group 'D' which covers an area up to 97.07 sq.km which is 33.72 % of total area.
Source: Institute of Remote Sensing, Identification of Recharge areas Using Remote Sensing and GIS in Tamil Nadu, Anna University, Chennai, 1998 – 1999		

A1.1.4. Western Zone

It constitutes an area of 15,678 sq.km under Erode, Coimbatore, Salem, Tiruchirappalli and Madurai districts. The annual normal rainfall is about 653 mm with Cauvery, Bhavani and Amaravati as major rivers. The region has undulating topography sloping towards east with peaks ranging from 1000 – 2700 m above MSL. Temperatures vary between 42°C in summers and 16°C in winters. The climatic zone ranges from semi-arid to sub-humid with frequent occurrence of drought. A summary of the geological properties is tabulated below in TableA1.7.

Table A1.7: **Water Table, Water Quality and Soil Type in Western Zone of Tamil Nadu**		
Sl. No.		
1	**Water table level**	Summer: 6.27 to 11.5 m, bgl Winter: 1.61 to 8.07m, bgl
2	**Water quality**	1620 – 1750 micromhos/cm
3	**Soil**	Red loamy and Black. The hydrological soil group 'B' with moderate infiltration and moderate runoff potential covers about three fourth area of the block. Hydrological soil group 'A' with high rate of infiltration occurs a little less than one-fifth area of the block. The rest of the area comes under soil group 'C' with slow rate of infiltration.
Source: Institute of Remote Sensing, Identification of Recharge areas Using Remote Sensing and GIS in Tamil Nadu, Anna University, Chennai, 1998 – 1999		

Annexure 2: Location and Number of Toilets in the Household

Table A2.1: **Number of Toilets in the Household and Location**												
S. No	**Where is the toilet located in the house?**			**How many toilets are there in the house?**							**Total**
				0	1	2	3	4	5	6	
1	Front side of the house	Zone type	Cauvery Delta Zone	0	2	1	0	0	0	0	3
			High Rainfall Zone	0	3	2	0	3	0	0	8
			Hilly Zone	0	26	1	2	0	0	1	30
			North Eastern Zone	0	19	4	1	0	0	0	24
			North Western Zone	1	25	2	2	1	1	0	32
			Southern Zone	0	7	1	2	0	0	0	10
			Western Zone	0	24	14	3	1	2	0	44
		Total		1	106	25	10	5	3	1	151
2	Outside the house boundary	Zone type	Cauvery Delta Zone		12	3			0		15
			High Rainfall Zone		3	0			0		3
			Hilly Zone		3	0			0		3
			North Eastern Zone		8	5			0		
			North Western Zone		6	1			0		7
			Southern Zone		4	2			0		6
			Western Zone		1	0			1		2
		Total			37	11			1		49
3	Rear side of the house	Zone type	Cauvery Delta Zone	1	28	15	1	2	0	0	47
			High Rainfall Zone	0	23	15	5	2	0	0	45
			Hilly Zone	0	26	5	1	0	1	0	33
			North Eastern Zone	0	8	9	2	1	1	0	21
			North Western Zone	1	18	12	1	1	1	1	35
			Southern Zone	0	31	11	2	5	0	0	49
			Western Zone	0	17	10	1	1	0	0	29
		Total		2	151	77	13	12	3	1	259
4	Within the house boundary	Zone type	Cauvery Delta Zone	0	8	13	2	1	1		25
			High Rainfall Zone	0	11	16	5	1	1		34
			Hilly Zone	0	19	4	1	0	0		24
			North Eastern Zone	1	13	12	2	4	0		32
			North Western Zone	0	10	2	4	0	0		16
			Southern Zone	0	16	7	0	2	0		
			Western Zone	0	7	4	1	2	1		25
		Total		1	84	58	15	10	3		171
5	Total	Zone type	Cauvery Delta Zone	1	50	32	3	3	1	0	90
			High Rainfall Zone	0	40	33	10	6	1	0	90
			Hilly Zone	0	74	10	4	0	1	1	90
			North Eastern Zone	1	48	30	5	5	1	0	90
			North Western Zone	2	59	17	7	2	2	1	90
			Southern Zone	0	58	21	4	7	0	0	90
			Western Zone	0	49	28	5	4	4	0	90
		Total		4	378	171	38	27	10	2	630

Table A2.1: **Number of Toilets in the Household and Location**									
S. No	**Where is the toilet located in the house?**	**How many toilets are there in the house?**							**Total**
		0	1	2	3	4	5	6	
Source: TNUSSP Primary Study, 2016									

Annexure 3: Cauvery Delta Zone

A3.1. Containment

In Cauvery Delta Zone (CDZ), 78 households out of 90 depend on septic tanks for disposal of blackwater. Two households depend on unlined single pits and nine households depend on concrete ring pit for disposal of blackwater.

Pits here have seven rings of height 0.5ft, depth 6ft and diameter 2ft. 11 households had vent pipes of 3m height. 12 households had their pit covers cemented to the pit making it difficult to de-sludge. 12 households had their pit walls made of precast rings.

In CDZ, on average, dimensions of septic tanks are 2.5m X 1.8m X 2.6m. 25 septic tanks had partition walls. 22 septic tanks had their partition walls placed at the centre of the tank whereas 6 had their partition walls placed at a 1/3rd distance from one side of the tank. 69 households had vent pipes for their septic tanks of 2-3m height. 36 septic tanks were lined at bottom. 12 septic tanks were located below toilets whereas in other cases it was located 3m from the toilet. Six septic tanks were connected to soak pits. Breakages/leaks were evident on septic tank walls and inlet /outlet pipe of one septic tank.

In CDZ, septic tanks are located, on average, 14.5m away from the nearest main road. In households depending on pits, two pits were constructed 10m away from the nearest point a desludging vehicle can be parked, in three households, this distance was 10-20m, 20-30m for five households and 30-50m for one household.

34 households were connected by roads more than 3m wide, 34 by roads 2-3m wide and two households were situated near roads less than 2m wide.

A3.1.1. Under Construction Containment Units

Lined septic tanks were constructed for six households and unlined septic tank was constructed for one. Excavation was done using earthwork machinery in two households and done manually in five households. Clay soil was found in one case, silt in three cases, loamy soil in three cases and gravel and mud were found in three cases.

Three households had overflow discharge outlet pipe from the septic tank connected to soak pits whereas four households didn't have an overflow discharge outlet pipe. Average size of septic tank was found to be 2.6m(L) X 1.2m(B) X 2m(D). Two septic tanks have partition walls. All septic tanks had vent pipe of around 3m height. Two septic tanks were not lined at the bottom.

Septic tanks in all households were constructed at a distance of less than 10m from where a desludging vehicle can be parked. One household had connecting road of width less than 2m making it impossible to de-sludge, three households had connecting road of width 2-3m where desludging can be difficult and two households had road width of more than 3m. Figure 3.5 shows a septic tank constructed on an elevated base.

A3.2. Enabling Environment – Masons

Out of nine masons surveyed, six masons were of the opinion that they themselves take the decision and three masons were of the opinion that the engineer gives toilet dimensions. Average area of the toilet is 2.08 sq.m. Eight masons agreed that they have been using squatting pan and seven masons agreed that they have been using western commode.

Seven masons said they provided one ventilation opening while one mason said that two ventilation openings were provided. Eight masons agreed that bricks were used as materials in construction. Out of nine masons surveyed, one mason said that the household members take the decision on toilet location, five masons were of the opinion that they themselves take the decision on toilet location and two masons were of the opinion that the engineer decides the location.

Out of nine masons surveyed, three felt that household members decide the type of containment system, four masons were of the opinion that they themselves take the decision on type of containment system and one mason was of the opinion that engineer decides the type of containment system.

Eight masons said that septic tanks were preferred. Average dimensions of septic tanks built: L x B x D as 2.8m X 1.9m X 2.4m. Three masons said that septic tanks that they construct are single chambered, five masons said that they construct two-chambered. Two out of nine masons said that they only plaster the bottom of septic tanks and four masons said that they use waterproofing plaster. Five masons said that overflow outlet of septic tank should be connected to stormwater drain and three masons said there shouldn't be any overflow outlets.

The below Table A3.1 highlights the resources required to build a toilet with septic tank for a household of five members.

Table A3.1: **Resources Required to Build a Toilet with Septic Tank for a Household of 5 Members in Cauvery Delta Zone of Tamil Nadu**

Sl. No.	Resources	Minimum	Maximum
1	Cost of Materials	Rs. 10,000	Rs.60,000
2	Cost of labour	Rs. 3,000	Rs.20,000
3	Total cost	Rs. 1,00,000	-
4	Time taken for construction	1 day	10 days
5	Area requirement	6 sq.ft	96 sq.ft
Source: TNUSSP Primary Study, 2016			

As per masons' survey, one mason agreed with single pits which were constructed circular in shape. Average diameter of the pit was 1.5m. Average depth of pit was 3m. Two masons said that pits were lined and constructed using concrete rings. The below Table A3.2 highlights the resources required to build a toilet with pits for a household of five members.

Table A3.2: **Resources Required to Build a Toilet With Pits for a Household of 5 Members in Cauvery Delta Zone of Tamil Nadu**

Sl. No.	Resources	Minimum	Maximum
1	Cost of materials	Rs. 2,500	Rs.5,000
2	Cost of labour	Rs. 1,500	Rs.2,000
3	Total cost	Rs. 1,00,000	-
4	Time taken for construction	1 day	2 days
5	Area requirement	1 sq.ft	16.sq ft.
Source: TNUSSP Primary Study, 2016			

All the masons agreed that they learnt about design of toilets and containment system through on-the-job training and observation. Two masons had heard about training programmes on toilet construction techniques. When inquired about willingness to attend masons training programmes, seven masons agreed.

A3.3. Emptying

As per primary survey, time taken for septic tanks to get fully filled is one year for 11 households and 1-2 years for 13 households. Of the total surveyed households in this zone: 10 households de-sludged in 3-5 years whereas for 9 households it's more than 5 years. This is mainly due to large sizes of septic tanks. Remaining 34 households had no idea about the time taken for septic tanks to get fully filled as these septic tanks have never been filled.

When time taken for septic tanks to get filled is compared with desludging intervals, five households out of 90 is de-sludged every six months and eight households are de-sludged once a year, whereas 14 households are de-sludged once in two years and nine households are de-sludged once in three years. Nine households are de-sludged once in five years and 10 households are de-sludged in more than 5 years' time intervals. Remaining households are never de-sludged. 27 out of 90 households are following the desludging frequency of once in 2 years.

A3.4. Collection and Transportation

Ten operators were interviewed within the Cauvery Delta Zone, six of them in Tharangambadi, three in Thanjavur and one in Vedaranyam. In addition, five trips were observed by a surveyor, three of them in Vedaranyam and Tharangambadi and two in Thanjavur. Three of the observed trips were carried out to desludge septic tanks from individual households and another three from groups of houses. Except for one operator, who also is the owner of the service, all interviewees were employed by the owner. Most of them had been running their business for 4 – 5 years, while others said it had been 9 – 10 years. Offered services were said to be only desludging of septic tanks. The number of vehicles per operator was either one or two and all operators said they distribute business cards to households for marketing purposes. The highest demand was during October to December between 6 am and 6 pm. Out of 10, two operators said they also de-sludge chemical waste from industries (soft drink company and oil processing unit). Chemical waste from the oil unit was being disposed by a Tharangambadi-based operator in a composting unit and waste from the cold drink company by an operator from Thanjavur near Thirukkanur Patti.

Desludging capacities vary between 3,500 and 10,000 litres, according to operators. To reach the customer, distances between 10 and 40 km was covered. The desludging process lasted between 3 and 20 min, depending on the amount of sludge. Pockets within the town area which were found to be inaccessible by the cesspools available include, Burma Colony and Keelavasal in Thanjavur, Thiruthurai Pundi in Vedaranyam as well as TVS Company (opposite to Road Karaikal), Thirunallaru, Ramakotta Theru and Therkutheru in and around Tharangambadi. Widths of the access roads ranged, during field visits, between 1.2 and 6m and the trucks were parked 1 – 15m away from the containment unit. Septic tanks without an opening were broken in 3 – 30 minutes by the operator, using a steel or iron rod. For this service, none of the operators interviewed claimed to charge extra. During accompanied trips, manholes had to be opened by the operator, in most cases. After the desludging process was finished, manholes were usually closed by the operator, but were covered, not sealed. Vacuum pumps were used to pump the sludge out (a truck mounted sludge pump, in one case) with 4, 5 or 10 HP. Manufacturers were found to be based in Trichy or Chennai, but also in Cuddalore and Coimbatore and the age of the pumps ranged between 20 years and two months. Input power source was the oil engine and occasionally the engine shaft or a separate engine. Hosepipes were found to be 8 - 25 m long with a diameter of 2 – 4 inches. Pump wetted parts were largely made out of PVC or

rubber and the sludge collection pipe was made of (plastic) rubber. For extended length, pipes were connected using clamps, couplings or PVC pipes. The pipes last for about 1 – 7 years, according to the interviewed operators.

If the sludge is very thick and cannot be pumped out, most operators add 100 – 1,000 litres of water from the household, using a bucket or the pipe. Three operators, based in Tharangambadi, said they would remove the sludge manually, in this event. During accompanied trips, suction valves operated easily and the addition of water was not necessary in most cases.

The amount of sludge remaining in the septic tank largely depends on the capacity of the containment unit. Some operators claimed 1 – 6 inches of sludge would remain after desludging and during field visits, it was 0.4 – 3 inches, approximately. Two operators reported that they wore masks; the others do not wear any protection equipment. Sludge usually does not spill around during the desludging process and if it did, it was discharged into open drains outside the house (four cases), septic tanks (three cases) or vacant land (two cases). If there is contact with spillage or sludge, workers said they wash their hands with water and soap. During desludging observations, spillages were not an issue and there was never any addition of chemicals to prevent smell. Only in one case, did the operator wear a mask for safety reasons, while other operators did not wear any protection equipment. Only three operators cleaned themselves after the desludging process and the truck was generally not cleaned after desludging. Some operators cleaned the pipe.

All surveyed operators use a strainer at the inlet to the suction pipe, which got blocked 1-4 times per desludging process. During field visits, all suction pipes were equipped with a strainer and no foreign objects within the sludge were observed. No leakages or blockages were recorded. While most operators said there would be local mechanics available if pump repairing was required (once a year – twice a month), four from Tharangambadi deny this.

The tanks used hold capacities of 3,500 – 10,000 litres of fecal sludge in 1 – 2 chambers. The sizes of the containment units, de-sludged during observed trips varied between 1 x 1 x 1m and 5 x 5 x 3m. The material of the inner surface of the tank was plastic, paint, rubber or steel. Outlet valves were ball valves, installed at a height between 0.6 – 1.2 m above the ground and diameter of 3 – 6 inches. The cesspools were manufactured between 1996 and 2016 and had only one axle (two, in one case). All vehicles were 2.1 – 2.4 m wide and diesel-fuelled (Rs. 50.6 – 57.5 per litre). Mileages range between 3 and 10 km per litre. During field observations, it was noted that the paint coating on the tank was new in five cases, while the remaining ones had little patches of rust.

Points of disposal were decided based on municipality rules and sometimes, according to the operator or the customer. Time and distance were the most common reasons for non-disposal into treatment plants. Operators travel distances of about 1 – 40 km to reach the desludging points (2 – 15 km during accompanied trips). Frequent areas used for disposal include the municipality compost area, Pillaiyar Patti bypass and Mundharithopu in Thanjavur, Sannathi Street in Vedaranyam as well as Karaikal compost, Pravapettai Karaikal and the Karaikal solid waste disposal plant in Tharangambadi. One operator said that he gets paid Rs. 200 by the farm owner. Problems during sludge disposal occur mostly between October and December. Vehicles were cleaned in periodic intervals every 1 – 6 months. In one case, leaks from the valve during transportation were noticed, but it did not recur. In all cases, fecal sludge was disposed into vacant lands. The process took 1 – 3 min and in one case up to 12 min.

Operators said 2 – 5 workers per vehicle were required to carry out the service. Payments were made daily (Rs. 300 for drivers/ Rs. 200 – 300 for helpers), on monthly basis (Rs. 7,500 – 15,000 for drivers/ Rs. 7,500 – 9,000 for helpers) or per trip (Rs. 150 – 700 for drivers/ Rs. 100 for helpers). In two cases, tips or fees for breaking the manhole were observed as other sources of income for the workers (Rs.

50/ Rs. 2,000 per month). On average, operators carry out 2 – 5 trips a day, adding up to 60 – 150 trips per month. The costs of desludging range from Rs. 700 – 3,500.

During accompanied trips, the price was negotiated in different ways: based on distance and sludge amount, sludge type or thickness of sludge or based on fixed rates which ranged from Rs. 1,200 – 3,500. Investment costs for the cesspool account for Rs. 1.5 – 16 lakh, Rs. 2,500 – 5 lakh for a pump, Rs. 6,000 – 20,000 for a desludging pump and Rs. 5,000 – 7 lakh for fitting the tank and other accessories. For maintenance of the vehicle, Rs. 2,000 – 2 lakh as well as Rs. 2,000 – 50,000 for the pump were being paid by the service providers. Major maintenance issues centred on the pump (due to heavy load) but also the cylinder, engine and clutch, according to the operators. Problems arise once in a month to five times per year. For repairing, service providers have to wait 30 minutes – four days and pay amounts ranging from Rs. 200 – 15,000.

A3.5. Reuse

In the CDZ, seven interviews were conducted with farmers from Vedaranyam (3), Thanjavur (2) and Karaikal (2). Three of them practice surface irrigation. The farmers acquire water for irrigation from various sources: bore wells, rainwater and salt water. Two farmers, who source water from bore wells, report that water was available throughout the year for 3 – 6 hours a day. One farmer who uses water from a bore well, said that pumping was required. Electricity costs required for water supply as well as costs for water supply were not specified by any interviewed farmer. There was no subsidy available for irrigation water. Banana, rice and sugarcane are crops that are being irrigated with fresh water. Common fertilisers found to be used were potassium and urea, which were manually mixed with soil.

Costs for fertilisers account for Rs. 2,000 – 15,000. Five out of seven farmers interviewed said that they also use wastewater to irrigate banana, rice, coconut and bamboo plantations due to its high nutrient value or because of a lack of freshwater. Sources were either own septic tanks/ soak pits/ pits or municipal sewers. One farmer said that pumping irrigation wastewater led to costs of Rs. 500. None of the farmers complained about water-borne diseases among their family members or regarding the quality of crops. There were no restrictions from any government body/ organisation towards the use of wastewater for irrigation.

Figure A3.1: **Farmers Interview Conducted by Our Team Members at Cauvery Delta Zone**

Source: TNUSSP Primary Study, 2016

Two farmers said they use fecal sludge as soil conditioner for growing grass for cows as well as for rice and green leaves. For growing grass, dried sludge is applied during cultivation, while for rice, fresh sludge is applied three months after the sludge is delivered. The sludge is disposed by private desludging operators - who are not paid for their service nor do they pay the farmers. Farmers did not observe mosquito breeding due to fecal sludge, and no pesticides were used. No equipment was used while applying fecal sludge as soil conditioner and no complaints regarding the quality of crops was noted. The farmers also said that there were no restrictions from any government body/ organisation towards the use of fecal sludge or agricultural purposes.

Annexure 4: High Rainfall Zone

A4.1. Containment

In High Rainfall Zone (HRZ), 48 out of 90 surveyed households depend on unlined single pits, 17 households depend on concrete-lined pits, six households on concrete-made ring pits, 10 households on brick-lined single pit containment systems, nine on septic tanks and 22 depend on systems such as soak pits for the disposal of blackwater.

In HRZ, on average, pits have seven rings of height 1-1.5ft each, depth of 10 ft and a diameter of 4ft. 53 households had a vent pipe of height 2-3 metres. 11 households had their pit located below the toilet while others had it located 3 metres away. 74 households had their pit cover cemented to the pit, three households had a cover temporarily placed and two households had no cover on the pits. 11 households had its pit walls made up of precast rings and 56 households had its pit walls made up of stone/ rubble masonry.

Five households had their pits sealed at the bottom. 72 pits had no openings in the pit walls and one household had an overflow pipe attached to the pit for discharging into the stormwater drain.

In HRZ, on average, the dimensions of the septic tank were found to be 2m X 1.7m X 3.5m. Only four septic tanks had partition walls, out of which two had their partition walls placed at the centre of the tank and two of them had it placed at 1/3rd distance from one side of the tank. Seven households had vent pipes for their septic tanks about three metres in height and six septic tanks were found lined at the bottom. Septic tanks were located at an average distance of 2.7m from the toilet.

In HRZ, septic tanks are located, on average, 10 metres away from the nearest main road. Among households depending on pits, 66 pits were found at least 10 metres away from the nearest point a desludging vehicle can park. For 10 households, this distance was 10-20 metres and for five, 20-30 metres. Six households were found to be situated near roads of 3-metre width, whereas two of them were connected by roads 2-3 metres wide.

A4.1.1. Under-construction Containment Units

Single pits were constructed in seven out of nine households surveyed and lined septic tanks were found constructed in the remaining two households. Excavation was done using earthwork machinery in five households and manually in four households. Clay soil was found in three cases, silt in four cases, black soil in one case and sandy soil in one case.

Three households had outlet pipes connected to the stormwater drain, one household had overflow discharge outlet pipe from the septic tank connected to the soak pit and five households didn't have an overflow discharge outlet pipe.

Average size of septic tank was 3.2m (L) X 1.4m (B) X 1.75m (D). Both septic tanks were three-chambered. For both septic tanks, the partition wall was constructed at 1/3rd distance from the tank wall. Both septic tanks had vent pipes of 2 and 3 metres height each. Both septic tanks were lined at the bottom. One septic tank was found connected to the soak pit. Septic tanks in both households were constructed at a distance of less than 10 metres from where a desludging vehicle can be parked.

One household was near a road of 2-3m width and the other household had road width of more than three metres. In households where pits were being constructed, the diameter of pits varied from 3ft to 6ft. The depth of the pit was 10ft. Out of seven households with pits, one pit had fully plastered walls. Four out of seven households had vent pipes of 3m average height.

Two pits were located below the toilets. All pits were located at a distance of 10 metres from where they can be de-sludged.

A4.2. Enabling Environment – Masons

Out of 11 masons surveyed, three masons felt that household members take the decisions for toilet dimensions, two masons said they themselves take the decision and two masons said that the engineer gives toilet dimensions. Figure 6.2 shows the interview conducted by our team member. Average area of toilet was 2.21 sq.m.

Figure A4.1: **Toilet Construction Mason Survey Interview Conducted by our Team Member**

Source: TNUSSP Primary Study, 2016

All the masons agreed that they have been using squatting pan and 7 masons agreed that they have been using western commode. Eight masons said they provided one ventilation opening and one mason said that two openings were provided. Seven masons said that bricks were used as materials of construction, two masons said they used stone blocks and concrete blocks. Out of 11 masons surveyed, five masons felt that household members decide the toilet location and four masons were of the opinion that engineer decides the location. Out of 11 masons surveyed, two masons felt that household members decide the type of containment system, two masons were of the opinion that they themselves take the decision and 5 masons were of the opinion that engineer decides the type of containment system.

Six masons said that single pit was preferred whereas three masons said that septic tanks were generally preferred. Average dimensions of septic tanks built: L x B x D as 2.5m X1.4m X 1.9m. All masons said that septic tanks, which they construct, are multi-chambered. Three out of 11 masons said that they only plaster the bottom of septic tanks and one mason said that he used waterproofing plaster. One mason said that overflow outlet of septic tank should be connected to stormwater drain, one mason said it should be connected to soak pit, one mason said that it should be connected to ditch and one mason said there shouldn't be any overflow outlet.

The below table highlights the resources required to build a toilet with septic tank for a household of 5 members.

Table A4.1: **Resources Required for Building a Toilet with Septic Tank for a Household of 5 Members in High Rainfall Zone of Tamil Nadu**			
Sl. No	**Resources**	**Minimum**	**Maximum**
1	Cost of Materials	Rs. 25,000	Rs.30,000
2	Cost of labour	Rs. 15,000	Rs. 25,000
3	Total cost	Rs. 6,000	Rs.60,000
4	Time taken for construction	3 days	8 days
5	Area requirement	40 sq. ft	100 sq ft
Source: TNUSSP Primary Study, 2016			

As per the survey, seven masons agreed with single pits and one mason agreed with twin pits that are constructed circular in shape. Average diameter of the pit was 1.2m and average depth was 2.9m. Seven masons said that pits were lined and constructed using concrete rings. The below table highlights the resources required to build a toilet with pits for a household of five members.

Table A4.2: **Resources Required to Build a Toilet with Pits for a Household of 5 Members in High Rainfall Zone of Tamil Nadu**			
Sl. No.	**Resources**	**Minimum**	**Maximum**
1	Cost of Materials	Rs. 5,000	Rs.50,000
2	Cost of labour	Rs. 2,500	Rs.15,000
3	Total cost	Rs. 6,000	Rs. 20,000
4	Time taken for construction	1 day	7 days
5	Area requirement	30 sq. ft	100 sq. ft
Source: TNUSSP Primary Study, 2016			

All the masons agreed that they learnt about design of toilets and containment system at their job training and observation. Only one mason had heard about training programmes on toilet construction techniques. When inquired about willingness to attend any of masons training programmes, six masons agreed whereas three masons said they are not interested in any such training, as they know enough.

A4.3. Emptying

As per primary survey, time taken for septic tanks to get fully filled is one year, 1-2 years and 3-5 years for one household each whereas for seven households it was more than five years. This is mainly due to the large sizes of the septic tanks. Remaining 71 households had no idea about the time taken for septic tanks to get fully filled as these septic tanks had never been filled.

When time taken for septic tanks to get filled is compared with desludging intervals, three households out of 90 were de-sludged once in two years, whereas one household was de-sludged once in five years. Seven households were de-sludged in more than five years' time

Figure A4.2: **Disposal of Sludge into a Low Lying Water Body**

Source: TNUSSP Primary Study, 2016

intervals. Remaining 71 households were never de-sludged. Only three out of 90 households were following a desludging frequency of once in two years. Figure A4.2 shows a common disposal point of the town.

A4.4. Collection and Transportation

In this zone, a total of six cesspool operators were interviewed, five of them based in Nagercoil and one in Peruvillai, all offering desludging of septic tanks only. On site, also the cleaning of leach pits was observed. Additionally, four desludging trips in Nagercoil and one in Peruvillai was observed in detail, the majority of them in individual houses.

Three operators were found to be owners of the service, two employed as drivers and operators of these vehicles and one was operated by a family member. The service is run by the owner from 1 – 2 up to 9 – 10 years. In Nagercoil, the surveyed operators run their service with 1 – 3 vehicles, whereas in Peruvillai five cesspools are operating under one service provider. It was observed in the field that the truck surface was rusty with little painting, or old but completely covered with painting. To reach out to potential clients, all surveyed operators distribute business cards to households. Operating is usually scheduled between October and December. Their operation timings differ but were found to be generally from 6 – 12 am to from 5 – 9 pm. Only one of the operators (based in Peruvillai) said they also desludge chemical waste from a rubber factory, which he disposes at a vacant tract of land. Most operators claimed there would be certain pockets within town that are not accessible, such as Idalakudi, Kulasekaram, Pechipaarai, Nagaraja Street, Kuttar, Susintharam and Katavalai in Nagercoil. During site visits, the width of the access road to the household was found to be 4 – 8ft and the vehicle could be parked 2 – 66ft away. No difficulties in reaching the destination was observed.

Figure A4.3: **Septic Tank Desludging Service Provided by a Private Operator**

Source: TNUSSP Primary Study, 2016

Septic tanks being de-sludged had a capacity of 4,500 – 5,000 litres and the service providers cover distances between 10 and 40 km to reach their clients as shown in Figure A4.3. Sludge is pumped out with a vacuum pump with horsepower of 10 – 20, manufactured at different locations in Tamil Nadu between 2004 and 2015. This process took about 3 – 8 min during field observations. Oil engines are the input power source in most cases, while two operators used engine shafts. Hosepipes are usually 33 – 50 m long and in one case only 7.6 m, while the diameter was four inches. Pump wetted parts are made of cast iron and the sludge collection pipe of rubber. To connect an extension pipe, clamps were used. Four out of six operators said that the hosepipe would have a life span of five years, while the remaining two claimed it was shorter.

Most operators add 100 – 1,000 litres of water from the household, using the pipe or a bucket, if the sludge is very thick and cannot be pumped out easily. In case a septic tank at the household does not

have a manhole, the operator breaks it open using a steel rod. During field visits, in two out of five cases, the tank was opened by a household member. The process of breaking the tank takes the operator 20 min to two hours and they charged extra (Rs. 200 – 600). Closing the manhole is not included in the services of the operator. Most operators said that no sludge is left in the septic tank after desludging, however during field visits, 2 – 15ft of sludge remained. Safety equipment for desludging was not used consistently, with some observed using latex gloves, masks or goggles. Only during one of the observed trips, did the operator use oil to prevent smell from the sludge and protective equipment was used during all five observed trips. In three out of five observations, workers did not clean their hands after desludging.

None of the operators said that sludge spills around the place of desludging. In the case of sludge contact, workers said they would wash their hands with soap and water. Spillage from pipes is disposed either in septic tanks or soaks pits. None of the surveyed operators use a strainer at the inlet to the suction pipe, but all operators claimed to have problems with pipe blockages. During field observations, foreign objects were not found in the sludge. Also, blockages or leaks in the pipe were not observed and the suction valve during desludging/ disposal operated well in most of cases, although manual effort was required once. In case of problems with the pipe, which happens 1 – 20 times per year, there are local mechanics available to repair the pump.

The capacity of the tank is 4,500 – 5,500 litres, the inner surface is rubber coated in four cases and without rusted paint in the remaining. Ball valves are used as outlet valves and measure 4 – 5 inches, placed approximately 1 m above ground level. Operating cesspools usually have two axles and a width of 7ft. All vehicles run on diesel. The mileage of the vehicles ranges from 4 – 8 km per litre.

Three of six surveyed operators said that the site of sludge disposal is decided based on municipality rules, whereas two mentioned they dispose sludge in vacant areas.

During field visits, the distance between desludging point and point of disposal was 4 – 15 km. All claimed that none of the known operators dispose sludge into waterbodies or drains, which is in contrast to field observations, during which the disposal point of the sludge was a natural drain in three of five cases.

Figure A4.4: **Solid Waste Dumping Yard Used as One of the Dumping Points for Sludge**

Source: TNUSSP Primary Study, 2016

Operators said that Vellamadam vacant land, Seethapal and Vellamadam in Nagercoil as well as Thalakudi Santhavelai in Peruvillai disposal sites are frequently used. Reasons for not disposing the sludge into the treatment plant were attributed to time and distance consistently. In 5 out of 6 cases, the cesspool operators mentioned to be rewarded Rs. 200 – 1,500 if the farmland for disposal is far away. Operators usually face problems in sludge disposal in the months of October and December. The desludging process required 3 – 4 min during field visits. Afterwards, the vehicles are not being cleaned but every two weeks to once

per year. During observations on the field it was noticed that the pipe was cleaned after the desludging process in two out of five cases. Furthermore, it was recognised that the driver was drunk during one trip and during another one, one of the workers was. Figure A4.4 shows the use of land as dumping point for sludge.

For the operation of the desludging vehicle, 3 – 8 workers are required. Drivers receive a monthly salary of Rs. 10,000 – 20,000 and helpers as well as other staff get an amount of Rs. 6,000 – 12,000. The maximum average number of trips per day an operator carries out is eight, the minimum is twice a week, which accounts for 8 – 90 trips per month. The costs of desludging range between Rs. 2,500 and 4,500, according to the operators. It was observed in the field that the service was done for free in three out of five cases (Rs. 4,500 have been paid by the rest). The amount of additional income accounts for Rs. 100 – 500 a month, however one operator said that Rs. 2,000 per person a month is being paid additional through other monetary benefits (ESI, PF, bonus, etc.).

The investment costs of a cesspool range between Rs. 8 and 15 lakh, plus Rs. 1 – 2.6 lakh for purchasing the pump, Rs. 35,000 to 1.5 lakh for the desludging pipe and 3 – 5 lakh for fitting the tank and other accessories. Maintenance costs for the cesspool accounts for 70,000 – 2 lakh and for the pump Rs. 8,000 – 60,000, which leads to costs of Rs. 75,000 – 2.22 lakh for the operator. As the main maintenance problems, operators listed the expired life cycle of the pump as well as breakages of the pump due to heavy loads. It requires 1 – 4 days to fix the pump, leading to costs of Rs. 6,000 – 26,000. In the field, leakage from the tanks shell was observed and no leakages during transportation in the remaining cases.

A4.5. Reuse

Six farmers were interviewed in this zone, two each from Agasthipuram, Kanyakumari and Nagercoil. All farmers practice surface irrigation. Fresh water was used for irrigation of ladyfinger, banana, mango, coconut and rice. In most cases, it was sourced from canals and in some cases, from bore wells without any related costs. Three farmers said fresh water was available throughout the year for 1.5 – 5 hours per day. The remaining three farmers said they face problems with freshwater supply during the summer. Farmers using bore wells require pumps for availing irrigation water and one of them said they pay Rs. 100 for electricity related to water supply. All farmers said there was no subsidy available for irrigation water. As fertilisers, farmers use cow and goat dung, urea and potassium, which were manually mixed with soil. The fertilisers cost around Rs. 300 – 4,500.

Two out of six farmers said they also use wastewater for irrigation of banana and coconut, due to its high nutrient value. Sources of wastewater included their own septic tanks/ soak pits/ pits. Both farmers did not report any cases of water-borne diseases within their households and did not receive any complaints regarding the quality of crops. Furthermore, the farmers said they did not face any restrictions from any government body/ organisation towards the use of wastewater for irrigation.

Only one farmer used dry fecal sludge as a soil conditioner for coconut, banana and leaves. The sludge was applied one month after the sludge was delivered by a private desludging operator – for which the farmer pays Rs. 50. The farmer did not note any increase in mosquitoes breeding due to fecal sludge, and he does not use any pesticide to ward off pests. No complaints regarding the quality of crops was raised and the farmer said that there were no restrictions from any government body/ organisation towards the use of fecal sludge or agricultural purposes.

Annexure 5: Hilly Zone

A5.1. Containment

In Hilly Zone (HZ), 27 out of 90 surveyed households depend on unlined single pits, 21 households depend on concrete lined pits, 23 depend on concrete-made ring pit, 18 on septic tanks and one household depends on other systems to dispose blackwater.

On average, pits in this zone have six rings of height 1ft, depth 12 ft and diameter of 3-4ft. 47 households were found to have vent pipes of 2-3 metre height. 18 households had its pit located below the toilet while others had it located 3 metres away. 61 households had their pit cover cemented to the pit making it difficult to de-sludge. 55 households had their pit walls made up of precast rings, two households had their pit walls made of bricks and four households had their pit walls made up of stone/ rubble masonry. 12 households had their pits sealed at the bottom. 45 pits had no openings provided in pit walls.

The dimensions of septic tanks in HZ were found to be 2.1m X 1.6m X 2.5m. Only one septic tank had a partition wall. 23 households had vent pipes reaching a height of three metres. 18 septic tanks were lined at bottom. Three septic tanks were located below toilets while others were located five metres away from the toilet. Figure A5.1 shows a septic tank constructed in this zone.

Figure A5.1: **Septic Tank Constructed in a Hilly Zone of Tamil Nadu**

Source: TNUSSP Primary Study, 2016

In HZ, septic tanks are located, on average, 20 metres away from the nearest main road. Among households depending on pits, 16 pits were constructed at 10 metres away from the closest parking space. This distance was 10-20 metres for eight households, 20-30 metres for six households, 30-50 metres for five households and more than 50 metres for 25 households. Roads of 3-metre width reached nine households, 2-3 metre width reached 12, and 15 households were connected by roads of less than 2-metre width.

A5.1.1. Under Construction Containment Units

In HZ, it was observed that containment systems are shared between two or more households. A single pit was constructed in six out of nine households surveyed and lined septic tanks were constructed in the remaining three households. In the three households surveyed, septic tanks were connected to two houses in each with a special case where 100 persons were dependent on one septic tank. In two instances, septic tanks were connected to 3 houses. Excavation was done using earthwork machinery in two households and done manually in seven households. Clay soil was found in four cases and red soil in eight cases.

One household had an overflow discharge outlet pipe from the septic tank connected to the soak pit but eight households didn't have an overflow discharge outlet pipe. The average size of septic tank was found to be 3m (L) X 1.2m (B) X 2.4m (D) and single-chambered. Dimensions of the septic tank

which has 100 users dependent on it was found to be 7.6m X 2.7m X 3.6m and three-chambered. All three septic tanks had vent pipes reaching a height of around five metres. One out of three septic tanks were not lined at the bottom. Septic tanks in two out of three households were constructed at a distance of more than 10 metres from where a desludging vehicle could be parked. Two households were accessible by roads of 2-3 metres width and one household had road width of more than three metres.

In households where pits are being constructed, the diameter of pit rings varied between 3ft and 4ft, the width of each ring was found to be 1ft and the depth was 8.5ft. Out of the six households with pits constructed, two had fully-plastered walls. All six households had vent pipes of 3m height, on average. Four pits were located at a distance of 30-50m and 2 households are located at a distance of 20-30 m from where they can be desludged.

A5.2. Enabling Environment – Masons

Out of nine masons surveyed, two felt that household members take the decisions for toilet dimensions, four masons said they themselves take the decision and five masons said that the engineer gives toilet dimensions. Average area of the toilet was 1.56 sq.m. Nine masons agreed that they used a squatting pan and eight masons agreed that they used western commode. Eight masons said they provided one ventilation opening and one mason said that two openings were provided. Seven masons agreed that bricks were used as construction material. Two masons said they used stone blocks and concrete blocks.

Figure A5.2: **Diagrammatic Explanation Provided by the Mason while Conducting the Interview**

Source: TNUSSP Primary Study, 2016

Out of 11 masons surveyed, five masons felt that household members decide the toilet location, two masons said they themselves take the decision on toilet location and three masons said that the engineer decides the location. Out of 11 masons surveyed, six masons said that they themselves take the decision on type of containment system and four masons said that engineer decides the type of containment system.

Figure A5.2 shows the picture drawn by the mason while explaining about toilet construction.

Five masons said that a single pit was preferred whereas four masons said that septic tanks were generally preferred. Average dimensions of septic tanks built: L x B x D as 1.8m X1.3m X 2.8m. Two masons said that the septic tanks they constructed were two-chambered. Two out of 11 masons said that they only plaster the bottom of septic tanks and two masons said that septic tanks were not lined at the bottom. Three masons said that overflow outlet of septic tank should be connected to soak pit, and one mason said there shouldn't be any overflow outlet.

Table A5.1: **Resources Required to Build a Toilet with Septic Tank for a Household of 5 Members in Hilly Zone of Tamil Nadu**			
Sl. No.	**Resources**	**Minimum**	**Maximum**
1	Cost of Materials	Rs. 6,000	Rs. 50,000
2	Cost of labour	Rs. 3,000	Rs. 15,000
3	Total cost	Rs. 6,000	Rs. 10,000
4	Time taken for construction	2 days	7 days
5	Area requirement	24 sq.ft.	100 sq.ft
Source: TNUSSP Primary Study, 2016			

As per the survey, five masons agreed with single pits and one mason agreed with twin pits that are constructed circular in shape. Average diameter of the pit was 1.15m. Average depth of pit was 2.6m. Five masons said that pits were lined and constructed using concrete rings.

Table A5.2: **Resources required to build a toilet with pit for a household of 5 members in hilly zone of Tamil Nadu**			
Sl. No.	**Resources**	**Minimum**	**Maximum**
1	Cost of Materials	Rs. 12,000	Rs.80,000
2	Cost of labour	Rs. 5,000	Rs.40,000
3	Total cost	Rs. 6,000	Rs.
4	Time taken for construction	2 days	14 days
5	Area requirement	40sq.mt	100sq.mt
Source: TNUSSP Primary Study, 2016			

All the masons agreed that they learnt about design of toilets and containment system through on-the-job training and observation. Two masons had heard about training programmes on toilet construction techniques. When inquired about willingness to attend any of masons training programmes, seven masons agreed whereas two masons said they were not interested in any such training as they know enough.

A5.3. Emptying

As per primary survey, time taken for septic tanks to get fully filled is 1 year for 4 households and 1-2 years for 5 households. For 2 households it is 3-5 years whereas for 12 households it is more than 5 years. This is mainly due to large sizes of septic tanks. Remaining 60 households had no idea about the time taken for septic tanks to get fully filled as these septic tanks never filled.

When time taken for septic tanks to get filled is compared with desludging intervals, 4 households out of 90 are desludged every year, whereas 5 households are desludged every 2 years. 1 and 2 nos. of households are desludged once in 3 years and once in 5 years respectively and 11 households are desludged in more than 5 years' time intervals. Remaining households are never desludged. Only 9 out of 90 households are following the desludging frequency of once in 2 years.

A5.4. Collection and Transportation

Three interviews were conducted with cesspool operators in this zone, all of them based in Udhagamandalam and employed by the owner. Additionally, one desludging process of a septic tank (6 x 4 x 8ft) at an individual house in Udhagamandalam was observed in detail. The service is run by

the owner for 1 – 2 up to 3 – 4 years. Most operators are equipped with one truck, carrying out desludging of septic tanks as a single service.

Display boards at public places and the distribution of business cards to households were the common means by which potential clients were reached out to. Operating is mostly scheduled in the morning hours (9 – 12am) between the months of October and December and in one case from April – May as well. The distances covered to carry out the service differed between the interviewed operators: households are 6 – 200 km away and the location of discharge was said to be 1 – 200 km apart. Two operators claimed to desludge chemical waste from a leather and a needle factory. Coonoor Bus stand, Hulical, Nondimadu and Thenadu Kambai are areas within Udhagamandalam that operators said were not accessible.

Septic tanks without an opening are usually broken by a household member or the operator, using a steel rod. This process takes approximately 30 min and is usually not charged extra. During the observed desludging process, the manhole was opened by a household member. Vacuum pumps with 10 HP, manufactured between 2008 and 2016, are used to pump the sludge out. The engine shaft was the input power source for all three surveyed cases and the sizes of hosepipes differ between 13 and 60 m in length and between 3.5 and 4 inches in diameter, according to the operator. The lifetime of a hosepipe is 3 – 6 years. Pump wetted parts were found to be made of cast iron and sludge collection pipes out of rubber. For extending the length of the pipe, clamps were used by two of the surveyed operators. In cases where the sludge is too thick to be pumped out easily, operators use 30 – 1,000 litres of water from the household. For safety purposes, operators said they wear masks or goggles (goggles were worn during the observed trip). After the desludging process was finished, about 2 inches – 2ft was observed to remain in the septic tank.

In case of contact with sludge spill over, operators said they wash their hands with soap and water and that they dispose the spillage into the septic tank. During the observation of the desludging process, it was noticed, that only the pipe was cleaned after the process and that workers did not wash their hands after being in contact with sludge. Operators reported facing problems of blocked pipes several times during the desludging process. A strainer was not used. For potential problems with the pump, mechanics are locally available. The capacity of the tank was found to be 2,000 – 6,000 litres and the inner surface was rubber coated. Outlet valves are ball valves, placed 3ft above the ground level and are 3 – 4 inches in diameter. During the accompanied trip by a surveyor, desludging took 15 min and no problems during the desludging process was faced (such as foreign objects in the sludge, blockages, etc.).

Cesspool vehicles were built between 2008 and 2016, according to the service provider. All had two axles, of length 16 – 18ft and width of 6ft. Their mileages range between 3 and 6 km per litre. All vehicles run on diesel, costing an estimated Rs. 57 – 58 per litre. It was observed that the painting on the tank is old but completely covered.

Operators said they choose the disposal site as per municipal rules, but that they do not discharge at a treatment plant because of the distance and the time it takes. Instead, Mettupalayam in the west and mini gardens were listed as frequent disposal points. Nevertheless, operators said that none of the known operators would dispose sludge in drains or water bodies. During the trip observed by a surveyor, the sludge was disposed in a treatment plant, 3 km from the desludging point. The process of sludge disposal took six minutes. Two of three operators said they were paid Rs. 400 – 2,000 by farmers for travelling long distances to farmlands for sludge disposal.

October to December are the months when operators face problems in disposing sludge. Vehicles are usually not cleaned after every single trip but on a weekly – monthly basis. Two to five labourers per desludging vehicle are required to carry out the service. Drivers receive a monthly salary of Rs. 9,000

– 32,000, while workers get Rs. 7,000 – 19,000 per month. One of the surveyed operators said other monetary benefits (ESI, PF, bonus, etc.) were paid to employees. The surveyed operators do approximately 2 – 5 trips a day, leading to 60 – 150 trips a month. Clients pay Rs. 2,000 – 3,000 on average for the desludging service. It was observed that a customer paid an amount of Rs. 2,000 which included tips and other expenses. Major maintenance problems associated with the desludging vehicle were mentioned to be the engine (due to heavy load) and tyres (due to puncture). For repairing the engine, mechanics take 5 days and charge Rs. 30,000, while repairing a tyre takes 1 day and costs Rs. 150.

A5.5. Reuse

Eight farmers were interviewed in the HZ, three of them from Naduvattam and Kotagiri respectively and another two from Udhagamandalam. Fresh water for irrigation was used for carrots, cabbage, beetroot, potatoes, cauliflower, radish, beans and white onions. Water was sourced from bore wells or open wells and in two cases, rainwater was found to be used. Water availability extends from 15 minutes to three hours a day. Five farmers said that freshwater would be available during the whole year but that there would be problems during summer. Four practice surface irrigation, while three use sprinklers. Most farmers said that pumping was required for availing irrigation water and one farmer said that electricity for water supply cost Rs. 1,200. Another farmer said that there was a subsidy of Rs. 30 available for irrigation water. As fertiliser, farmers used urea, potassium, TAP, M45 and compost as well as cow and goat dung, which was manually mixed with soil. The cost of fertiliser accounted usually for Rs. 300 – 650 and in one case Rs. 40,000 – 50,000.

None of the interviewed farmers said they use wastewater for irrigation purposes. Only one farmer said that he uses dry fecal sludge as a soil conditioner to grow potatoes and cabbage. The sludge was applied during cultivation of crops by the head of the household. There were no mosquitoes breeding due to the fecal sludge and no pesticides were being used to repel pests. The farmer said that he did not receive any complaints regarding the quality of crops and vegetables and that he did not face any restrictions from government bodies/ organisations.

Annexure 6: North Eastern Zone

A6.1. Containment

In North Eastern Zone (NEZ), two out of 90 surveyed households depend on unlined single pits, 13 households depend on concrete lined pits, three households on concrete-made ring pits and 71 depend on septic tanks for the disposal of blackwater. Pits have six rings of height 1ft, depth 5 ft and 3ft in diameter. Five households had vent pipes of 3-metre height. One household had its pit located below the toilet while others had it located at a distance of five metres. Four households had their pit cover cemented to the pit and in three households the cover was temporarily placed. Six households had their pit walls made up of precast rings and one household had its pit walls made of bricks. One household had its pit sealed at the bottom and four households were found to have no openings in their pit walls.

In NEZ, on an average, dimensions of septic tank were found to be 2.3m X 1.7m X 2.6m. 26 septic tanks had a partition wall; 25 of them had their partition walls placed at the centre of the tank while one had its partition wall placed 1/3rd away from one side of the tank. 75 households had vent pipes for their septic tanks of 3-metre height. 51 septic tanks were lined at bottom. 24 septic tanks were located below toilets, and in other cases it was located at an average distance of four metres away from the toilet.

One septic tank was connected to a soak pit. Breakages/leakages were evident in one septic tank. In NEZ, septic tanks are located around seven metres away from the nearest main road. In households depending on pits, three of them were 10 metres away from where desludging vehicles can be parked while for four households, this distance was 10-20 metres. 52 households were connected by roads of more than 3-metre width, 15 of them were accessible by roads of 2-3 metre width and one household was located near a road less than two metres in width which is inaccessible for desludging.

A6.1.1. Under Construction Containment Units

Lined septic tank was found constructed in eight out of 10 households surveyed whereas unlined septic tanks were found constructed in two households. Excavation was done using earthwork machinery in three households and done manually in eight households. Clay soil was found in nine cases, silt in one case with rocks and hard soil found in one case.

One household had an overflow discharge outlet pipe from the septic tank connected to soak pit, two septic tanks had their overflow discharge pipes let into stormwater drain whereas seven households did not have an overflow discharge outlet pipe.

Average size of septic tank was found to be 1.6m (L) X 1.4m (B) X 1.4m (D). Only two septic tanks have partition walls and both are two-chambered. All septic tanks had vent pipes of around 3-4m height. Two out of 10 septic tanks were not lined at the bottom. One septic tank was constructed below the toilet. Septic tanks in all the households were constructed at a distance of less than 10m where a desludging vehicle can be parked. Three households had connecting road of the width 2-3m where desludging can be difficult whereas seven households had road width of more than 3m.

A6.2. Enabling Environment – Masons

Out of 10 masons surveyed, one mason felt that household members take the decisions for toilet dimensions, seven masons said they take the decision and three masons said that the engineer gives toilet dimensions. Average area of toilet was 1.32 sq m. Nine masons agreed that they have been using squatting pan and ten masons agreed that they have been using western commode. All masons agreed

on providing one ventilation opening. Ten masons agreed that bricks were used as materials of construction.
Out of 10 masons surveyed, five masons felt that household members decide the toilet location, four masons said that they themselves take the decision on toilet location, two masons said that the engineer decides the location and two masons felt that toilet location was decided as per *vaastu*.
Out of 10 masons surveyed, one mason felt that household members decide the type of containment system, eight masons were of the opinion that they themselves take the decision on the type of containment system and two masons were of the opinion that engineer decides the type of containment system.

Eight masons said that septic tanks were preferred whereas two masons said that single pit was generally preferred. Average dimensions of septic tanks built: L x B x D as 2.5m X 2.1m X 2.2m. Six masons said that the septic tanks they construct are single chambered, two masons said that the septic tanks that they construct are two-chambered. Three out of 10 masons said that they only plaster the bottom of septic tanks whereas two masons said that they use waterproofing plaster and one mason said that septic tanks were not lined at the bottom and four masons said they use other materials such as stones. One mason said that overflow outlet of septic tank should be connected to the stormwater drain and nine masons said there shouldn't be any overflow outlets.

Table A6.1: **Resources Required to Build a Toilet with Septic Tank for a Household of 5 Members in North East Zone of Tamil Nadu**

Sl. No.	Resources	Minimum	Maximum
1	Cost of Materials	Rs. 20,000	Rs. 75,000
2	Cost of labour	Rs. 4,500	Rs.25,000
3	Total cost	Rs. 20,000	-
4	Time taken for construction	3 days	7 days
5	Area requirement	16sq.ft	84.5sq.ft
Source: TNUSSP Primary Study, 2016			

As per the survey, four masons agreed with single pits which were constructed circular in shape. Average diameter of the pit was 1.4m. Average depth of pit was 1.9m. Four masons said that pits were lined and constructed using concrete rings.

Table A6.2: **Resources Required to Build a Toilet With Pits for a Household of 5 Members in North East Zone of Tamil Nadu**

Sl. No.	Resources	Minimum	Maximum
1	Cost of Materials	Rs. 10,000	Rs.
2	Cost of labour	Rs. 1,500	Rs.2,000
3	Total cost	Rs. 6,000	-
4	Time taken for construction	1 day	
5	Area requirement	25sq.ft	
Source: TNUSSP Primary Study, 2016			

All the masons agreed that they learnt about the design of toilets and containment systems through on-the-job training and observation. None of the masons had heard about training programmes on toilet construction techniques. When inquired about willingness to attend any of masons training programmes, 5 masons agreed whereas 4 masons said they are not interested in any such training.

A6.3. Emptying

As per primary survey, time taken for septic tanks to get fully filled is 1 year for 18 households and 1-2 years for 9 households. For 6 households its 3-5 years whereas for 14 households it is more than 5 years. This is mainly due to large sizes of septic tanks. Remaining 28 households had no idea about the time taken for septic tanks to get fully filled as these septic tanks never filled.

When time taken for septic tanks to get filled is compared with desludging intervals, 6 households out of 90 are de-sludged every 6 months, whereas 13 households are de-sludged every year. 10 households are desludged once in 2 years. 3 households are de-sludged once in 3 years. 3 households are de-sludged once in 5 years and 8 households are de-sludged in more than 5 years' time intervals. Remaining households are never de-sludged. 29 out of 90 households are following the desludging frequency of once in 2 years.

A6.4. Collection and Transportation

In this zone, a total of 10 operators were interviewed, out of which five were based in Kancheepuram, three in Vellore and two in Sriperumbudur. Additionally, 12 trips were observed in detail, four of them with Vellore-based operators, three from Sriperumbudur and five from Kancheepuram. All surveyed operators were employed by the owner, who was found to be running the service with 1 – 3 vehicles from around 2 – 3 years up to 9 – 10 years. Cleaning septic tanks is the only offered service carried out by the operator.

Five out of 10 operators said they distribute business cards to households. Customers' calls were reported to come in at different times: some operators receive calls early morning, while others receive calls through the day until 7pm. The highest desludging requests were received in November but also during October and December.

Quantities being de-sludged were reported to range from 4,000 – 10,800 litres. To reach the desludging point, 6 – 30 km was covered. Two out of 10 operators also de-sludge chemical waste from institutions such as industries and small-scale units. They dispose such waste at Amarmedu as well as at a vacant tract of land within the municipality boundary as shown in Figure A4.5. During site visits, desludging services were observed for 11 residential customers as well as for one industry: all of them use septic tanks of dimensions ranging from 2 x 1 x 2 ft to 10 x 10 x 10 ft. To investigate the volume of the containment unit, operators used a steel rod.

Figure A6.1: **Fecal Sludge Dumped at Low Lying Land**

Source: TNUSSP Primary Study, 2016

With one exception, all operators reported that there would be certain pockets which were not accessible by cesspools, such as Saidapet, Kakithapattarai, Sorpanan Medu, Solan Pattai and Saidapet in Vellore, Kamarajar Nagar in Sriperumbudur. Similar inaccessible areas in Kancheepuram include Onarikupam Orikai Thirukalimedu, Vinayakapuram, Potheri, CVM Nagar, Arul Nagar, the Old Railway Station, and Pillayarpalayam main road. During observed trips, narrow roads, barricades or other temporary road blockages caused difficulties in terms of reaching the desludging point. Access roads had a width ranging from 3 – 12 m and the cesspool could be parked 1 – 12 m away from the septic tank.

Septic tanks without an opening were broken, usually by the operator with a steel rod and hammer. During site visits, the manholes were often concealed and opened by the operator. This process is not being charged extra but it takes from five minutes up to one hour. After the desludging process is finished, the tank is most often closed by the operator. The sludge is being pumped out with 10 HP vacuum pumps, which were manufactured in Chennai in most of cases. The oldest pump an operator was found using was from 1997, the newest ones were less than a year old. Hosepipes measure 20 – 100ft in length and a diameter of 3 – 4 inches. The material of pump wetted parts as well as the sludge collection pipe and the tank differ between PVC, rubber and steel. To extend the pipe, either couplings or clamps were used. Life spans of hosepipes vary enormously between operators, some of them stating it would be only four months while others use it up to 10 years.

In case the sludge is very thick and cannot be pumped out, 50 – 1,000 litres of water from households was added, using a bucket or the hosepipe. One operator reported using a mixture of kerosene, soap and water to soften the sludge. During most of the observed trips, this was not necessary. After the desludging process was finished, operators claimed, up to 3ft of sludge remained in the tank. During observations on the field, 1 inch – 5ft were left in the tank. No chemicals or additives were used to prevent smell, while in one case, kerosene was added. According to observations on the field, the desludging process took about 10 – 17 min.

If safety equipment was used, it was only a mask, while gloves, goggles, shoes or uniforms were not. During two of the observed trips, a mask as well as latex gloves were worn by the workers, while during the remaining 10, no safety equipment was used. In case of spillage or if workers came in contact with the sludge, they said they would wash their hands with soap and water or only water. During seven out of 12 observed trips, workers cleaned themselves with freshwater. Spillage from pipes was disposed into the open drains outside the house, while only two out of 10 operators disposed it in septic tanks. All operators said they used a strainer at the inlet to the suction pipe, which got blocked several times during desludging. During site visits, no pipe leaks were observed during the desludging process or transportation except in one case. There were no blockages while desludging. Usually the suction valve operated easily, however during two surveyed trips manual effort was required.

Six out of 10 operators claimed, there would be local mechanics available in case the pump was broken, which happens one to four times a year. Most of the tanks being used had one chamber and hold a capacity of 4,000 – 16,000 litres of sludge. Outlet valves were mounted 0.5 – 1.5 m above the ground and they were of 4 – 8 inches in diameter. Valve types differ between operators but most of them used ball valves, some butterfly or diaphragm valves. Operating vehicles were manufactured between 1997 and 2012 and have either one or two axles. Their length ranged between 1.5 and 9 m, and their mileage from 1.5 – 6 km per litre. All vehicles run on diesel, leading to costs of Rs. 52 – 57 per litre.

Six out of 10 operators said they dispose fecal sludge according to the municipality rules. Reasons for not discharging at the treatment plant included procedures in most of the cases, as well as lack of time and distance. Frequently-used disposal points were 6 – 30 km away from the source: the STP at the

new bus stand and Sathuvachari bypass in Vellore, Amarmedu and Aayakulathur village in Sriperumbudur and in Thirukalimedu (behind MGR Nagar) in Kancheepuram.

During site observations, 1 – 10 km was covered to reach the disposal point, which was vacant land in nearly all cases. In case long distances were covered to reach farmlands for disposal, two out of 10 operators were paid Rs. 100 by the farm owners. Problems during sludge disposal arose during October – December. None of the operators claimed to know any other operator discharging sludge into open drains or waterbodies. Vehicles were found to be not washed after every single trip but at periodic intervals from once a week to once a year. The pipe, pump and tank were cleaned during observations and this took about 1 – 4 minutes.

The number of staff per desludging vehicle ranges from 2 – 6. Drivers and workers receive either a monthly salary (Rs. 7,000 – 12,000 for drivers/ Rs. 5,000 – 10,000 for workers) or were being paid on a daily basis (Rs. 250 – 400 for drivers/ Rs. 100 – 200 for workers). Desludging trips were carried out, on average, once a day for some operators and up to seven times per day for others, leading to a monthly number of 30 – 210 trips. The cost of desludging services was found to vary between suppliers: one surveyed operator claimed to charge Rs. 300, others charged up to Rs. 3,500. Other sources of income were rare. During site visits, the price of desludging was fixed according to the distance, the condition of the sludge and it ranged between Rs. 750 and 13,000.

Investment costs of desludging vehicles account for a minimum of Rs. 75,000 and a maximum of 15 lakhs, while vacuum pumps cost Rs. 30,000 – 4 lakh and a pipe Rs. 1,000 – 20,000. Additionally, Rs. 2,000 – 1.5 lakh are required for fitting the tank and other accessories. Maintenance of the pump leads to costs of Rs. 10,000 – 5 lakh, while the vehicle requires maintenance costs of Rs. 35,500 – 1.5 lakh. Major maintenance problems came up often, mainly concerning the pump. For repairs, Rs. 200 would be required for fixing a puncture and Rs. 80,000 for a fitness certificate was charged by mechanics.

A6.5. Reuse

Five farmers were interviewed in this zone, two in Vellore and Kanchipuram respectively and one in Sriperumbudur. All surveyed farmers practice surface irrigation but use different sources for irrigation: lake and canal water, water from open wells and rainwater. One farmer said that he did not use any fresh water but only treated wastewater. Farmers using water from lakes, canals and open wells for irrigation said that water supply was available throughout the year, but others said they face seasonal difficulties in water supply. The farmer using water from an open well requires pumping for availing irrigation water. While most farmers do not pay for the water supplied for irrigation, one farmer (using rainwater), pays Rs. 100 for electricity. All farmers agree that there was no subsidy available for irrigation water. Groundnut and rice were the crops yielded with freshwater. Potassium and urea were commonly used as fertilisers. They are manually mixed with soil and cost Rs. 300 – 5,000.

Four out of five farmers claim to use wastewater from STP outlets for irrigation due to the lack of freshwater and/ or because of its high nutrient value. There were no restrictions from any government body/ organisation towards the use of wastewater for irrigation. The wastewater was either supplied from the private sector (two farmers) or the municipality (one farmer). None of the farmers pay for the wastewater or for pumping involved in irrigating wastewater or require any transportation to avail wastewater. Sugarcane, groundnut and rice were the crops being irrigated with wastewater. One of the farmers claimed a family member suffered from cholera, while the others did not report any water-borne diseases. Problems regarding the quality of crops were attributed to a bacterial occurrence that make the crops look old.

Three out of five farmers claimed to use fecal sludge as soil conditioner for sugarcane. It was applied one week after the arrival of the sludge without the use of any equipment. One farmer said that the

fecal sludge would be poured in the ground and allowed to drain and flow in the cultivated land. Suppliers are cesspool operators. In one case, the sludge was found to be fresh and directly discharged from the cesspool and in one other case, the sludge was dried. Charges were not paid for either availing fecal sludge by the farmer or for disposing it by the desludging operator. An increasing amount of mosquitoes due to fecal sludge was not recognised by the famers and no pesticides were used to avoid mosquitoes and other pests. Farmers did not face restrictions from any government body/ organisation.

Annexure 7: North Western Zone

A7.1. Containment

In North West Zone (NWZ), one out of 90 surveyed households depends on an unlined single pit, 14 households depend on concrete lined pits, seven households on concrete-made ring pits, eight households depend on brick-lined single pit containment systems and 60 households depends on septic tanks for disposal of black water.

On average, pits were found to have six rings of height 1ft, depth 8.5 ft and diameter 4 ft. Eight households had vent pipes of height 3-4 metres, as shown in Figure 3.10. Five households had their pits located below the toilet while others had it located at a distance of one metre. Ten households had their pit cover cemented to the pit making it difficult to desludge. One household had its pit wall made of bricks. Two pits had overflow discharge pipe directed into the stormwater drain. Eight pits had no openings provided in pit walls.

Figure A7.1: **Ventilation Improved Pit as Observed in One of the Surveyed Towns**

Source: TNUSSP Primary Study, 2016

The dimensions of septic tanks in this zone were found to be, on average, 2.4m X 1.7m X 2.6m. 38 septic tanks had partition wall. 68 households had vent pipe for their septic tanks with 3m-height pipe. 73 septic tanks were lined at bottom. 45 septic tanks were located below toilets whereas in other cases it was located at an average distance of 4.5 metres from the toilet. Two septic tanks were connected to soak pit. Breakages/leakages were evident on inlet /outlet pipe of 10 septic tanks.

In NWZ, septic tanks were found to be located, on average, 11 metres away from the nearest main road. In households depending on pits, five were constructed 10 metres away from where the nearest point a desludging vehicle could be parked while for three households, this distance was 10-20 metres, 30-50 metres for one household and more than 50 metres for one household. 38 households were connected by roads more than 3 metres wide, 40 households by roads of 2-3 metres width and two households of less than 2 metres width.

A7.1.1. Under Construction Containment Units

Lined septic tanks were constructed in all the 10 households surveyed. Only in one case was containment designed for two houses. Excavation was done using earthwork machinery in six households and done manually in four. Clay soil was found in two cases, silt in five cases and rocks in one case and red soil was found in two cases.

One household had overflow discharge outlet pipe from septic tank connected to soak pit, two septic tanks had their overflow discharge pipe let into the stormwater drain, three septic tanks had their overflow discharge pipe directed into the ground and four households didn't have an overflow discharge outlet pipe.

Average size of septic tank was found to be 2.4m(L) X 1.6m(B) X 2.4m(D). Only five septic tanks had partition walls and three septic tanks were two-chambered as shown in Figure 3.24, whereas two septic tanks were three-chambered. Eight septic tanks had vent pipes of around 4m height. One septic tank was not lined at the bottom. Three septic tanks were constructed below the toilet. Septic tanks in all the households were constructed at a distance of less than 10m where a desludging vehicle can be parked. Four households had connecting road of the width 2-3m where desludging can be difficult five households had road width of more than 3m.

A7.2. Enabling Environment – Masons

Out of nine masons surveyed, three masons felt that household members take the decisions for toilet dimensions, five masons said that they themselves take the decision and two masons were of the opinion that engineer gives toilet dimensions. Average area of toilet was 2.24 sq.m. Eight masons agreed that they used squatting pan and seven masons agreed that they used western commode. All masons agreed about providing one ventilation opening. Eight masons said that bricks were used as materials of construction. Out of 9 masons surveyed five masons were of the opinion that they themselves take the decision on toilet location, two masons said that the engineer decides the location and two masons felt that toilet location is decided as per *vaastu*. Out of nine masons surveyed, two masons felt that household members decide the type of containment system, six masons said that they themselves take the decision on the type of containment system and one mason said that an engineer decides the type of containment system. Eight masons said that septic tanks were preferred and one mason said that the single pit is generally preferred.

Average dimensions of septic tanks built: L x B x D as 2.4m X 1.6m X 2.4m. One mason said that the septic tanks that they construct are single-chambered, seven masons said that the ones they construct are two-chambered. Eight out of 9 masons said that they only plaster the septic tanks at the bottom and one mason said that he used waterproofing plaster. Two masons said that overflow outlet of septic tank should be connected to stormwater drain and three masons said there shouldn't be any overflow outlets.

Table A7.1: **Resources Required to Build a Toilet With Septic Tank for a Household of 5 Members in North West Zone of Tamil Nadu**

Sl. No.	Resources	Minimum	Maximum
1	Cost of Materials	Rs. 10,000	Rs.1,00,000
2	Cost of labour	Rs. 5,000	Rs. 25,000
3	Total cost	Rs. 6,000	Rs. 30,000
4	Time taken for construction	4days	20 days
5	Area requirement	48sq.ft	100sq.ft

Source: TNUSSP Primary Study, 2016

As per the survey, two masons agreed with single pits, which were constructed circular in shape. Average diameter of the pit was 1.2m. Average depth of pit was 1.8m. Three masons said that pits were lined and constructed using concrete rings.

Table A7.2: **Resources Required to Build a Toilet With Pits for a Household of 5 Members in North West Zone of Tamil Nadu**

Sl. No.	Resources	Minimum	Maximum
1	Cost of Materials	Rs. 15,000	-
2	Cost of labour	Rs. 6,000	Rs.7,000

Table A7.2: **Resources Required to Build a Toilet With Pits for a Household of 5 Members in North West Zone of Tamil Nadu**			
Sl. No.	**Resources**	**Minimum**	**Maximum**
3	Total cost	Rs. 6,000	Rs.
4	Time taken for construction	2 days	6 days
5	Area requirement	30sq.ft	42sq.ft
Source: TNUSSP Primary Study, 2016			

All the masons agreed that they learnt about design of toilets and containment system through on-the-job training and observation. Only one mason had heard about training programmes on toilet construction techniques. When inquired about willingness to attend any of masons training programmes, five masons agreed whereas four masons said they are not interested in any such training, as they know enough in this field.

A7.3. Emptying

As per primary survey, time taken for septic tanks to get fully filled is 1 year for 2 households and 1-2 years for 6 households. 9 households expressed it to be 3-5 years whereas for 7 households it is more than 5 years. This is mainly due to large sizes of septic tanks. Remaining 61 households had no idea about the time taken for septic tanks to get fully filled as these septic tanks have never been filled. When time taken for septic tanks to get filled is compared with desludging intervals, 1 household out of 90 is de-sludged every 6 months and 1 household is de-sludged once a year, whereas 7 households are de-sludged once in 2 years and 3 households are de-sludged once in 3 years. 9 households are de-sludged once in 5 years and 4 households are de-sludged in more than 5 years' time intervals. Remaining households are never de-sludged. Only 9 out of 90 households are following the desludging frequency of once in 2 years.

A7.4. Collection and Transportation

A total of seven interviews with cesspool operators were carried out in this zone, all of them based in Salem. Five of them were employed by the owner of the service while one identified themselves as a relative. Additionally, three trips for desludging septic tanks of different sizes (10 x 8 x 10 ft/ 10 x 10 x 10 ft / 7 x 3 x 8 ft) at individual houses in Salem was observed in detail. The duration of operation falls between 1 – 2 years to 11 – 12 years. Most operate with one vehicle, while one service provider operated three cesspools. Offered services were mainly only desludging of septic tanks only, while one service provider supplied water as well.

Business cards are distributed to reach out to new clients. Highest customer demand was observed in October – December between 7 and 12am as well as in the evening from 5 – 10pm. None of the surveyed operators claimed to de-sludge any chemical waste from institutions such as industries and small-scale units.

Certain areas were not accessible by desludging vehicles, such as Vinayaga University, Vidhya Nagar and the new bus stand in Amma Petti, the old bus stand as well as Salem bus stand and junction. In case the septic tank was sealed, operators said they broke it open, using a steel rod and hammer, which takes 5 min to 1 hour, according to the operator. For this service, five survey operators said they charged Rs. 100 – 300 extra. Usually, operators are not involved in closing the manhole after the desludging process is completed. The vehicle was parked 1.2 – 4.5 meters away from the septic tank.

Operators said that to get to their customers, they would need to travel from 15 to 100 km. Usual desludging capacities range between 5,000and 7,000 litres. During a field observation, the desludging process required eight min. Operators use vacuum pumps with a power of 10, in one case 22 HP. The pumps were manufactured in different cities in Tamil Nadu, mostly in Chennai between 1998 and 2014. The input power source is the engine shaft in all surveyed cases.

In case the sludge is too thick, operators add 400 – 500 litres of water from the household with the use of the pipe. During one of the observed trips, addition of 5,000 litres of water was noted, but no use of other additives. After the desludging process was completed, operators said that one inch to two feet of sludge remained in the tank, while surveyors observed five inches – 2ft of sludge remained.

Regarding safety equipment, some were found to use latex gloves (3 cases), goggles (2 cases) or a mask (1 cases). One operator said he did not use any protection wear. During observed trips, in none of the cases was any kind of protection equipment worn. No addition of chemicals for preventing the smell of sludge was noted. Usually, the sludge does not spill around during the desludging process. Spillage from pipes was generally disposed in the septic tank. If in contact with sludge, operators wash their hands with soap and water. In six out of seven cases, operators did not use strainers at the inlet to the suction pipe and in most cases; the pipe gets blocked several times during desludging. Most operators claimed there would be local mechanics available in case the pump broke, which happens up to 20 times per year. During accompanied trips, surveyors did not experience cases of leaking pipes or blockages during operations. The suction valves operated easily while desludging and disposal and in case of spillover, spillage was discharged in the septic tank and equipment as well as the hands of the worker were cleaned with fresh water.

The tank holds capacities of 5,000 – 7,000 litres of sludge in 1 – 2 chambers. The inner surface of the tank is rubber coated. Outlet valves are generally ball valves, placed 3 – 4ft above the ground and having a diameter of 4 – 6 inches. Vehicles were manufactured between 1998 and 2014, have a width between six and 7ft and had two axles in all surveyed cases. Mileages vary between 4 and 10 km per litre, according operators. All vehicles run on diesel.

Cesspool operators travel distances from 3 – 50 km for discharging sludge, mostly in Neikara Patti, but also in Thirumna Mutharu, Tharamangalam and KR Thoppu. During observed trips, the disposal point was 10 km away from any farmland. Approximately half the interviewed operators said they decided on the point of disposal based on municipality rules, while the other half said they decide as per the wishes of the customer. While most of operators claimed not to know of any service providers disposing sludge into drains and waterbodies, one confirmed this to be true. Reasons for not discharging into a treatment plant were attributed to distance and time, by nearly all operators. One said that he travelled long distances to reach farms for disposal and gets paid Rs. 1,000 by the farm owner. Problems with disposal generally arise between October and December. Usually, vehicles were not cleaned after every desludging trip but between once a week and every two months. During field observations, sludge disposal took about three minutes. The truck was cleaned after sludge disposal in one out of three cases; however, the pipe was always cleaned.

It was observed that 3 – 4 workers were required for operations per desludging vehicle. Drivers receive a monthly salary of Rs. 8,000 – 15,000, while helpers get less with Rs. 3,000 – 10,000 per month. The number of average trips per day differs between service providers, with some of them claiming to run up to three trips a day, while others said they function only every second day, leading to 15 – 90 trips a month. Costs of desludging was found to be Rs. 2,500 uniformly, which was verified during accompanied trips. Additionally, Rs. 30 – 200 was received through tips, breaking the manhole and, in two cases, an additional Rs. 3,000 – 5,000 of other monetary benefits (ESI, PF, bonus, etc.) was paid to employees.

Investment costs for the cesspool was found to be Rs. 9 lakh, and in some cases up to Rs. 12 lakh. A pump costs Rs. 1 – 2 lakh, a pipe Rs. 10,000 – 1.2 lakh and another Rs. 3 – 4.5 lakh was required for fitting the tank and other accessories. For maintenance of the vehicle and the pump, monthly costs add up to Rs. 46,000 – 1.5 lakh. Maintenance of the vehicle constitutes a majority of the costs. Major maintenance issues arise concerning the pump, the engine or the radiator, mostly due to heavy load, which happens once a month to once a year. For repair work, one day up to two weeks is estimated, with the cost amounting to Rs. 3,000 (radiator) – 30,000 (pump).

A7.5. Reuse

Six interviews were conducted with farmers in this zone; two each in Sankagiri, Salem and Edappadi. All surveyed farmers practiced surface irrigation. Freshwater was used for the irrigation of rice, groundnut, corn and brinjal. Sources of freshwater were bore wells, open wells and rainwater. Freshwater was found to be available throughout the year for 1 – 5 hours. Most farmers said that pumping was required for availing irrigation water, one of them specifying the costs to be Rs. 300 for electricity. All interviewed farmers said they did not pay any amount for irrigation water and that there was no subsidy available for the same. Urea, potassium, cow dung and TP are manually mixed with the soil and used as fertiliser. The costs for fertiliser account for Rs. 300 – 980 per farmer. Two out of six farmers claim not to use any kind of fertiliser.

Half the participating farmers said they use wastewater for irrigation of rice, corn and leaves due to its high nutrient value and lack of freshwater. Wastewater is usually from own sources and delivered by private companies (two cases) or by the farmers themselves (one case). No waterborne diseases were recorded among the farmers' families; neither did they receive any complaints regarding the quality of crops/ vegetables. There were no restrictions from any government body/ organisation regarding the use of wastewater for irrigation.

Two out of six farmers use fecal sludge as soil conditioner for growing banana and coconut. It was applied to the soil during cultivation and disposed by private desludging operators. Farmers neither pay for availing fecal sludge nor do they receive any amount of money from the disposer. None of the interviewed farmers found any mosquitoes breeding due to fecal sludge and they do not use any pesticide. No complaints regarding the quality of crops was noted.

Annexure 8: South Zone

A8.1. Containment

In Southern Zone (SZ), 74 households out of a total of 90 depend on septic tanks for disposal of blackwater. Nine households depend on concrete lined single pits and seven households depend on concrete-made ring pits for disposal of blackwater. In SZ, on average, pits have seven rings of height 1ft, depth 6.8ft and diameter 2ft. Eight households had vent pipes of 2-3 metres height. Two households had their pits located below toilets while others had them located at a distance of 1-2 metres. Eight households had their pit covers cemented to the pit, three households had pit covers that were temporarily placed and one household had no pit cover. 12 households had their pit walls made of precast rings. Four households had their pits sealed at bottom. One pit had an overflow discharge outlet directed into the stormwater drain.

The dimensions of septic tanks here were found to be, on average, 2.4m X 1.4m X 2.4m. 25 septic tanks had partition walls. 71 of the households had vent pipes for their septic tanks of 3 m-height. 71 septic tanks were lined at bottom. 38 septic tanks were located below toilets and in other cases they were located 3m from the toilet. 4 septic tanks were connected to soak pit. Breakages/leaks were evident on inlet /outlet pipe of one septic tank.

In SZ, septic tanks are located, on average, 7m away from the nearest main road. In households depending on pits, 10 pits were constructed 10m away from the nearest point a desludging vehicle can park while for 20 households, this distance was 10-20m. 36 households were connected by roads more than 3m wide, while 36 of them had 2-3m of width and four households were connected by roads less than 2m wide.

A8.1.1. Under Construction Containment Units

Lined septic tank was constructed for all 11 households surveyed. Only in one case was the containment designed for four houses. Excavation was done using earthwork machinery in three households and done manually in eight households. Clay soil was found in four cases, silt in three cases, loamy soil in one case and red soil was found in two cases.

Two households had overflow discharge outlet pipe from septic tank connected to a soak pit but nine households didn't have overflow discharge outlet pipes. Average size of septic tank was found to be 1.8m(L) X 1.1m(B) X 1.7m(D).

Four septic tanks had partition walls. All septic tanks had vent pipes of around 3m height. All septic tanks were lined at the bottom. Three septic tanks were constructed below the toilet. Septic tanks in all households were constructed at a distance of less than 10m from where a desludging vehicle can be parked. One household had connecting road of width less than 2m making it impossible to de-sludge, three households had connecting road of the width 2-3m where de-sludging can be difficult and six households had road width of more than 3m.

A8.2. Enabling Environment – Masons

Out of nine masons surveyed, four masons felt that household members take the decisions for toilet dimensions, four masons were of the opinion that they themselves decide and four masons said that the engineer gives toilet dimensions. Average area of toilet was 1.69 sq.m. Nine masons said that they used the squatting pan and seven masons said that they used western commode. Eight masons said

that they provided one ventilation opening while one mason said that two ventilation openings were provided. All nine masons agreed that bricks were used as materials for construction.

Figure A8.1: **Mason's Interview Conducted by Our Team Members On-Site**

Source: TNUSSP Primary Study, 2016

Out of nine masons surveyed, six masons said that they themselves take the decision on toilet location, six masons were of the opinion that household members take the decision on toilet location and four masons said that the engineer decides the location. Out of nine masons surveyed, five masons felt that household members decide the type of containment system, four masons said that they themselves take the decision on type of containment system and three masons were of the opinion that the engineer decides the type of containment system.

Eight masons said that septic tanks were preferred and one mason said that a single pit is generally preferred. Average dimensions of septic tanks built: L x B x D as 2.2m X 1.5m X 2.5m. Six masons said that the septic tanks that they construct are single-chambered, two masons said that they constructed two-chambered. Eight out of nine masons said that they only plaster the bottom of septic tanks and one mason said that they use waterproofing plaster. Five masons said that overflow outlet of septic tank should be connected to stormwater drain and four masons said there shouldn't be any overflow outlets.

Table A8.1: **Resources Required to Build a Toilet with Septic Tank for a Household of 5 Members in South Zone of Tamil Nadu**

Sl. No.	Resources	Minimum	Maximum
1	Cost of Materials	Rs. 16,000	Rs.1,00,000
2	Cost of labour	Rs. 3,600	Rs.20,000
3	Total cost	Rs. 5,000	-
4	Time taken for construction	4 days	15 days
5	Area requirement	20sq.ft	220sq.ft

Source: TNUSSP Primary Study, 2016

All the masons agreed that they learnt about the design of toilets and containment systems through on-the-job training and observations. Four masons had heard about training programmes on toilet construction techniques. When inquired about willingness to attend any of masons training programmes, four masons agreed whereas five masons said they are not interested in any such training, as they know enough in this field.

A8.3. Emptying

As per primary survey, time taken for septic tanks to get fully filled is one year for one household and 1-2 years for 3 households. Of the total surveyed households in this zone: 10 households desludged in 3-5 years frequency whereas for 20 households it's more than 5 years. This is mainly due to large sizes of septic tanks. Remaining 53 households had no idea about the time taken for septic tanks to get fully filled as these septic tanks have never been filled.

When time taken for septic tanks to get filled is compared with desludging intervals, 2 households out of 90 are desludged once in a year and 3 households is desludged once in 2 years, whereas 6 households are desludged once in 3 years and 7 households are desludged once in 5 years. 16 households are desludged in more than 5 years' time intervals. Remaining households are never desludged. Only 5 out of 90 households are following the desludging frequency of once in 2 years.

A8.4. Collection and Transportation

In the SZ, a total of four cesspool operators were interviewed, three of them in Thoothukudi (3 employed by the owner and 1 relative) and one in Kovilpatti (employed by the owner). In addition to the interviews, surveyors accompanied a service provider operating in Thootikudi for one trip, which was carried out to desludge a leach pit of an industrial unit. The services have been running between 2 and 3 years and 14 and 15 years. Three interviewed operators said they have one truck and one of them said they manage three trucks for desludging – the only service all operators said they offer. They distribute business cards and pamphlets to households and display mobile numbers on the vehicles to reach out to new clients. The busiest time periods were reported to be from 6am – 3pm from October to December. None of the interviewed operators said they desludge chemical waste from industries.

All operators said that there were certain areas inaccessible for their vehicles: Gandhi Nagar in Kovilpatti as well as Jeyalani Street, Theru Puthu Street and SS Pillaiyar Market in Shanmugam Puram, Fathima Nagar and Thomas Nagar in Thoothukudi. The operators cater to customers situated within a 10 – 50 km area.

In case of septic tanks without openings, operators said they break the tank using a steel rod, which usually takes between 10 minutes and one hour. This service was, only for one case, charged extra (Rs. 400). The sludge quantity varies between 3,000 and 5,000 litres, according to the operators. During the observed trip, the pit was concealed and opened by the operator. The access road had a width of 6 metres and the truck was parked one metre away from the containment unit. No chemicals or other additives were used to prevent smell and no protective equipment was worn by the operator.

Sludge was pumped out using vacuum pumps, which have a power of 10 HP (or 5 HP in one case). Two operators said their pumps were manufactured in Madurai or Thoothukudi, between 1998 and 2014. The input power source was the engine shaft in all surveyed cases. The hose pipes being used were manufactured 1 – 10 years ago, a length of 4.4 – 36.6 m, and diameter between 3 and 6 inches and made out of rubber. For extended length of the pipe, another pipe is connected using couplings. In case the sludge is too thick to be desludged easily, one operator said he adds kerosene, and the others said they use 200 – 1000 litres of water, supplied from the household, using a bucket or a pipe. After the desludging process is finished, sludge up to 1 inch remains in the septic tank.

One operator said they wear uniforms and another said they wear masks as safety equipment during the desludging process. Sludge usually does not spill while desludging. If they come in contact with spillage, operators said they wash their hands with soap and water. Two out of four operators said they dispose spillage into the septic tank, while one disposes into drains and another into vacant lands. During the observed trip, there was a strainer present at the inlet suction pipe. The use of additional water was not required and the suction valve operated easily. No leakages or blockages were noticed

during desludging, but there were leakages from the valve during transportation. Workers cleaned their hands and their equipment with fresh water after the desludging process. No sludge was left in the pit after desludging.

Usually, no strainers are used at the inlet to the suction pipe. Blockages of the pipe happen approximately once per desludging process. In case the pump breaks – which happens generally 1 – 3 times a year – all operators said there were local mechanics available to repair it. Tank capacities measure between 3,000 and 5,000 litres, distributed between 1 – 2 chambers. The inner surfaces are rubber lined/ paint coated. The type of the outlet valves are ball valves, placed 3 – 4ft above the ground and measure 4 – 6 inches in diameter. Available cesspools were manufactured in 1998, 2002 or 2012, all have one axle and a width of 5 – 8 ft. All desludging vehicles of the surveyed operators are diesel-fuelled (costs of Rs. 54 – 58), with a mileage of four (in one case six) km per litre.

The points of discharge are usually 10 – 50 km apart (6 km in the case of the observed trip) and often decided upon as per the rules of the municipality. Reasons given for non-disposal into treatment plants were time and distance and in the case of the Kovilpatti-based operator, procedures. As frequent discharge points, operators from Thoothukudi listed Tharuvaikulam, Pakkil channel and Thoothukudi, and the operator from Kovilpatti said that they usually discharge fecal sludge in the Municipality Compost Karangaluku Patti. Two out of four operators said they were paid by farm owners between Rs. 100 and Rs. 1000 if they had to travel a long distance for disposing sludge in their farmlands. Problems with disposing sludge arose in March - April as well as in October – December. None of the interviewed operators said they were aware of any service provider disposing fecal sludge into drains or waterbodies. However, during the observed trip, sludge was disposed into a stormwater drain. Cesspool cleaning is done at periodic intervals, on a weekly up to quarter-yearly basis.

Out of four operators, three of them said that at least four workers were required per desludging vehicle; one operator said they run the service with only three workers per vehicle. The salary offered differs between operators: drivers receive Rs. 13,000/ 14,000/ 40,000 per month and helpers Rs. 8,500/ 10,000/ 30,000 per month. In one case, the staff were being paid daily: drivers Rs. 350 and helpers Rs. 200 a day. One operator said workers receive an additional Rs. 100 per loading through tips or for breaking the manhole and in one case, workers get another Rs. 1,500 through monetary benefits (ESI, PF, bonus, etc.). The service provider that pays the highest salaries carries out 10 trips a day (300 per month), while the others only do 1/2 in a day (30/ 60 a month).

The costs for desludging falls between Rs. 1,500 and 3,500 (Rs. 1,200 in the case of the observed trip). Investment costs for the vehicle account for Rs. 12 up to 20 lakh, for the pump it is Rs. 1.5 – 2.1 lakh, for the pipe Rs. 1,200 – 60,000 and the costs for fitting the tank and other accessories are Rs. 3 – 4.5 lakh. For maintenance of the pump, Rs. 2,000 – 70,000 is required to be paid and for the vehicle Rs. 0.6 – 1.5 lakh. Major maintenance problems, operators stated, are often concerning the pump, which occurs once a year and leads to costs of Rs. 16,000 – 35,000 and requires 1 – 2 days for repairs. One operator said major maintenance problems concerned oil changes and tires. These problems would occur once a month and was estimated to cost Rs. 5,000.

A8.5. Reuse

Four interviews with farmers were conducted in SZ (two in Thoothukudi and Kovilpatti respectively). Banana plants, mango trees as well as rice were irrigated with freshwater, which was sourced from bore wells (2) and/ or open wells (2) or using rain water (1). None of the interviewed farmers said they receive water throughout the year. Problems with fresh water supply mainly arise during summer. The farmers based in Thoothukudi practice drip irrigation, while farmers from Kovilpatti do surface irrigation. In the case of sourcing water through wells, pumping was required, but no farmer pays either for electricity required for water supply or for the water supplied for irrigation. There were no subsidies

available for irrigation water. Urea, potassium, TAP as well as cow or goat dung were observed to be the fertilisers used for farming. To apply it to cultivated land, the fertilisers are usually mixed manually with soil. For urea, potassium and TAP, farmers pay, on average, Rs. 2,400 – 6,000, for goat dung Rs. 2,000 and for cow dung Rs. 15,000.

Three of four farmers use wastewater for irrigation of banana trees and rice, either due to a lack of freshwater or because of its high nutrient value. Sources of wastewater are the farmer's own septic tanks/ soak pits/ pits as well as greywater from washing and cleaning. None of the interviewed farmers said that there were cases of water-borne diseases among their household members. There were also no restrictions from any government body/ organisation towards the use of wastewater for irrigation. No complaints were received regarding the quality of crops. None of the interviewed farmers in the SZ use fecal sludge as soil conditioner.

Annexure 9: West Zone

A9.1. Containment

Seventy-five households out of a total of 90 in the West Zone (WZ) depend on septic tanks for disposal of black water. Fourteen households depend on concrete-lined single pits and one household depends on concrete ring pits for disposal of black water.

In WZ, on average, pits have six precast rings of 1.5-ft height, 6-ft depth and 4-ft diameter each. Out of the two households, only one household had a vent pipe of three metres height. Out of the two respondents, one household had its pit located below the toilet while the other had it located 1 metre away. In both cases, the pit cover was fixed to the pit. Out of two respondents, one household had its pit sealed at the bottom. There were also no openings in the pit walls. One household had an overflow pipe attached to the pit to discharge it into the stormwater drain.

In WZ, on average, the dimensions of septic tanks were found to be 2.27m (L) X 1.4m (B) X 2.6m (D). 69 households had a vent pipe reaching three metres in height for their septic tanks. The study found 82 septic tanks lined at the bottom. 36 tanks were located below the toilets while the rest were installed an average of 3 metres away from the toilet. 76 septic tanks didn't have manhole covers and only one septic tank was connected to a soak pit. One septic tank and the inlet/outlet pipe of 23 septic tanks were found to have breakages/leakages.

In WZ, septic tanks were found to be located, on average, 7-8 metres away from the nearest main road. The width of roads leading to 36 households were found to be only 3 metres wide, while 42 households were connected by roads 2-3 metres in width. The narrow routes make it difficult for desludging vehicles to carry out operations. It is not possible for vehicles reach the nine households connected by roads less than two metres wide.

A9.1.1. Under Construction Containment Units

Lined septic tanks were constructed in all nine households surveyed. Excavation was done using earthwork machinery in five households and done manually in four households. Clay soil was found in five cases along with silt and rocks were found in four cases. Red soil was also found in two cases.

Three households had outlet pipes from the septic tanks connected to the stormwater drain but six households were found not to have overflow discharge outlet pipes from their septic tanks. Average size of septic tanks was 2.5m (L) X 1.1m (B) X 2.4m (D).

Three septic tanks were single chambered, four septic tanks were two-chambered and two septic tanks were three-chambered. Four septic tanks had partition walls constructed in the centre of the tank while two of them had partition wall constructed at 1/3rd distance from the tank wall. Eight septic tanks had vent pipe of 3-4 metres height.

All 9 septic tanks surveyed were lined at the bottom. Three out of 9 septic tanks are constructed below the toilet. Five were constructed near the wells with less than 10 metres distance between them. Septic tanks in 8 out 9 households were constructed at a distance of less than 10 metres where a desludging vehicle can be parked. Three out of nine households were connected by roads of 2-3 metres width where desludging can be difficult and the remaining six households were situated near roads of more than 3 metres.

A9.2. Enabling Environment – Masons

Out of 11 masons surveyed, five masons felt that household members take decisions regarding toilet dimensions, four masons were of the opinion that they themselves take the decision and two masons were of the opinion that the engineer details toilet dimensions. Average area of the toilet was 2.5 sq.m. All the masons said that they have been using squatting pans and western commodes. Nine masons said they provided one ventilation opening whereas two masons said that two openings were provided. All the masons said that they used bricks as materials of construction.

Out of 11 masons surveyed, eight masons felt that household members decide the toilet location, three masons were of the opinion that they themselves take the decision on toilet location, one mason said that the engineer decides the location and one mason felt that toilet location was decided as per *vaastu*. Out of 11 masons surveyed, six masons felt that household members decide the type of containment system, four masons said that they themselves decide on the type of containment system and one mason said that the engineer decides the type of containment system.

All the masons said that only septic tanks were preferred. Average dimensions of septic tanks built were as 2.3m(L) X1.2m(B) X 2.1m(D). All masons said that the septic tanks that they constructed were two-chambered. Ten out of 11 masons said that they only plaster the bottom of septic tanks and one mason said that he uses waterproof plaster. Six masons said that overflow outlet of septic tank should be connected to stormwater drain, two masons said it should be connected to soak pits and two masons said there shouldn't be any overflow outlets.

Figure A9.1 shows a mason being interviewed. Table A9.1 highlights the resources required to build a toilet with septic tank for a household of 5 members.

Figure A9.1: **Toilet Building Mason Interview Conducted by our Team Member at the House**

Source: TNUSSP Primary Study, 2016

Table A9.1: **Resources Required to Build a Toilet with Septic Tank for a Household of 5 Members in Western Zone of Tamil Nadu**

Sl. No.	Resources	Minimum	Maximum
1	Cost of Materials	Rs. 21,000	Rs. 50,000
2	Cost of labour	Rs. 4,500	Rs. 20,000
3	Total cost	Rs. 6,000	Rs. 40,000
4	Time taken for construction	2 days	12 days
5	Area requirement	16 sq.ft	100sq.ft.

Source: TNUSSP Primary Study, 2016

As per masons' survey, only single pits are constructed which are circular in shape in WZ. Average diameter of the pit was 0.7m. Depth of pit varies from 0.9m to 2.4m. Three masons said that pits were lined and constructed using concrete rings. The below table A3.2 shows the resources required to build a toilet with pits for a household of 5 members.

Table A9.2: **Resources Required to Build a Toilet With Pits for a Household Of 5 Members in Western Zone of Tamil Nadu**			
Sl. No.	**Resources**	**Minimum**	**Maximum**
1	Cost of Materials	Rs. 10,000	Rs.15,000
2	Cost of labour	Rs. 3,000	Rs. 5,000
3	Total cost	Rs. 8,000	Rs.15,000
4	Time taken for construction	1 day	3 days
5	Area requirement	3ft x 4ft	-
Source: TNUSSP Primary Study, 2016			

All masons said that they learnt about design of toilets and containment system at their job training and observation. Six masons had heard about training programmes on toilet construction techniques. When asked about willingness to attend any masons training programmes, nine masons agreed and two masons said they were not interested in any such training as they know enough.

A9.3. Emptying

As per primary survey, time taken for septic tanks to get fully filled was found to be 1-2 years and 3-5 years for two households in each whereas for 18 households it was more than five years. This is mainly due to the large sizes of the septic tanks. Remaining 53 households had no idea about the time taken for septic tanks to get fully filled as these septic tanks had never been filled.

When time taken for septic tanks to get filled is compared with desludging intervals, one household out of 90 is desludged every six months, whereas two households were desludged every year. Three households were desludged once in two years. Four households were desludged once in five years and 13 households were desludged in more than 5 years' time intervals. Remaining households were never desludged. Only five out of 90 households were following the desludging frequency of once in two years.

A9.4. Collection and Transportation

A total of 6 cesspool operators were interviewed in this region, 3 respectively from Bhavani and Erode. All operators offer septic tank cleaning as a single service. Seven desludging trips were observed by surveyors, five in Erode and two in Bhavani. The period, since the service is run by the owner, is 1 – 2 up to 14 – 15 years. On site, the cleaning of leach pits was rarely observed. Dimensions of containment units varied across households.

Most operators are based out of Erode or Bhavani and serve towns and villages in nearby areas – within a radius of 10 – 50 km. At Erode, it is common for owners to hire workers to drive and operate these vehicles, while in Bhavani, the owners themselves operate the vehicles. Distribution of business cards was found to be the most common means of marketing to generate demand. Most operators own one truck and one Bhavani-based operator owned three. The age of vehicles range between 2 and 15 years, with four of them being less than five years of age. Customers usually call for services from October to December and operations are carried out between 6 – 12 am and 5 – 10 pm (in Bhavani only in the morning). One operator from Bhavani as well as one from Erode, de-sludge chemical waste from a clothes industry and a steel factory.

Within all surveyed towns are areas which are not accessible for operators, namely Akkaragaram and Bhavani in Erode as well as Aagaragaram, Pallipalayam, Kumarapalayam and Jambai in Bhavani. During observations, the width of the access road to households was found to be 2 – 3m and in most

cases, the destination was not inaccessible. The distance between the cesspool and the containment unit was found to be between two and 50 m while desludging. During field observations, the process of desludging usually took 6 – 17 min. Septic tanks are opened by the operator. Tanks without an opening are usually broken using a drilling machine, a steel rod or hammer. Most operators surveyed said that it would require approximately 30 – 60 min to break the septic tank, whereas one operator, who uses a steel rod and hammer, claimed it would only take 10 min. This operator did not collect any extra fees for this service while the others collected Rs. 100 – 600 more. After desludging was completed, the operators usually do not get involved in sealing the manhole. In most of the desludging processes observed, the operators did not add any kind of chemicals to prevent bad odour, while the use of kerosene was noticed in one case.

Figure A9.2: **Measuring the Width of the Road to Observe the Truck Accessibility**

Source: TNUSSP Primary Study, 2016

All operators use vacuum pumps with the engine shaft as input power source and a horsepower of 10 (25 in one case) for desludging. Pumps were manufactured at different locations, 15 – 380 km apart. One operator uses pumps and pipes from 1989; the equipment used by the rest of the operators were manufactured between 2005 and 2016, and their lifetime is estimated to be 3 – 10 years. The length of the hosepipes used were between 15 and 60 m with a diameter of 2 – 5 inches. Pump wetted parts are made of cast iron and sludge collection pipes are made of rubber.

In case the sludge is very thick and cannot be pumped out, operators add 1,000 – 2,000 litres of water, which is usually taken from the household. The study found that safety equipment was not used consistently. Only during one observed trip, was the use of latex gloves and a protection mask noticed. Operators said that sludge spillage around the place of desludging is usually not a problem. Workers claimed to wash their hands with soap and water if they ever came in contact with spillage. On the field, it was observed that the equipment is rarely cleaned after there's a spillage. Spillage from pipes was being disposed in the septic tank, which was confirmed during field visits. Five of the six operators surveyed, do not have a strainer at the inlet to the suction pipe. Pumps break down approximately every 1 – 2 years, in which case local mechanics are available to repair the pump. During field observations, no leaks or blockages of the pipe were noticed and the operation of the suction valve during desludging/ disposal seemed to be straightforward.

Most tanks were found to have one chamber with a capacity of 3,000 – 5,000 litres. The inner surface is rubber coated. Outlet valves have uniformly a diameter of 4 inches and are mostly 3 feet above ground level. Five out of six operators use ball valves, the sixth uses a butterfly valve. Cesspools have

two axles, with sizes ranging from 10ft length/ 7ft width to 17ft length/ 6ft width. The highest mileage of 10 km per litre was found with the smallest and oldest truck (manufactured in 1989) from Bhavani, and the lowest of 4 km per litre, a 15ft length/ 6ft width one from 2005, was located in Erode. All vehicles run on diesel and it usually costs Rs. 58 costs per litre. Surveyors observed that the painting of the tank was old but covered completely.

Four of six operators said they decide on the disposal site depending on the farmers' requirements. All claimed that none of the known operators dispose sludge into waterbodies or drains, whereas Thindal, Veppadai, Lakka Puram and Pallipalayam in Erode as well as Rajalakshmi Road and Thayir Palayam in Bhavani are supposed to be frequent disposal sites. During the survey, operators said they cover 10 – 20 km to reach the disposal destination. Figure A.4.4 shows one of the disposal points. During site observations, the distances were shorter ranging from 1 – 10 km. Disposal on farmlands, lasting 3 – 5 min, was mostly noticed during observations at the site. Reasons for not disposing fecal sludge into the treatment plant were attributed to lack of time and distance consistently. Farm owners (four out of six surveyed) paid amounts ranging from Rs. 500 – 2,000 for operators to travel a long distance to deliver sludge. From October to December, operators often faced problems within the disposal process. Vehicles are generally not cleaned after every disposal but only once per week or every 3 months. It was observed that hosepipes are usually cleaned after the desludging process.

For the operation of the desludging vehicle, 3 – 4 workers were found to be required. Drivers receive a monthly salary of Rs. 10,000 – 15,000 and helpers get an amount of Rs. 9,000 – 10,000. On average, one vehicle desludges 2 – 4 septic tanks per day (60 – 120 per month). The costs of desludging are Rs. 3,000 in Bhavani and Rs. 1,800 – 3,000 in Erode, usually based on the condition of sludge. The amount of additional income, such as tips and incentives like provident funds, accounts for monthly Rs. 200 – 11,000. The investment costs of a cesspool range from Rs. 10,000 – 16 lakh, additional Rs. 30,000 – 1.5 lakh are required for purchasing a pump, Rs. 20,000 to 1 lakh for the desludging pipe and Rs. 60,000 – 6 lakh for fitting the tank and other accessories. For maintenance of the vehicle and the pump, the operators spend Rs. 75,000 – 1.7 lakh. Overload of the engine and the pump are the main maintenance problems which operators face at intervals from once a year to twice a month. The repair work requires 1 – 10 days of time and costs Rs. 5,000 – 50,000.

A9.5. Reuse

In the western zone, seven interviews were conducted with farmers from Erode (3), Bhavani (2) and Jambai (2). Common practice among farmers here is surface irrigation. Fresh water is fed to tapioca, banana, sugarcane and corn fields from bore wells as well as from open wells. Water is available throughout the year, mostly for 1 – 4 hours and in some cases for 8 – 10 hours. All interviewed farmers stated pumping was required for availing irrigation water. They also said that there were no subsidies available for irrigation water. Potassium, urea and cow dung were being used as fertilisers, leading to costs of Rs. 300 – 900 per farmer. Usually, fertilisers were mixed with soil manually.

None of the interviewed farmers claim to use wastewater for irrigation purpose, while four out of seven farmers use fecal sludge as a soil conditioner, supplied by private desludging operators. Two respondents said they used the sludge dry and two preferred it fresh. It was applied to the soil for either three days or one month after arrival or during cultivation. In general, no charges were paid either for availing fecal sludge or for disposal. Farmers said they did not encounter an increase in mosquitoes due to fecal sludge and that no pesticides were used to avoid mosquitoes and other pests. The farmers did not face any restrictions from any government body/ organisation towards the use of fecal sludge for agricultural purposes.

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