SFD Promotion Initiative

Tiruchirappalli

India

Final Report

This SFD Report was created through desk-based research
by Centre for Science and Environment (CSE) as part of the SFD Promotion Initiative.

Date of production: 26/09/2015
Last update: 19/02/2016

SFD Promotion Initiative

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On behalf of Federal Ministry for Economic Cooperation and Development

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SFD Report Tiruchirappalli, India, 2016

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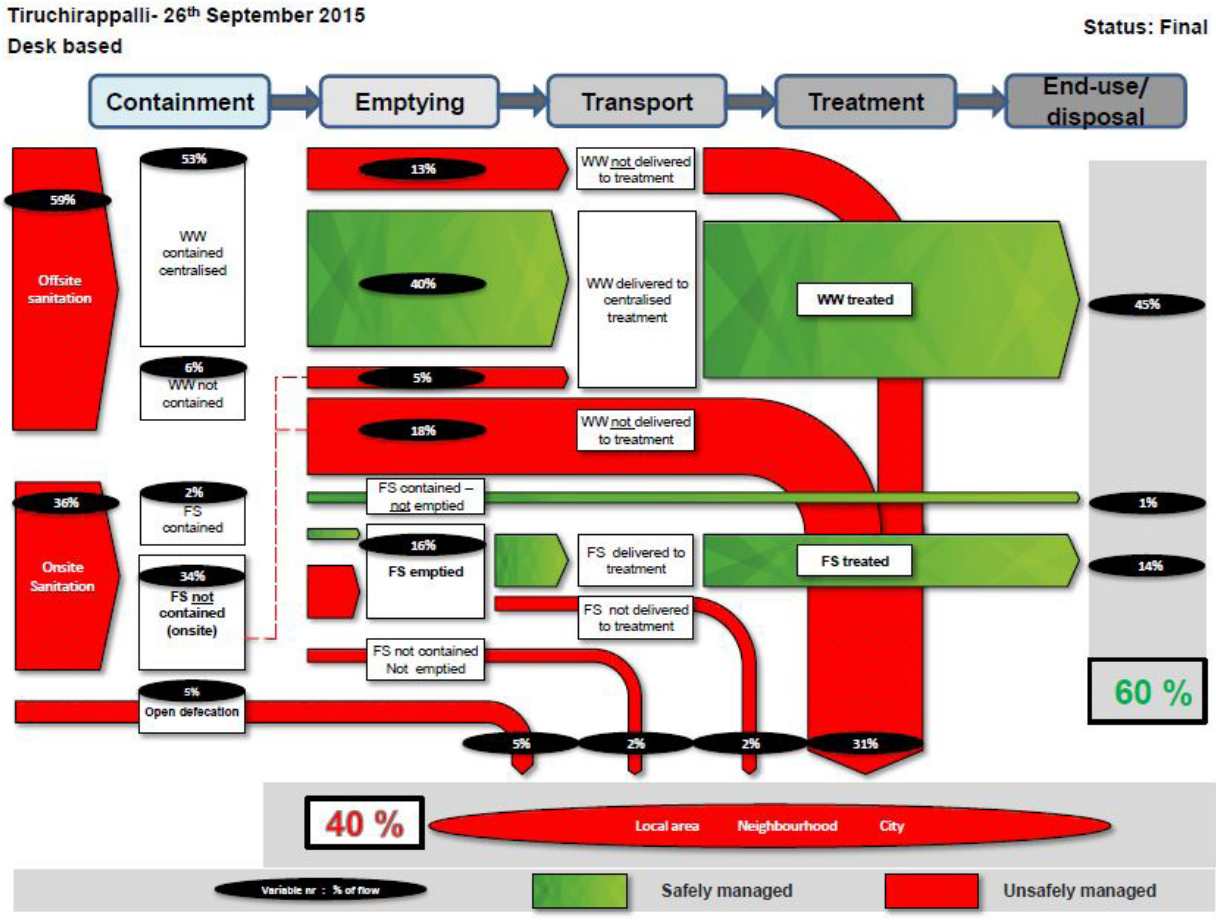
1. The Diagram



2. Diagram information

Desk or field based:
This is a desk based SFD

Produced by:
Centre for Science and Environment (CSE), New Delhi

Status:
This is a final SFD

Date of production:
26/09/2015

3. General city information

Tiruchirappalli, also known as Trichy, is one of the largest cities in Tamil Nadu and is known as an important trade, education and pilgrimage centre. The famous Sri Ranganatha Swamy temple is located in the city, which attracts lakhs of tourists every year (TCC, 2015).

The population of city as per the 2011 Census is 916,857. The density of city is 5,483 persons per sq.km which is very high when compared to state average of 515 persons per sq.km. Total slum population is 228,518 which is 26% of the total population (Census of India, 2011).

Municipal boundary has been chosen for the current study. It comprises of an area of 159 sq.km (TCC, 2015).

4. Service delivery context

In 2008, the Ministry of Urban Development (MoUD) issued the National Urban Sanitation Policy (NUSP). The policy aims to: raise awareness, promote behaviour change; achieve open defecation free cities; develop citywide sanitation plans; and provide 100% safe confinement, transport, treatment and disposal of human excreta and liquid wastes. The NUSP mandates states to develop state urban sanitation strategies and work with cities to develop City Sanitation Plans (CSPs). Furthermore, it explicitly states that cities and states must issue policies and technical solutions that address onsite sanitation, including the safe confinement of faecal sludge (USAID, 2010).

The objectives of NUSP are to be realized through CSPs and state sanitation strategies. As of now there are very few cities which have finalized their CSPs, and those plans are also not implemented. This remains a major drawback in implementation of NUSP.

The advisory note on septage management in urban India, issued by MoUD in 2013, recommends supplementing CSPs with Septage Management Sub-Plan (SMP). Still septage management in India is not prominent due to lack of knowledge, consideration of septage management as an interim solution, lack of sufficient funding and many other socio-political issues.

There are no specific legal provisions relating to septage management, but there are a number of provisions relating to sanitation services and environmental regulations, which majorly stems from, The Environment (Protection) Act, 1986 and the Water (Prevention and Control of Pollution) Acts. Municipal acts and regulations usually refer to management of solid and liquid wastes but may not provide detailed rules for septage management (MoUD, 2013).

Tamil Nadu is the first state to develop operative guidelines on septage management. In September 2014 it has passed a Government Order on “Operative Guidelines for septage management for local bodies in Tamil Nadu”. This order is applicable for 12 Corporations, 124 Municipalities, 528 Town Panchayats and 12808 Panchayats in the state.

5. Service outcomes

Overview on technologies and methods used for different sanitation systems through the sanitation service chain is as follows:

Containment: There is sewerage network which covers 53% of the population. 34% of the city is majorly dependent on septic tanks which are generally not adhering to design prescribed by Bureau of Indian Standards (BIS). The effluent from the septic tank flows into open drains. Some households are also connected to pits.

Emptying: There are around 30 private emptiers of varying capacities plying in the city. The emptying fee ranges from INR 1000 to 1500 15 to 22 USD per trip. Apart from private service Tiruchirappalli City Municipal Corporation (TCC) operates its own emptier of 4000 litre capacity. According to city corporation approximately 0.756 Million litres of septage is collected per month through 190 trips (TCC, 2015b). There are no instances of manual emptying reported.

Transport: Private emptiers transport septage by truck mounted vacuum tankers to sewage pumping stations. Septage mixes with sewage and is conveyed to the Sewage Treatment Plant (STP) through pumps.

Treatment: There is one STP of 58 MLD capacity based

Figure 1: Private emptier discharging septage in to sewage pumping station (Source: Bhitush/CSE, 2015)

Figure 2: Septic tank connected to community toilet in Ariamangalam slum (Source: Bhitush/CSE, 2015)

on Wastewater Stabilization Pond (WSP) technology (TWADB, 2015). Septage is co-treated with sewage.

End-use/Disposal: There is one STP of 58 MLD capacity based on Wastewater Stabilization Pond (WSP) technology (TWADB, 2015). Private emptiers dispose septage in to four sewage pumping stations. Septage is co-treated with sewage (TCC, 2015b). A minimal charge of INR 30 (0.45 USD) is collected as emptying fees from private emptiers. Private emptiers has to renewal their license by paying INR 2000 (30 USD) every year. The treated waste water is discharged in to Koriyaar River.

According to Census, 59% of city is dependent on offsite systems and population connected to sewer line is 53%. It is assumed that 13% of waste water is lost in transportation, and 40% is treated and hence shown safe in SFD. User interface directly discharging in open drain or open ground is around 6% and 17% of Faecal Sludge (FS) i.e. effluent from septic tanks also joins in open drain. Out of 23% of waste water in open drain around 5% is tapped and treated at STP.

Rest of the 36% of the city is dependent on onsite sanitation systems (OSS), out of which 34% is dependent on septic tanks and 2% on pits. The public latrines are either connected to septic tanks and sewers hence are incorporated partially in onsite systems and rest in offsite systems. Septic tanks are not contained as they are connected to open drains but pits are contained as ground water table is more than 10 mbgl.

There is no clear differentiation between percentage of effluent and septage generated from septic tanks, hence it's assumed to be 50% each. Therefore, 17% of FS which is effluent goes into open drain. Some FS is always left in the tanks and is assumed to be 2%. Whereas 1% of FS from pits is contained in pits, which includes infiltration of water as well, and rest 1% of pits are emptied in pumping station. Overall out of 16% of FS emptied 14% is conveyed through pumping stations and is co-treated with sewage at STPs. 5% of population practices open defecation and hence shown unsafe on SFD.

6. Overview of stakeholders

The 74th Constitutional Amendment Act of 1992 reformed the sector by transferring responsibility for domestic, industrial, and commercial water supply and sewerage (WSS) from state agencies, such as Departments of Public Health Engineering and State Water Boards, to Urban Local Bodies (ULBs). This transfer has resulted in a variety of implementation models, as well as lack of clarity in allocation of roles and responsibilities between state and local agencies, which sometimes leave large gaps in implementation (USAID, 2010).

The following stakeholders are responsible for sanitation service delivery in Tiruchirappalli:

Table 1: Key stakeholders (Source: compiled by CSE, 2015)

Key Stakeholders	Institutions / Organizations
Public Institutions	Tamil Nadu Water Supply and Drainage Board (TWAD Board), Tiruchirappalli Municipal Corporation (TCC)
Tamil Nadu Pollution Control Board (TNPCB)	
Private Sector	Private emptiers

TWAD Board is responsible for planning, designing and construction of sewerage system.TCC is responsible for operation and maintenance of sewerage network. The city corporation licenses private emptiers and allows them to dispose septage in sewage pumping stations.

Private emptiers and TCC both are responsible for septage management.

TNPCB is responsible for monitoring and evaluation of STPs.

7. Credibility of data

Two key sources of data are used; Census of India, 2011 and data from TCC. Most of the data is then updated by Key Informant Interviews (KIIs). Six KIIs have been conducted with different stakeholders.

Data on containment is available in Census. Data on emptying and transport is collected by KIIs. However most of the data is qualitative.

Some of the issues and challenges are listed below:

- Data insufficiency & non availability:
  - No data available on how many septic tanks are connected to open drains and how many are connected to soak pits (for effluent infiltration)
  - No data available about commercial establishments, institutions etc.
- Accuracy: Discrepancy observed between Census data and actual ground situation
- Data available at different time lines
- Limited data available on reuse (formal / informal)

Assumptions followed for preparing SFDs:

- Data provided by Census of India, 2011 is correct
- Septic tanks and sewer connections on ground are as per septic tanks & sewer connections defined in Census
- Volume of waste water generated is 80 % of water supplied
- 90% of the people get their tanks emptied when full

8. Process of SFD development

Data is collected through secondary sources, and then a visit to the city is done to conduct KIIs with relevant stakeholders, to fill in the gaps in data and to crosscheck the data collected.

To start with, a relationship between sanitation technologies defined in Census of India and that defined in the project is established.

The data was fed into the calculation tool to calculate the excreta flow in terms of percentage of population.

Overall 60% of excreta is safely managed in the city and rest 40%, which also includes 5% of city defecating in open, is shown unsafe in SFD.

Limitations of SFD:
It's dependent on secondary data and true picture of the city may differ.

The data available is at different timelines, for example data on containment is from census 2011, and data on emptying and transportation is collected through KIIs conducted in 2015.

Excreta is safely managed or not is dependent on the containment of the system, and not on whether the waste is safely handled or not.

9. List of data sources

Below is the list of data sources used for the development of SFD.

- Published reports and books:
  - Census of India 2011, House listing and Housing data, Government of India
  - Service levels in water and sanitation sector, MoUD, 2012.
- KIIs with representatives from
  - Government agencies: TCC, TWAD Board
  - Service providers: Private emptiers
  - Residents
- Websites/web links:
  https://www.trichycorporation.gov.in/

Tiruchirappalli, India, 2015

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Abbreviations

BIS	Bureau of Indian Standard
CPHEEO	Central Public Health & Environmental Engineering Organization
CSE	Centre for Science and Environment
CGWB	Central Ground Water Board
CPCB	Central Pollution Control Board
CMA	Commissionerate of Municipal Administration
FS	Faecal Sludge
GoTN	Government of Tamil Nadu
KII	Key Informant Interview
MLD	Million Litres per Day
MOUD	Ministry of Urban Development
NIUA	National Institute of Urban Affairs
OSS	Onsite Sanitation System
SLB	Service Level Benchmarks
STP	Sewage Treatment Plant
SWM	Solid Waste Management
TCC	Tiruchirappalli City Municipal Corporation
TNPCB	Tamil Nadu Pollution Control Board
TWADB	Tamil Nadu Water Supply and Drainage Board
USAID	United States Agency for International Department
WSS	Water Supply and Sewerage
WW	Waste Water

1 City context

Tiruchirappalli, also known as Trichy, is one of the largest cities of Tamil Nadu, located along the Cauvery river delta, spread across 167.23 sq.km. It is centre for trade, education, pilgrimage and is the administrative headquarters of Tiruchirappalli district. The presence of a large number of energy equipment manufacturing units in and around the city has earned it the title of "Energy equipment and fabrication capital of India". The famous Sri Ranganatha Swamy temple is located in the city, which attracts lakhs of tourists every year. The city has a population of 916,857 with density of 5,483 per sq.km, which is very high when compared to state average of 515 persons per sq.km (TCC, 2015). There are 211 approved and 75 unapproved slums with population of 228,518 which is 26% of the total population. The daily floating population of the city was estimated at around 250,000 (TCC, 2015a). Table 1 describes the population growth rate.

Table 1: Decadal population growth rate of Tiruchirappalli

Year	Population	Decadal growth rate in %
1951	323693	-
1961	374284	15.63
1971	478363	27.81
1981	578767	20.99
1991	669452	15.67
2001	746062	11.45
2011	847387	13.58

(Source: Census of India, 2011)

City lies on the plains between the Shevaroy Hills to the north and the Palni Hills to the south and south-west. The topography of Trichy is almost flat, with an average elevation of 88 meters. The city is located within the geographic coordinates of 10.8050° N and 78.6856° E. It experiences a tropical savanna climate with no major change in temperature between summer and winter. The annual mean temperature is 28.9 °C and the monthly average temperature ranges from 25 °C and 32 °C. As the city is located on the Deccan Plateau, the days are extremely warm and dry; evenings are cooler because of cold winds that blow from the southeast. The warmest months are from April to June; from June to September, the city experiences a moderate climate tempered by heavy rain and thundershowers. The average annual rainfall is 841.9 mm and because of the northeast monsoon winds, rainfall is heaviest during the months October to December (TCC, 2015).

River Cauvery is the major source of water for the city, and municipal water supply is 128 MLD (TWADB, 2015). The treated waste water is disposed in Koriyaar River. Community latrines are unusable due to the damaged septic tanks and broken drainage pipes, leaving people with no choice but to defecate in open. The nearby drains or open spaces are used by children whereas women wait for the nightfall. The urinals/ toilets are very difficult to maintain in areas like bus stand due to huge floating population.

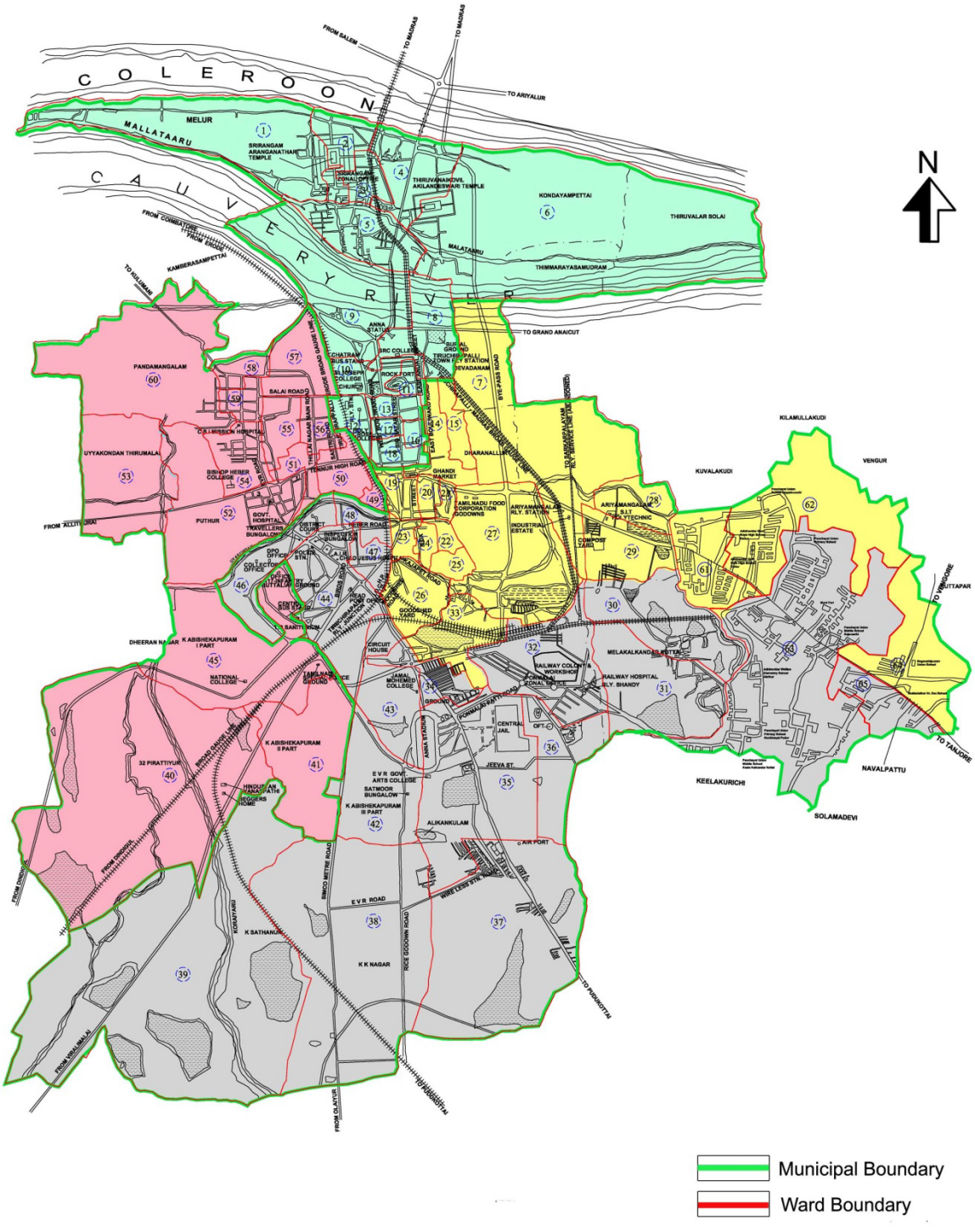

Figure 1: Ward map of Tiruchirappalli

2 Service delivery context description/analysis

2.1 Policy, legislation and regulation

2.1.1 Policies, legislations and regulations at national level

In 2008, the Ministry of Urban Development (MoUD) issued the National Urban Sanitation Policy (NUSP). The policy aims to: raise awareness, promote behaviour change; achieve open defecation free cities; develop citywide sanitation plans; and provide 100% safe confinement, transport, treatment and disposal of human excreta and liquid wastes. The NUSP mandates states to develop state urban sanitation strategies and work with cities to develop City Sanitation Plans (CSPs). NUSP specifically highlights the importance of safe and hygienic facilities with proper disposal and treatment of sludge from on-site installations (septic tanks, pit latrines, etc.) and proper operation and maintenance (O&M) of all sanitary facilities. Furthermore, it explicitly states that cities and states must issue policies and technical solutions that address onsite sanitation, including the safe confinement of faecal sludge (FS) (USAID, 2010). The objectives of NUSP are to be realized through CSPs and state sanitation strategies. As of now there are very few cities, which have finalized their CSPs, and those plans are also not implemented. This remains a major drawback in implementation of NUSP.

The advisory note on septage management in urban India, issued by MoUD in 2013, recommends supplementing CSPs with Septage Management Sub-Plan (SMP) as a part of the CSP, being prepared and implemented by cities. Septage here broadly refers to not only FS removed from septic tanks but also that removed from pit latrines and similar on-site toilets. This advisory provides references to Central Public Health & Environmental Engineering Organisation (CPHEEO) guidelines, Bureau of Indian Standard (BIS) standards, and other resources that users of this advisory may refer for details while preparing their SMP (MoUD, 2013). It clearly discusses on techno- managerial and socio- economic aspects of septage management in India and provides guidelines for Urban Local Bodies (ULBs) to plan and implement SMP.

There are no specific legal provisions relating to septage management, but there are a number of provisions relating to sanitation services and environmental regulations, which majorly stems from, The Environment (Protection) Act, 1986 and the Water (Prevention and Control of Pollution) Act, 1974. It also applies to households and cities with regard to disposing wastes into the environment. ULBs/ utilities also have to comply with discharge norms for effluent released from sewage treatment plants and to pay water cess under the Water Cess Act, 1977. The ULB is responsible for ensuring the safe handling and disposal of septage generated within its boundaries, for complying with the Water Act for meeting all state permit requirements and regulations (CSE, 2010). Municipal acts and regulations usually refer to management of solid and liquid wastes but may not provide detailed rules for septage management (MoUD, 2013).

The Prohibition of Employment as Manual Scavengers and their Rehabilitation Act is enacted in 2013. This act prohibits employment of manual scavengers, installation of insanitary latrines. It has laid strong emphasis on rehabilitation of manual scavengers. This act has become instrumental in eradicating manual scavenging from India.

2.1.2 Policies, legislations and regulations at state level and ULB level

According to Constitution of India, water and sanitation is a state subject. Statutory powers are conferred to the state for making laws on water and sanitation.

There is state urban sanitation policy for Tamil Nadu, drafted in 2012 .The overall goal of this policy is to transform Tamil Nadu into "*community driven, totally sanitized, healthy and liveable towns and cities"*. This

policy is yet to be endorsed by the government. There are no specific laws and regulations on septage management at state level. But municipal laws have some provisions for septage management and are listed below:

a. The Tamil Nadu District Municipalities Act, 1920

This is an Act to consolidate and amend the law relating to district municipalities. As per this act, cesspools within the municipality are under the control of the municipal council. A septic tank or cesspool has to be constructed in the premises if there is no sewerage or the premises is more than hundred feet away from sewerage.

b. Tamil Nadu Town Panchayats, Third Grade Municipalities, Municipalities and Municipal Corporations (Public Disclosure) Rules, 2009.

The Rules are applicable to all Town Panchayats, Third Grade Municipalities, Municipalities and Municipal Corporations in the State. These rules recognize septic tank desludging as one of the services to be provided by ULB's. The rule directs the ULB's to maintain record of number of the septic tanks if there is no underground drainage.

c. Operative Guidelines for Septage Management for Urban Local Bodies in Tamil Nadu (Government Order (G.O). (Ms) No.106, dated 1/09/2014)

The guideline applies to all the urban and rural local bodies of Taminadu. These guidelines seek to empower the local bodies with knowledge, procedures and facilities. It covers key elements of septage management: Design, construction and desludging of septic tanks; Transportation, treatment and disposal of septage; Tariff setting for desludging services; Information, education and communication; record keeping and reporting.

2.1.3 Institutional roles

The MoUD is the nodal Ministry for policy formulation and guidance for the urban water supply and sewerage sector. The Ministry's responsibilities include broad policy formulation, institutional and legal frameworks, setting standards and norms, monitoring, promotion of new strategies, coordination and support to state programmes through institutional expertise and finance. The Ministry is also responsible for managing international sources of finance. The Central Public Health and Environmental Engineering Organisation (CPHEEO), created in 1953, is the technical wing of the MoUD, which advises the Ministry in all technical matters and collaborates with the State Agencies about water supply and sanitation activities. CPHEEO plays a critical role in externally funded and special programmes. CPHEEO also plays a central role in setting design standards and norms for urban water supply and sanitation (Planning Commission, 2002).

The 74th Constitutional Amendment Act of 1992 reformed the sector by transferring responsibility for domestic, industrial, and commercial water supply and sewerage (WSS) from

state agencies, such as Departments of Public Health Engineering and State Water Boards, to Urban Local Bodies (ULBs). This transfer has resulted in a variety of implementation models, as well as lack of clarity in allocation of roles and responsibilities between state and local agencies, which sometimes leave large gaps in implementation (USAID, 2010).

Management and delivery of urban basic services in Tamil Nadu is governed by various institutions. The following are the institutions responsible for policy making, service provision and regulation of urban services.

1. Municipal Administration and Water Supply Department (MAWSD)
2. Commissionerate of Municipal Administration (CMA)

3. Tamil Nadu Water Supply and Drainage Board (TWADB)
4. Tamil Nadu Pollution Control Board (TNPCB)
5. Tiruchirappalli City Municipal Corporation (TCC)

The following table provides roles and responsibilities of various institutions:

Table 2: Institutional roles and responsibilities

Institution	Roles and responsibilities
Municipal Administration and Water Supply Department (MAWSD)	The Municipal Administration and Water Supply Department is committed to implement progressive schemes for the creation of urban infrastructure, improved civic governance, delivery of civic services and making the cities and towns in the State safe, clean and liveable.
Commissionerate of Municipal Administration (CMA)	The Commissionerate of Municipal Administration is the nodal department responsible for coordinating and supervising the functions of all Municipalities and Municipal Corporations in the State except the Corporation of Chennai.
Tamil Nadu Water Supply and Drainage Board (TWADB)	It is responsible for the implementation of providing Water Supply and Sewerage facilities to the public of the entire state of Tamil Nadu except Chennai Metropolitan area.
Tamil Nadu Pollution Control Board (TNPCB)	Advises state on pollution related standards and policies. Monitoring of treatment plants. Key regulator for pollution related issues.
Tiruchirappalli City Municipal Corporation (TCC)	Overall management of the civic services in the city. Operation and maintenance (O&M) of urban infrastructure. Development control. Regulation of septage management.

A host of institutions are involved in management of sanitation activities with varying roles. While most of the state level institutions are responsible for policy setting, oversight and monitoring, TCC is responsible for actual implementation. The Municipal Acts place most of the responsibilities in the area of sanitation to TCC. Three departments in TCC i.e., Town planning, Public Health Engineering and Sanitation are vested with powers of implementation of sanitation related schemes/projects.

2.1.4 Service provision

Institutional arrangements for water supply and sanitation in Indian cities vary greatly. Typically, a state-level agency is in charge of planning and investment, while the local government (Urban Local Bodies) is in charge of operation and maintenance (NIUA, 2005). Some of the larger cities have developed municipal water and sanitation utilities that are legally and financially separated from the local government. However, these utilities remain weak in terms of financial capacity. In spite of decentralization, ULBs remain dependent on capital subsidies from state governments. Tariffs are also set by state governments, which often subsidise operating costs (Planning Commission, 2002a).

Furthermore, when no separate utility exists, there is no separation of accounts for different activities within a municipality. Some states and cities have non-typical institutional arrangements. For example, in Rajasthan the sector is more centralized and the state government is also in charge of operation and maintenance,

while in Mumbai the sector is more decentralized and local government is also in charge of planning and investment (NIUA, 2005).

In Tiruchirappalli, TWAD Board is responsible for planning, designing and construction of sewerage network. TCC is responsible for the operation and maintenance of sewerage network and treatment plant. Public health and sanitation are delivered by TCC through the engineering (sewerage), health and sanitation department of TCC. TCC and private emptiers both are responsible for providing emptying services. TCC regulates private emptiers by licensing.

2.1.5 Service standards

1. Service Level Benchmarks (SLB), 2008: Issued by the Ministry of Urban Development in 2008, It seeks to (i) identify a minimum set of standard performance parameters for the water and sanitation sector that are commonly understood and used by all stakeholders across the country; (ii) define a common minimum framework for monitoring and reporting on these indicators and (iii) set out guidelines on how to operationalize this framework in a phased manner. SLB refers to improving service through better provision and delivery. It evaluates the performance of ULBs in providing urban services.

2. General Standards for Discharge of Environmental Pollutants Part-A: Effluents-The Environment (Protection) Rules, 1986 (Schedule VI): Issued by Central Pollution Control Board (CPCB), a statutory organisation constituted in September, 1974 under the Water (Prevention and Control of Pollution) Act, 1974.

3. Manual on Sewerage & Sewage Treatment, Second Edition, 2013: This manual has been developed by Central Public Health and Environmental Engineering Organization (CPHEEO).It provides detailed design and guidelines for various technologies of wastewater management.

4. Code of Practice for Installation of Septic Tanks, 1985**:** Issued by Bureau of Indian standards. It is a national standards setting body of India. The code specifies standards and design consideration for installation of septic tanks.

3 Service outcomes

Service outcome analysis is based on secondary sources. Two key sources of data are used; Census of India, 2011 and data from TMC. The data is crosschecked and updated by key informant interviews (KIIs). Data on containment is available in Census. Data on emptying and transportation is collected by KIIs. However most of the data is qualitative.

3.1 Overview

This section presents the range of sanitation technologies/infrastructure, methods and services designed to support the management of FS and wastewater (WW) through sanitation service chain in Tiruchirappalli. The details on quantitative estimations are presented in table below and following sections:

Table 3: Sanitation technologies and contribution of excreta in terms of percentage of population

S. No.	Sanitation technologies and systems as defined by:		SFD Reference Variable	Percentage of population
	Census of India	SFD Promotion Initiative		
1	Piped sewer system	User interface discharges directly to centralized separate sewer	T1A1C2	45.1
2	Septic tank	Septic tank connected to open drain or storm sewer	T1A2C6	27.5
3	Other systems	User interface discharges directly to open ground	T1A1C8	1.2
4	Pit latrine with slab	Lined pit with semi-permeable walls and open bottom, no outlet or overflow, significant risk	T1A5C10	2.1
5	Pit latrine without slab	Unlined pit no outlet or overflow, significant risk	T1A6C10	0.3
6	Night soil disposed into open drain	User interface discharges directly to open drain or storm drain	T1A1C6	4.8
7	Service latrine	User interface discharges directly to ‘don’t know where’	T1A1C9	0.3
8	Public latrine	Public toilet connected to centralized separate sewer	T1A1C2	8.5
9	Public latrine	Septic tank connected to open drain or storm sewer	T1A2C6	5.5
10	Open defe-cation	Open Defecation	T1B11C7 TO C9	4.8

3.1.1 Sanitation facilities

This section presents on existing sanitation facilities apart from household toilets.

Public and community toilets: In Tiruchirappalli, there are 306 public toilets and 78 integrated sanitary facilities (ISF). ISF includes bathroom facilities along with separate toilet seats for men and women. There are 384 facilities in total, out of which 233 are connected to sewerage network whereas 151 are connected to septic tanks (TCC, 2015a).

Institutional and Commercial areas: There are 33 public health centers, 2 bus stands, 101 marriage halls, 3 shopping complexes, 11 daily markets. Public toilets are available in markets and bus stands (TCC, 2015a).

School sanitation: There are 42 elementary, 24 middle, 6 high schools and 2 higher secondary schools. There is no data on private schools (TCC, 2015a).

Due to lack of data on excreta generated from institutions, industrial areas, restaurants and hotels. These establishments have not been taken into consideration for production of SFD. The excreta from public toilets and residential areas are considered for this study.

3.1.2 Containment

The sewerage network caters to around 53% of the population. 45% are connected through individual toilet to sewerage network whereas 8.5% are connected through public toilets. Out of 65 wards, 25 are fully covered, 25 partially covered and 15 are uncovered by sewerage network (TCC, 2015). The rest of the city is majorly dependent on septic tanks. It was observed during the visit to the city that, size, location, and design of on-site systems are majorly dependent on the space available, the practice followed in the area and discretion of local masons. The septic tanks constructed are generally not adhering to design prescribed by Bureau of Indian Standards (BIS). The effluent from the septic tank flows into open drains. Some households are also connected to pits.

Figure 2: Septic tank connected to community toilet in Ariamangalam slum (Source: Bhitush/CSE, 2015)

3.1.3 Emptying

Figure 3: Vacuum tankers used for emptying onsite sanitation systems (Source: Bhitush, Rahul/CSE, 2015)

There are around 30 private emptiers of varying capacities plying in the city. The emptying fees ranges from INR 1000 to 1500 (15 to 22 USD) per trip. Apart from private service, Tiruchirappalli city Municipal Corporation (TCC) operates an emptier of 4000 litres capacity. According to city corporation approximately 0.756 million litres of septage is collected per month through 190 trips (TCC, 2015b). There are no instances of manual emptying reported.

3.1.4 Transportation

The total length of main sewer is 352.4 km (refer appendix 7.4 for sewerage map). The sewage is conveyed to the only STP located at Panjapur. There are 30 open drains spread across the city, 20 of them feed into STP and 10 others feed untreated waste water to river directly. Total length of drains is 801.14 km (TCC, 2015). The emptiers transport septage by truck mounted vacuum tankers to 4 major sewage pumping stations. Septage mixes with sewage and is conveyed to the Sewage Treatment Plant (STP) through pumps (TCC, 2015b).

Figure 4: Septic tank connected to community toilet in Ariamangalam slum (Source: Bhitush/CSE, 2015)

3.1.5 Treatment and Disposal

There is one STP of 58 MLD capacity based on Wastewater Stabilization Pond (WSP) technology (TWADB, 2015). Private emptiers dispose septage in to four sewage pumping stations. Septage is co-treated with sewage (TCC, 2015b). A minimal charge of INR 30 (0.45 USD) is collected as emptying fees from private emptiers. Private emptiers have to renew their license by paying INR 2000 (30 USD) every year. The treated waste water is discharged in to Koriyaar River.

Figure 5: Waste Stabilisation Pond at Panjapur (Source: Bhitush/CSE, 2015)

3.2 SFD matrix

The final SFD for Trichy is presented in appendix 7.3.

3.2.1 SFD matrix explanation

According to Census of India, 2011, 59% of city is dependent on offsite systems and population connected to sewer line is 53%. It is assumed that 13% of waste water is lost in transportation, and 40% is treated and hence shown safe in SFD. User interface directly discharging in open drain or open ground is around 6% and 17% of Faecal Sludge (FS) i.e. effluent from septic tanks also joins in open drain. Out of 23% of waste water in open drain around 5% is tapped and treated at STP.

Whereas 36% of the city is dependent on onsite sanitation systems (OSS), out of which 34% is dependent on septic tanks and 2% on pits. The public latrines are partially connected to septic tanks and rest connected to centralized sewer network. Septic tanks are not contained as they are connected to open drains but pits are contained as ground water table is more than 10 mbgl.

It is difficult to determine the percentage of effluent and septage generated from tanks, hence to reduce the maximum error; it's assumed to be 50% each. Therefore, 17% of FS which is effluent goes into open drain. Some FS is always left in the tanks and is assumed to be 2%. Whereas 1% of FS is contained in pits, which includes infiltration of water as well, and rest 1% of pits are emptied in pumping station. Overall out of 16% of FS emptied, 14% is conveyed through pumping stations and is co-treated with sewage at STPs. 5% of population practices open defecation and hence shown unsafe on SFD.

Table 4: Description of variables used in SFD

Variable	Description
W2	WW contained centralized (offsite)
W15	WW not contained (offsite)
W11	WW not delivered to treatment
W11a	WW not delivered to centralized treatment plant
W11c	WW not contained not delivered to treatment plant
W4a	WW delivered to centralized treatment plant
W4c	WW not contained delivered to treatment plant
W12a	WW not treated at centralized treatment plant
W5a	WW treated
F10	FS not contained (onsite)
F2	FS contained (onsite)
F3	FS emptied
F3a	FS contained- emptied
F3b	FS not contained- emptied
F4	FS delivered to Treatment Plant
F8	FS contained- not emptied
F15	FS not contained- not emptied
F11	FS not delivered to treatment
F5	FS treated
OD9	Open Defecation

Assuming Census figures are correct; W2 was estimated to be around 53%, which includes WW from public toilets connected to separate sewers. It is assumed that 13% of wastewater is lost in transmission hence W11a=13%. Around 40% of WW reaches STP through centralized separate sewer hence W4a is estimated to be 40%. W15, WW not contained, is rounded off as 6%, as it includes WW discharged in open drains i.e. 4.8%, WW discharged on open ground (defined as other systems in Census) i.e. 1.2% and WW from service

latrines i.e. 0.3%. 17% of FS, which is effluent from septic tanks, is discharged into open drains. WW tapped from open drain and delivered to treatment plant is estimated to be 5%, therefore W4c=5%. Rest of the WW which is not contained and not delivered to treatment plant comes out to be 18%, hence W11c=18%. Total WW not delivered to treatment plant, i.e.W11 comes out to be 31% (W11=W11a+W11c). Around 45% of WW is being treated at STP, therefore W5a =45%.

F10 is estimated to be around 34%, which constitutes population dependent on septic tanks and F2 is estimated to be around 2% which constitutes of 2.1% population dependent on lined pits with semi-permeable walls & open bottom and 0.3% dependent on unlined pits. Since there is no clear demarcation in quantity of solid FS generated and effluent/infiltration generated from an onsite system, it is assumed to be 50% each. It is also assumed that 90% of population (dependent on onsite systems) gets their system emptied when full. Therefore out of 34% septic tank dependent population, FS of 15% population gets emptied, therefore F3b=15%. Similarly for lined pits and unlined pits FS emptied taken together (i.e. F3a), comes out to be 1% approximately, making total FS emptied (i.e. F3) equal to 16%. Whereas FS contained but not emptied, i.e. F8 comes out to be 1%. Most of the emptied FS is disposed in sewage pumping stations, from where it gets diluted with sewage and then pumped to co-treat at STP, therefore F5, FS treated, is assumed to be around 14%. FS emptied and discharged untreated in environment is approximated around 2%, therefore F11 comes out to be 2%. Since there's some sludge always left in the tanks and pits, F15 is estimated to be 2%. 5% of population practice open defecation and hence OD9 is computed to be 5%.

It can be concluded that excreta of only 60% population is managed safely in Tiruchirappalli and 40% of excreta is discharged in environment untreated.
The table 3 summarizes the percentage of the population using each sanitation technology and method along the service chain.

3.2.2 Risk of groundwater contamination

Groundwater generally occurs under semi-confined conditions in the fissured and fractured zones at deeper levels. Major soil type encountered in city is alluvial soil. It is observed that in general the ground water is suitable for drinking and domestic uses in respect of all the constituents except fluoride of higher concentration at Siruganallur (1.85 mg/L) and at few places are having higher concentration of NO3 than BIS permissible limit (TCC,2015a).

Table 5: Percentage of the population using each system technology and method

System type	Containment	Emptying	Transport	Treatment	End-use/ disposal
Offsite	T1A1C2 (Reference L1): 53% of the population is connected to centralised sewer, hence W2 is 53%. T1A1C6 (Reference L4): 4.8 % of the population is discharging their excreta directly to open drain. T1A1C8 & T1A1C9 (Reference L5): 1.2 % of the population is discharging their excreta directly to open ground and 0.3% discharging-don't know where. Total WW not contained (offsite), i.e.W15, adds up to 6%.	Not Applicable.	WW of 40%of the population served by centralised sewers, reaches treatment facilities, hence W4a is 40%. It is estimated that rest of the 13% would be lost in transportation, hence W11a=13%. WW not contained, delivered to centralised treatment plant, i.e. W4c is estimated to be5%. WW not contained not delivered to centralised treatment plants, i.e. W11c, is 18% which includes effluent from OSS. Total WW not delivered to treatment plant, i.e. W11, is 31%.	All the WW delivered at treatment plant gets treated hence W5a is 45%. It also includes 5% of WW which is tapped from open drains.	Treated WW is disposed in river and used for irrigation occasionally.
Onsite	36% of population is dependent on onsite sanitation systems, hence F10, FS not contained is 34% and F2, FS contained is 2% T1A2C6 (Reference L8): 34% of population is dependent on septic tanks connected to open drain T1A5C10 (Reference L11):2.1% of population is dependent on lined pit with semi permeable walls and open bottom T1A6C10 (Reference L11):0.3% of population is dependent on unlined pit	It is assumed that 90% of population gets their onsite system emptied. Since there is no clear differentiation between % of septage and effluent, it is assumed to be 50% each. FS not contained-emptied, i.e. F3b comes out to be 15% and FS contained-emptied, i.e. F3a is 1%. FS contained-not emptied, i.e. F8, becomes 1 % and FS not contained-not emptied, i.e. F15 becomes 2%.	FS is pumped to treatment plant via sewage pumping stations therefore FS delivered to treatment plant, i.e.F4 is approximated to be 14%. FS not delivered , i.e. F11 is assumed to be 2%.	FS co-treated with sewage, therefore FS treated, i.e. F5, is 14%.	Treated FS is disposed with WW
Open Defecation	5% of population practice open defecation and hence OD9 is computed to be 5%.				

4 Stakeholder Engagement

4.1 Key Informant Interviews

The relevant departments were contacted through e-mail, letter, call and fax prior to visit to the city. The purpose of the SFD study and depth of data required was conveyed through introductory letter to respective departments. Overall, 6 KIIs were conducted with different stakeholders like government functionaries, private emptiers, (see appendix 7.2). The GoTN operates through its MAWSD. MAWSD is supported by CMA.

Limited documents were available on web hence the visit to city also helped in collecting data, including unpublished reports. The KIIs and data collected helped in understanding the existing situation and upcoming development plans in the sanitation sector. Due to limitation of desk-based study all the key stakeholders engaged in sanitation services could not be interviewed in person.

5 Acknowledgements

This report was compiled as part of the SFD promotion initiative project funded by the Bill and Melinda Gates foundation (BMGF). We would like to take this opportunity to thank Ms. M. Vijayalakshmi, Commissioner, TCC, Mr. S. Nagesh, City Engineer, TCC, Mr J. Arivazhagan, Executive Engineer, TWADB for their support during our visit to Tiruchirappalli. A special thanks to Dr. Suresh Kumar Rohilla, Programme Director, CSE for his supervision and guidance at every step of the assessment and report writing.

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7 Appendix

7.1 Stakeholder identification (Tab 2: Stakeholder Tracking Tool)

Table 6: Stakeholder identification

No.	Stakeholder group	In Tiruchirappalli context
1	City council / Municipal authority / Utility	Tiruchirappalli City Municipal Corporation
2	Ministry in charge of urban sanitation and sewerage	Municipal Administration and Water Supply Department, GoTN
3	Ministry in charge of urban solid waste	Municipal Administration and Water Supply Department, GoTN
4	Ministries in charge of urban planning finance and economic development.	Municipal Administration and Water Supply Department, GoTN
	Ministries in charge of environmental protection/	Department of Environment, GoTN
	Ministries in charge of health	Health and Family Welfare Department , GoTN
5	Service provider for construction of onsite sanitation technologies	Local masons
6	Service provider for emptying and transport of faecal sludge	Private Emptiers and Tiruchirappalli City Municipal Corporation
7	Service provider for operation and maintenance of treatment infrastructure	Tiruchirappalli City Municipal Corporation
8	Market participants practising end-use of faecal sludge end products	Farmers
9	Service provider for disposal of faecal sludge (sanitary landfill management)	Tiruchirappalli City Municipal Corporation
10	External agencies associated with FSM services: e.g. NGOs, academic institutions, donors,	Gramalaya

7.2 Tracking of Engagement (Tab 3: Stakeholder Tracking Tool)

Table 7: Tracking of stakeholder engagement

Name of the organisation	Name of the contact person	Designation	Date of Engagement	Purpose of engagement
Tamil Nadu Water Supply and Sewerage Board	Mr J. Arivazhagan	Executive Engineer	11.05.2015	KII
Tiruchirappalli City Municipal Corporation	Ms M Vijayalakshmi	Commissioner	11.05.2015	Introducing SFD
Tiruchirappalli City Municipal Corporation	Mr S Nagesh	City Engineer	12.05.2015	KII
Tiruchirappalli City Municipal Corporation	Mr K.Bala subramanian	Junior Engineer	12.05.2015	KII
Tiruchirappalli City Municipal Corporation	Mr T. Ravindran	Junior Engineer (Solid waste)	12.05.2015	KII
Tiruchirappalli City Municipal Corporation	Mr Edison	Sewage Pumping Station Operator	12.05.2015	KII
Sri Amman Septic tank Cleaning	Mr M. Ratnam	Vacuum tanker driver	13.05.2015	KII

7.3 SFD matrix

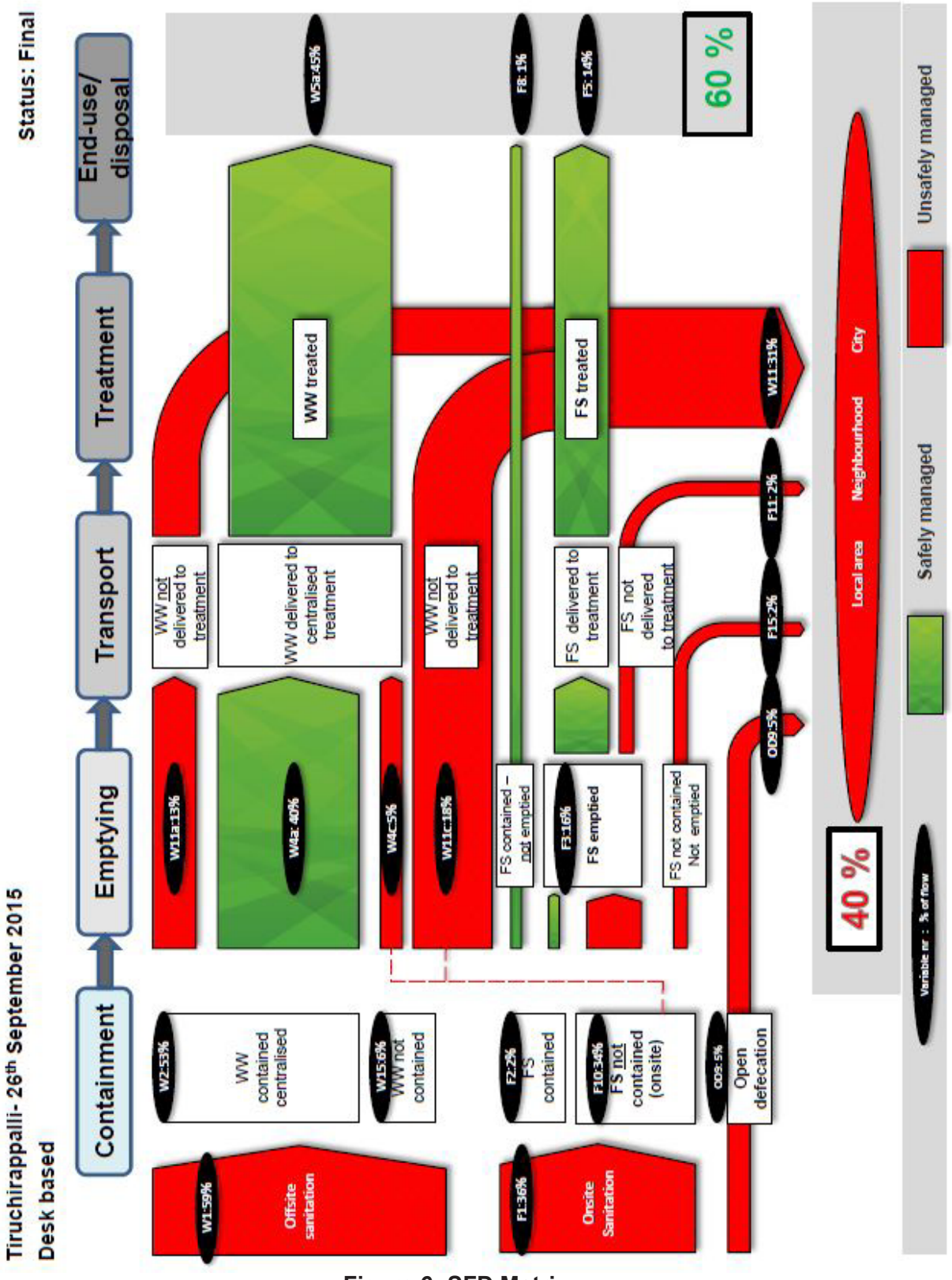

Figure 6: SFD Matrix

7.4 Map showing areas covered by sewerage network

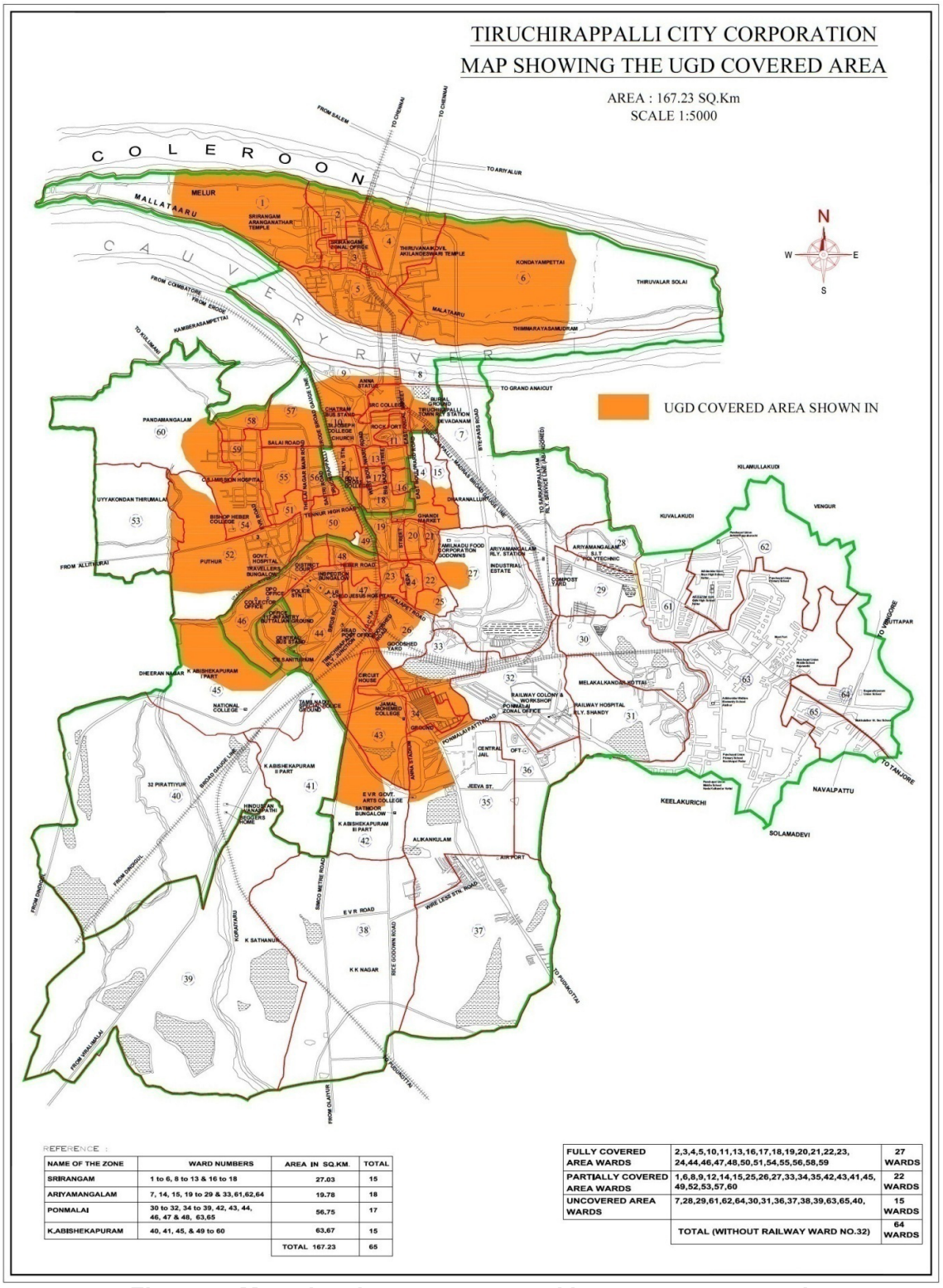

Figure 7: Map showing areas covered by sewerage network

7.5 SFD graphic

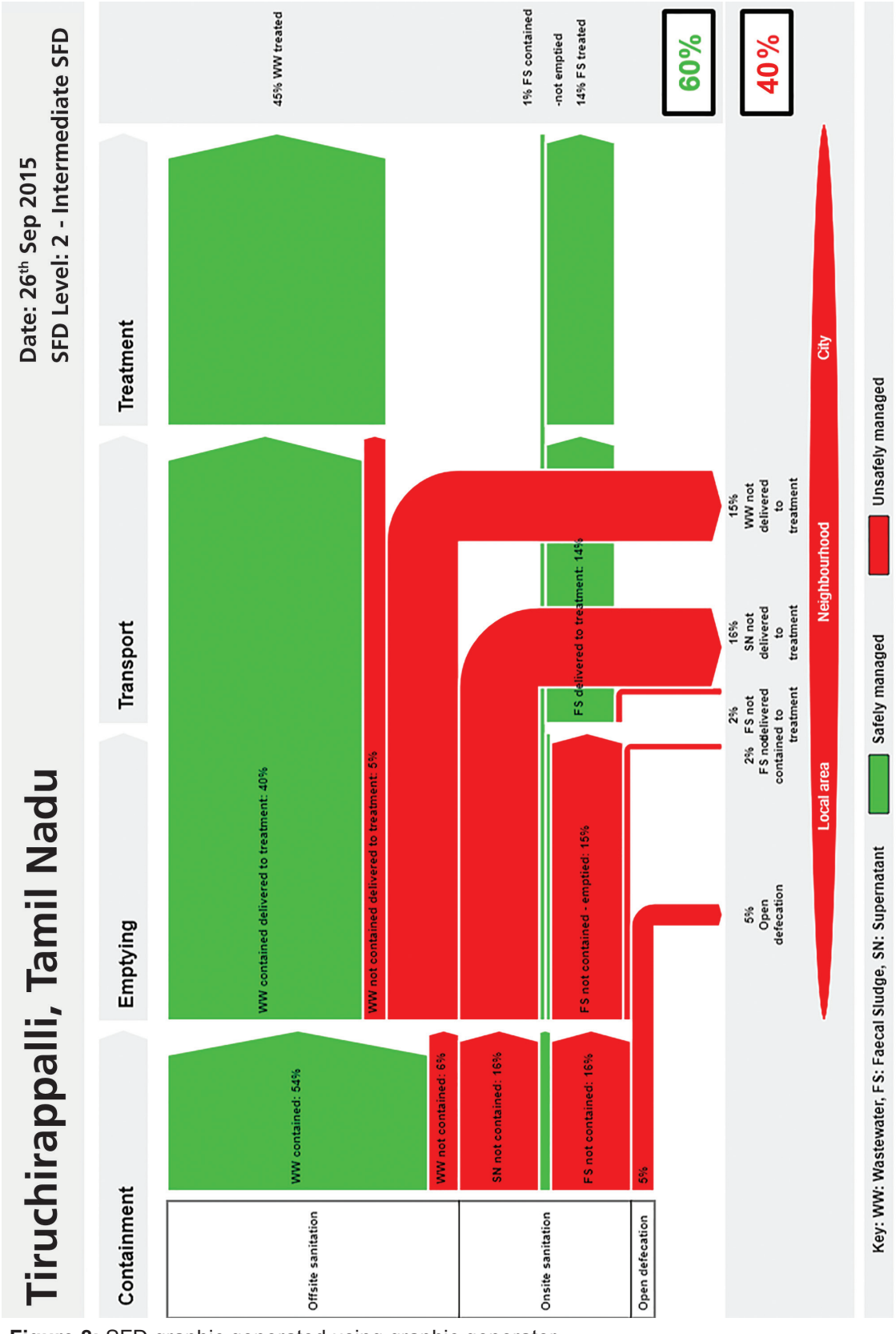

Figure 8: SFD graphic generated using graphic generator

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