SFD Promotion Initiative

Tumkur
India

Final Report

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On behalf of Federal Ministry for Economic Cooperation and Development

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SFD Report Tumkur, India, 2015

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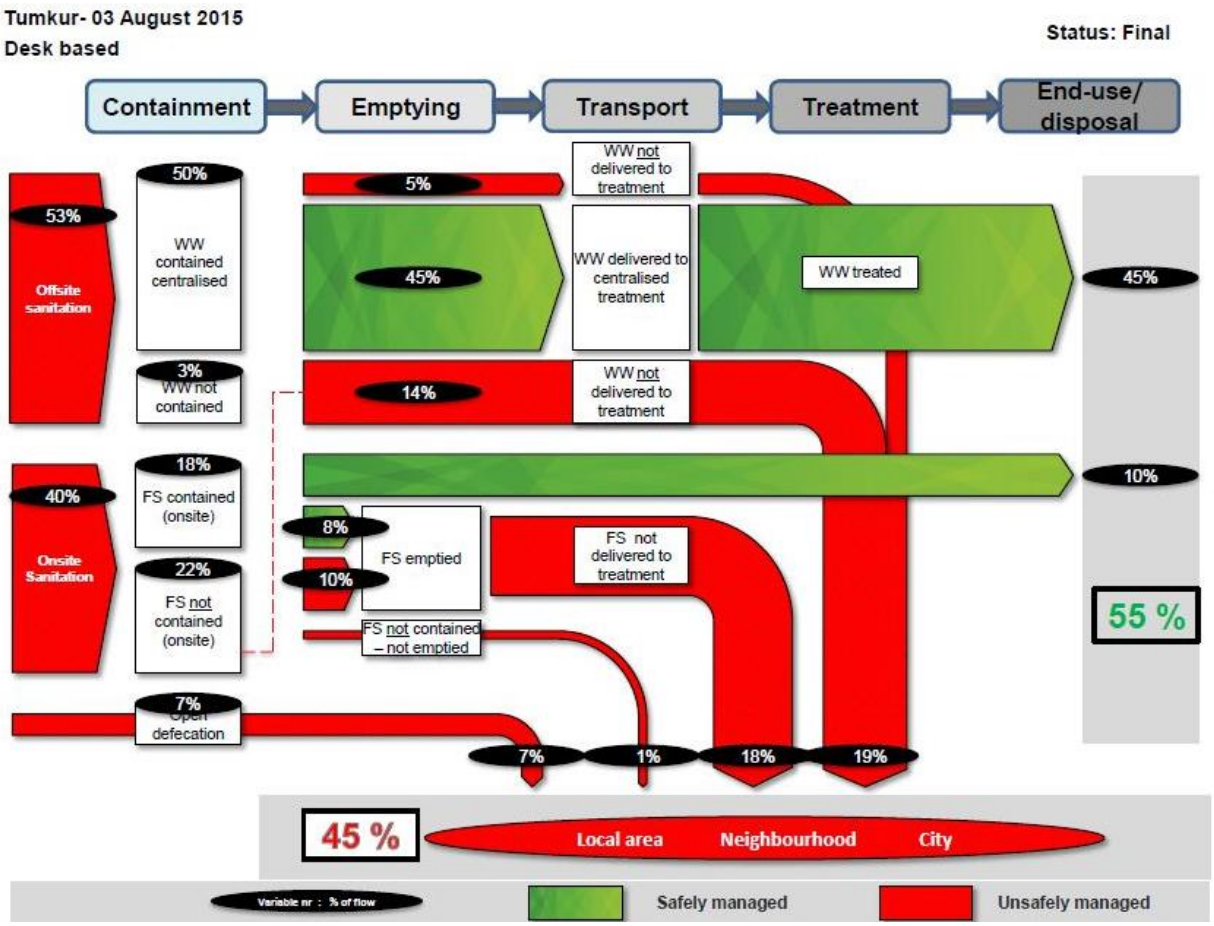
1. The Diagram



2. Diagram information

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3. General city information

Tumkur (also known as Tumakuru) is located in the state of Karnataka at a distance of 70 km to the northwest of the capital city, Bangalore. It is the district headquarters. The city is surrounded by hills (DMA, 2012).

The population of city as per the Census, 2011 is 305,821. The density of city is 6,292 persons per sq.km which is very high when compared to state average of 319 persons per sq.km. Slum population is 52,429, which is 17% of the total population (DMA, 2012).

Municipal boundary has been chosen for the current study. It comprises of an area of 48.60 sq.km (DMA, 2012).

City falls in the southern plateau region of India. The temperature starts rising from January and peaks in May, around 40^0C is common in Tumkur (DMA, 2012).

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).

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 half of the population. Rest 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.

The pits are constructed with concrete concentric rings placed one above the other with open bottom.

Emptying: There are five private emptiers with eight vacuum tankers of 5000 litres capacity each. The emptying fee ranges from INR 800 – 1200 (13 to 18 USD) per trip. On an average each private vacuum tanker empties 30–50 septic tanks/pits per month. Monsoon is the peak season for emptying. There are no instances of manual emptying reported.

Transport: Private emptiers transport septage by truck mounted vacuum tankers to disposal sites. Sewage is conveyed to a sewage treatment plant (STP).

Treatment: There is one Sewage Treatment Plant (STP) with the capacity of 24.5 MLD to treat the sewage generated. There are no treatment facilities for septage.

End-use/Disposal: The emptied septage is disposed in agriculture farms; farmers dry the raw sludge and use it for agriculture. It is a common practice to use the dried sludge as compost in banana gardens and grape orchards. The local farmers collect tipping charge of INR 10000 (150 USD) per year from private emptiers for allowing septage to dispose in their farms. Treated sewage is disposed in to Beemasandra Lake, leading to eutrophication. Untreated sewage flows in to Shimsha River and Amanikere Lake.

Figure 1: Toilet connected to pit with opening for emptying septage (Source: Rahul/CSE, 2015)

According to Census of India, 2011, 53% of city is dependent on offsite systems, population connected to sewer line is 50% and user interface directly discharging in open drain is only 3%, it is assumed that 5% of waste water is lost in transportation, and 45% is treated and hence shown safe in SFD.

Figure 2: Water hyacinth in Bheemasandra lake **(Source: Rahul/CSE, 2015)**

Rest of the 40% of the city is dependent on onsite sanitation systems (OSS), out of which 22% is dependent on septic tanks and 18% on pits. The public latrines are connected to septic tanks and hence are incorporated in onsite systems. Septic tanks are not contained as these 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, it's assumed to be 50% each. Therefore, 11% of faecal sludge (FS) is effluent which goes into open drain and rest is septage that is emptied from tanks whenever full. Some FS is always left in the tanks and is estimated to be 1%. Whereas FS from pits is considered contained and is calculated as 10%, it includes infiltration of water as well.

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 Tumkur:

Key Stakeholders	Institutions / Organizations
Public Institutions	Karnataka Urban Water Supply and Drainage Board (KUWSDB), Tumkur City Corporation (TMC) State Pollution Control Board (SPCB)
Private Sector	Private emptiers

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

KUWSDB is responsible for planning, designing and construction of sewerage system.TMC is responsible for operation and maintenance of sewerage network. The city corporation licenses private emptiers and allows them to park vacuum tankers inside their office premises.

Private emptiers are responsible for septage management. They are providing services within the city and some rural areas nearby. State Pollution Control Board is responsible for monitoring and evaluation of STPs.

7. Credibility of data

Two key sources of data are used; Census of India, 2011 and draft CSP, 2012. The data is crosschecked and updated by Key Informant Interviews (KIIs). Three 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)
- 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 the ones defined in project is established.

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

Overall 55% of excreta is safely managed in the city and rest 45%, which also includes 15% 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.

Whether excreta is safely managed or not is dependent on whether the system is contained or not, and not on whether waste is safely handled.

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
- Un–published documents:
  - Draft CSP Tumkur, Directorate of Municipal Administration, Govt. of Karnataka, 2012
- KIIs with representatives from
  - Government agencies: TMC, KUWSDB
  - Service providers: Private emptiers
- Websites/web links:
  http://moud.gov.in/cityplan
  http://www.tumkurcity.gov.in/

Tumkur, India, 2015

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Abbreviations

BIS	Bureau of Indian Standard
CSP	City Sanitation Plan
CPHEEO	Central Public Health & Environmental Engineering Organization
CSE	Centre for Science and Environment
CGWB	Central Ground Water Board
CPCB	Central Pollution Control Board
DMA	Directorate of Municipal Administration
FS	Faecal Sludge
GOK	Government of Karnataka
KII	Key Informant Interview
KUIDFC	Karnataka Urban Infrastructure Development & Finance Corporation
KUWSDB	Karnataka Urban Water Supply and Drainage Board
KSPCB	Karnataka State Pollution Control Board
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	Tumkur City Corporation
USAID	United States Agency for International Department
UDD	Urban Development Department
WSS	Water Supply and Sewerage
WW	Waste Water

1 City context

Tumkur is located in the state of Karnataka at a distance of 70 km to the northwest of the capital city, Bangalore. It is also the district headquarters. The Government of Karnataka (GoK) has upgraded the Tumkur City Municipal Council to City Corporation in August 2010 after considering the increased population of over 0.3 million and resource mobilization capacity crossing Rs. 60 million annually (DMA, 2012).

Tumkur was officially renamed as Tumakuru in 2014. The population of the city, as per the Census of India 2011, is 305,821. The area of Municipal Corporation is about 48.60 sq. km. The current gross population density of the city is 6,291 persons per sq. km. The slum population is 50,570, which is 17% of the total population (TCC, 2015)). Municipal boundary has been chosen for the current study. Tumkur City Corporation (TCC) is divided into 35 wards. The population growth rate of the city is given in the following table.

Table 1: Decadal population growth rate of Tumkur city (Source: DMA, 2012)

Census Year	Population	Growth Rate (%)
1971	70467	-
1981	108670	54%
1991	179877	65%
2001	248929	38%
2011	305821	23%

Tumkur is a commercial, educational and industrial centre. Agricultural activity in and around the city is another source of income. The city is also famous for Temples and Dargas. Tourists come in huge numbers to visit these places. The floating population is increasing every year and is around 5000-6000 persons per day (DMA, 2012).The influx of services like industry and agriculture and expansion of the education sector in and around the city has resulted in an increased population of 305,821 with decadal growth of 23%.

The city is located at 13^0 20’ N and 77^0 06’ E. It has an altitude of 822 meters. Tumkur lies in the archaean complex of granite, gneisses and schists. The major soil types include red loamy, red sandy, mixed red and black soil. The predominant soil in the eastern tract of Karnataka is the red soil overlying the granite from which it is derived. There are no perennial rivers in the city (DMA, 2012).

The city falls in the eastern dry agro-climatic zone. The temperature start rising from January to peak in May reaching its maximum to 40^0C. The humidity is low during the dry season and highest during the monsoon period. The winds are predominantly south westerly during the summer monsoon and northeasterly during the winter monsoon.

The dry season is from January to February followed by hot weather from March to May. Over 18% of annual rainfall occurs during the pre monsoon season. The monsoon season is from June to September, yielding around 52% of the annual rainfall. The post monsoon period from October to December contributes to nearly 30% of annual rainfall. On an average, annually over 650 mm of rainfall occurs in nearly 45 rainy days (DMA, 2012).

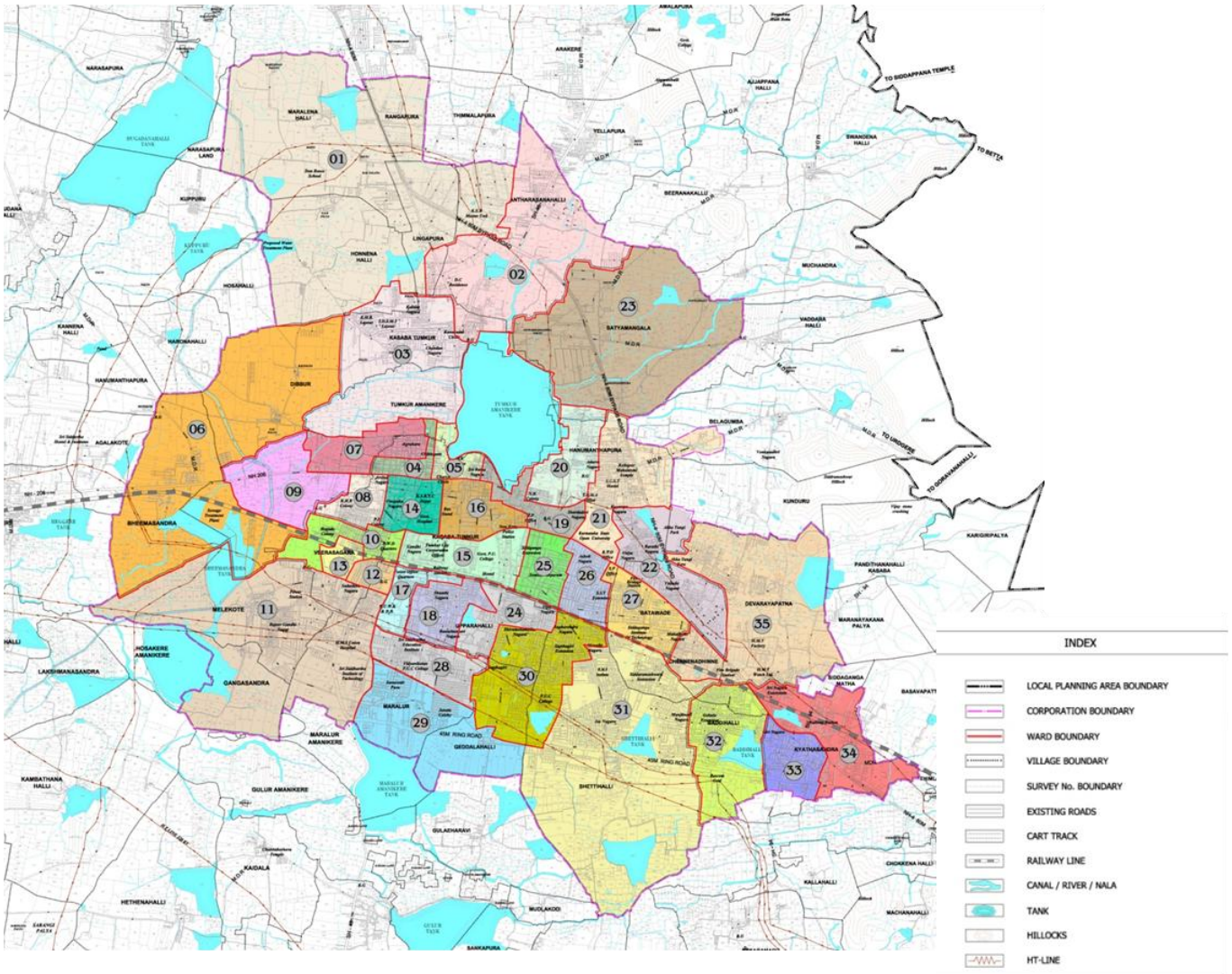

Figure 1: City map of Tumkur

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 from pit latrines and similar on-site systems. 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 to, 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 in India.

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

According to Constitution of India, water & sanitation is a state subject. Statutory powers are conferred to the state for making laws on water and sanitation. Some of the policies, laws and regulations are listed below:

a. Karnataka Urban Drinking Water and Sanitation Policy, 2002

The objective of the policy is to ensure universal coverage of water and sanitation services that people want and are willing to pay for, ensuring a minimum level of service. While doing this, the state should also preserve precious water resources without compromising the commercial and economical sustainability of operations (DMA, 2012).

b. Karnataka Municipalities Act, 1964

The act governs the structure and management of the City Municipal Councils (CMC), Town Municipal Councils (TMC), Town Panchayats (TPs) and Notified Area Committees (NACs). Provisions for septage management have been listed here.

Chapter 4 of Karnataka Municipalities Act, 1964 states the following:

"Municipal fund can be used for construction, maintenance of disposal sites and for buying mechanically propelled transport facilities (vacuum tankers)" (GoK, 1964).

"Provisions under the prohibition of nuisance: Whoever uses or stores night soil without written permission from the municipal commissioner or chief officer shall be punished with fine which may extend to one hundred rupees" (1.5 USD) (GoK,1964).

c. Karnataka Corporations Act,1976

The act governs the structure and management of the Municipal Corporations. Provisions for septage management have been listed here.

Chapter 9 of Karnataka Corporations Act, 1964 states the following:

"*Prohibit the practice of employing persons for carrying night soil as head-load"* (GoK, 1964a).

"No person shall employ or allow himself to be employed for wages or salary for carrying night-soil as head-load or by the manual handling thereof" (GoK, 1964a).

Operative Guidelines: Septage/Faecal sludge for urban local bodies in Karnataka, 2015 has been drafted by the Consortium for DEWATS Dissemination (CDD) society. This is yet to be endorsed by the state government.

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

1. Directorate of Municipal Administration (DMA)
2. Urban Development Department (UDD)
3. Karnataka Urban Infrastructure Development & Finance Corporation (KUIDFC)
4. Karnataka Urban Water Supply and Drainage Board (KUWSDB)
5. Karnataka State Pollution Control Board (KSPCB)
6. Tumkur City Corporation (TCC)

Table 2 provides roles and responsibilities of various institutions. 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, KUWSDB and TCC are responsible for actual implementation. The Municipal Acts place most of the responsibilities in the area of sanitation to TCC.

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 subsidize operating costs (Planning Commission, 2002a).

In the absence of a separate utility, 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).

Table 2: Institutional roles and responsibilities

Institution	Roles and responsibilities
Directorate of Municipal Administration (DMA)	It is responsible for policy formulation, preparation of municipal laws, monitoring and evaluation of programmes, supervision of municipal administration, coordination with related state government departments, liaison with the central government and external funding agencies, etc.
Urban Development Department (UDD)	It is the executive arm of DMA that is responsible for implementation of laws, policies and programmes relating to the urban sector. It is responsible for administrative and financial management of municipalities, implementation of development programmes like Integrated Development of Small and Medium Towns (IDSMT), Swarna Jayanti Shahari Rozgar Yojana (SJSRY), Urban Infrastructure Development Scheme for Small and Medium Towns (UIDSSMT), Integrated Housing and Slum Development Programme (IHSDP), Integrated Low Cost Sanitation (ILCS) etc. The UDD acts as a conduit between the municipalities and the government and provide guidance, help and assistance to all local bodies.
Karnataka Urban Infrastructure Development & Finance Corporation (KUIDFC)	It extends technical assistance to the local bodies in the preparation and implementation of development schemes and is designated as the state level nodal agency for Jawaharlal Nehru National Urban Reform Mission (JNNURM). It acts as a conduit between the ULBs, the Government of India and financing agencies like Housing and Urban Development Corporation (HUDCO). The corporation, on behalf of the municipality borrows loans from financial institutions and acts as a financial intermediary.
Karnataka Urban Water Supply and Drainage Board (KUWSDB)	Responsible for planning, designing and execution of water supply and sewerage schemes.
Karnataka State Pollution Control Board (KSPCB)	Advises state on pollution related standards and policies. Monitoring of treatment plants. Key regulator for pollution related issues.
Tumkur City Corporation (TCC)	Responsible for operation and maintenance (O&M) of urban infrastructure. Development control. Overall management of the civic services in the city. Responsible for septage emptying, transportation and disposal.

In Tumkur, KUWSDB is responsible for planning, designing and construction of sewerage network. TCC is responsible for the operation and maintenance of sewerage network. 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, which 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 draft CSP, 2012. The data is crosschecked and updated by Key Informant Interviews (KIIs). Data on containment is available in Census. Data on emptying and transport 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 Waste Water (WW) through sanitation service chain in Tumkur. 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	50%
2	Septic tank	Septic tank connected to open drain or storm sewer	T1A2C6	20.3%
3	Other systems	User interface discharges directly to open ground	T1A1C8	2.1%
4	Pit latrine with slab	Lined pit with semi-permeable walls and open bottom, no outlet or overflow, general situation	T1A5C10	17.2%
5	Pit latrine without slab	Unlined pit no outlet or overflow, general situation	T1A6C10	0.4%
6	Night soil disposed into open drain	User interface discharges directly to open drain or storm drain	T1A1C6	0.3%
7	Service latrine	User interface discharges directly to 'don't know where'	T1A1C9	0.6%
8	Public latrine	Septic tank connected to open drain or storm sewer	T1A2C6	2.1%
9	Open defecation	Open Defecation	T1B11C7 TO C9	7.1%

3.1.1 Sanitation facilities

This section presents existing sanitation facilities apart from household toilets

Community toilets/ Public toilets: There are six community toilets with 24 seats located in the slum areas. Nine Public toilets with 65 seats are located in public and commercial areas. (DMA, 2012).

Institutions: There are many government institutions located at Tumkur, as it is the headquarters of the district. According to the primary survey, there are 30 toilets with approximately 30 seats (DMA, 2012).

School sanitation: There are total 35 government schools in the city. All the school toilets are connected to the septic tanks. There is no data on private schools (DMA, 2012).

Commercial areas: There are 10 toilets in commercial areas, market places (DMA, 2012). Except for schools, there is no data on how many toilets are connected to septic tanks/pits.

Due to the lack of data on excreta generated in industrial areas, restaurants and hotels, these establishments have not been taken into consideration for production of SFD. Whereas excreta from public toilets, residential as well as commercial areas is considered for this study.

3.1.2 Containment

The existing sewerage network covers half of the population. Around 40% of the city is majorly dependent on septic tanks that are generally not adhering to design prescribed by the Bureau of Indian Standards (BIS) (TCC, 2015). The effluent from the septic tank flows into open drains. Some households are also connected to the pits. The commonly found pit toilets are made of concentric concrete rings placed one above the other. Theses pits are generally constructed with open bottom. This kind of containment is prevalent in slum areas (TCC, 2015).

Figure 2: Toilet connected to a pit with opening for emptying septage (Source: Rahul/CSE,2015)

3.1.3 Emptying

There are five private emptiers with eight vacuum tankers of 5000 litres capacity each (Rajappa, 2015). TCC has one vacuum tanker with 5000 litres capacity (DMA, 2012). The emptying fees range from INR 800 – 1200 (13 to 18 USD) per trip (Rajappa, 2015). Private emptiers park their tankers in the corporation's premises. On an average, each private vacuum tanker empties 30–50 septic tanks/pits per month. Monsoon is the peak season for emptying (Rajappa, 2015). There are no instances of manual emptying reported.

3.1.4 Transportation

Both private and municipal emptiers transport septage by truck mounted vacuum tankers to disposal sites. The private emptiers travel 10-15 km outskirts of city to discharge septage into agricultural lands. Sewage is conveyed to a Sewage Treatment Plant (STP).

Figure 3: A Private vacuum tanker parked in municipal premises (Source: Rahul/CSE, 2015)

Figure 4: Water hyacinth in Bheemasandra lake (Source: Rahul/CSE, 2015)

3.1.5 Treatment and disposal

There is one STP with the capacity of 24.5 MLD to treat the sewage generated (KUWSDB, 2015). There is no treatment facility available for septage. The emptied septage is disposed into agriculture farms; farmers dry the raw sludge and use it for agriculture. It is a common practice to use the dried sludge as compost in banana gardens and grape orchards (Rajappa, 2015). The local farmers collect tipping charge of INR 10000 (150 USD) per year from private emptiers for allowing them to discharge septage on their farms (Rajappa, 2015). Treated sewage is disposed into Beemasandra Lake, causing eutrophication (Fig.4). Untreated sewage flows into Shimsha River and Amanikere Lake (KUWSDB, 2015).

3.2 SFD matrix

The final SFD for the Tumkur is presented in appendix 7.3.

3.2.1 SFD matrix explanation

According to Census of India 2011, 53% of the city is dependent on offsite systems, population connected to sewer line is 50% and user interface directly discharging in open drain or open ground is only 3%, it is assumed that 5% of waste water is lost in transportation, and 45% is treated and hence shown safe in SFD. Around 40% of the city is dependent on onsite sanitation systems (OSS), out of which 22% is dependent on septic tanks and 18% on pits. The public latrines are connected to septic tanks and hence are incorporated in onsite systems. Septic tanks are not contained as they are connected to open drains but pits are contained as the groundwater table is more than 10 mbgl (DMA, 2012).

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, 11% of FS is effluent, that goes into open drains and rest is emptied from tanks whenever full. Some FS is always left in the tanks and is assumed to be 1%. FS from pits is considered contained and is calculated as 10%, this includes infiltration of water as well. 7% of the population still practices open defecation. Definition and estimation of different variables (used to make SFD) are explained below.

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
W5a	WW treated at centralized treatment plant
F2	FS contained (onsite)
F10	FS not contained (onsite)
F3	FS emptied
F3a	FS contained- emptied
F3b	FS not contained- emptied
F8	FS contained- not emptied
F15	FS not contained- not emptied
F11	FS not delivered to treatment
OD9	Open Defecation

Assuming Census figures are correct; W2 was estimated to be around 50%. It is assumed that 45% of WW would reach STP hence W4a is estimated to be 45% and W11a as 5%. W15 is rounded off as 3%, as it includes WW discharged into open drains i.e. 0.3%, WW discharged on open ground (defined as other systems in the Census) i.e. 2.1% and WW from service latrines i.e. 0.6%. Since all the WW reaching STP is getting treated, W5a becomes 45%. 11% of the effluent from septic tanks is discharged into open drains and hence is added in W11c to make it 14%. Total WW not delivered to the treatment plant, i.e. W11 comes out to be 19% (W11=W11a+W11c).

F10 is estimated to be around 22% and F2 is estimated to be around 18% which constitutes of 17.2 % population dependent on lined pits with semi-permeable walls and open bottom and 0.4% are dependent on unlined pits. Since there is no clear demarcation in the 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 the population (dependent on onsite systems) gets their system emptied when full. Therefore, out of 22% septic tank dependent population, FS of 10% population gets emptied, hence F3b=10%. Similarly for lined pits and unlined pits FS emptied taken together (i.e. F3a), comes out to be 8% approximately, making total FS emptied (i.e. F3) equal to 18%. Whereas FS contained but not emptied, i.e. F8 comes out to be 10%. The emptied FS is discharged untreated in the environment; therefore F11 comes out to be 18%. Since there's some sludge always left in the tanks and pits, F15 is estimated to be 1%. 7% of population practice open defecation and hence OD9 is computed to be 7%.

It can be concluded that excreta of 55% population is managed safely in Tumkur city and 45% of excreta is discharged in environment untreated. Table 5 summarizes the percentages of the population using each sanitation technology and method along the service chain.

3.2.2 Risk of groundwater contamination

The depth of the groundwater level varies from 1.17 to 11.85 mbgl in pre-monsoon and 0.26 to 10.65 mbgl in post monsoon (DMA, 2012). There might be a possibility of contamination in slum areas where pit latrines are prevalent. There is no data available on ground water contamination.

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): 50% of the population is connected to centralised sewer, hence W2 is 50%. T1A1C6 (Reference L4): 0.3 % of the population is discharging their excreta directly to open drain. T1A1C8 & T1A1C9 (Reference L5): 2.1 % of the population is discharging their excreta directly to open ground and 0.6% discharging-don't know where. Total WW not contained (offsite), i.e.W15, adds up to 3%.	Not Applicable.	WW of 45%of the population served by centralised sewers, reaches treatment facilities, hence W4a is 45%. It is assumed that 5% would be lost due to leakage, hence W11a=5%. WW not contained, delivered to centralised treatment plant, i.e. W4c is 0%. Therefore WW not contained not delivered to centralised treatment plants, i.e. W11c, is 14% which includes W15=3%. Total WW not delivered to treatment plant, i.e. W11, is 19%.	45% of the population has their WW treated, and therefore W5a is 45%. There's no treatment of WW which is not contained.	Treated WW is disposed in lake and also used for irrigation sometimes. Total WW disposed untreated in local area comes out to be 19%.
Onsite	40% of population is dependent on onsite sanitation systems, hence F10, FS not contained is 22% and F2, FS contained is 18% T1A2C6 (Reference L8): 22% of population is dependent on septic tanks connected to open drain. T1A5C10 (Reference L11):17.2% of population is dependent on lined pit with semi permeable walls and open bottom. T1A6C10 (Reference L11):0.4% of population is dependent on unlined pit.	Since most of the population is getting their systems emptied, it is assumed 90% of population has their onsite technology 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 10% and FS contained-emptied, i.e. F3a is 8%. FS contained- not emptied, i.e. F8, becomes 10 % and FS not contained-not emptied becomes 1%.	No FS is transported to treatment plant therefore FS not delivered to treatment plant, i.e.F11, is 18%.	No treatment facility exists hence no FS is treated, therefore FS treated, i.e. F5, is 0%.	All the FS emptied ends up in local area without any treatment.
Open Defecation	7% of population practice open defecation and hence OD9 is computed to be 7%.				

4 Stakeholder engagement

4.1 Key informant interviews

The relevant departments were contacted through e-mail, letter, call and fax prior to a visit to the city. The purpose of the SFD study and depth of data required was conveyed through an introductory letter to respective departments. Overall, 3 KIIs were conducted with different stakeholders like government functionaries and private emptiers (see appendix 7.2).The GoK, operates through its DMA that is supported by UDD.

Limited documents were available on the 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 Acknowledgement

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7 Appendix

7.1 Stakeholder identification

Table 6: Stakeholder identification

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

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
Tumkur City Corporation	Mr Vasanth Kumar	Assistant Executive Engineer (water supply)	07.05.2015	Data collection
Tumkur City Corporation	Mr Lavakumar	Assistant Executive Engineer (Sewerage)	07.05.2015	KII
Swapna septic tank cleaners	Mr Rajappa	Private Emptier	08.05.2015	KII
KUWSDB	Mr G.M.Nagaraju	Executive Engineer	08.05.2015	KII

7.3 SFD matrix

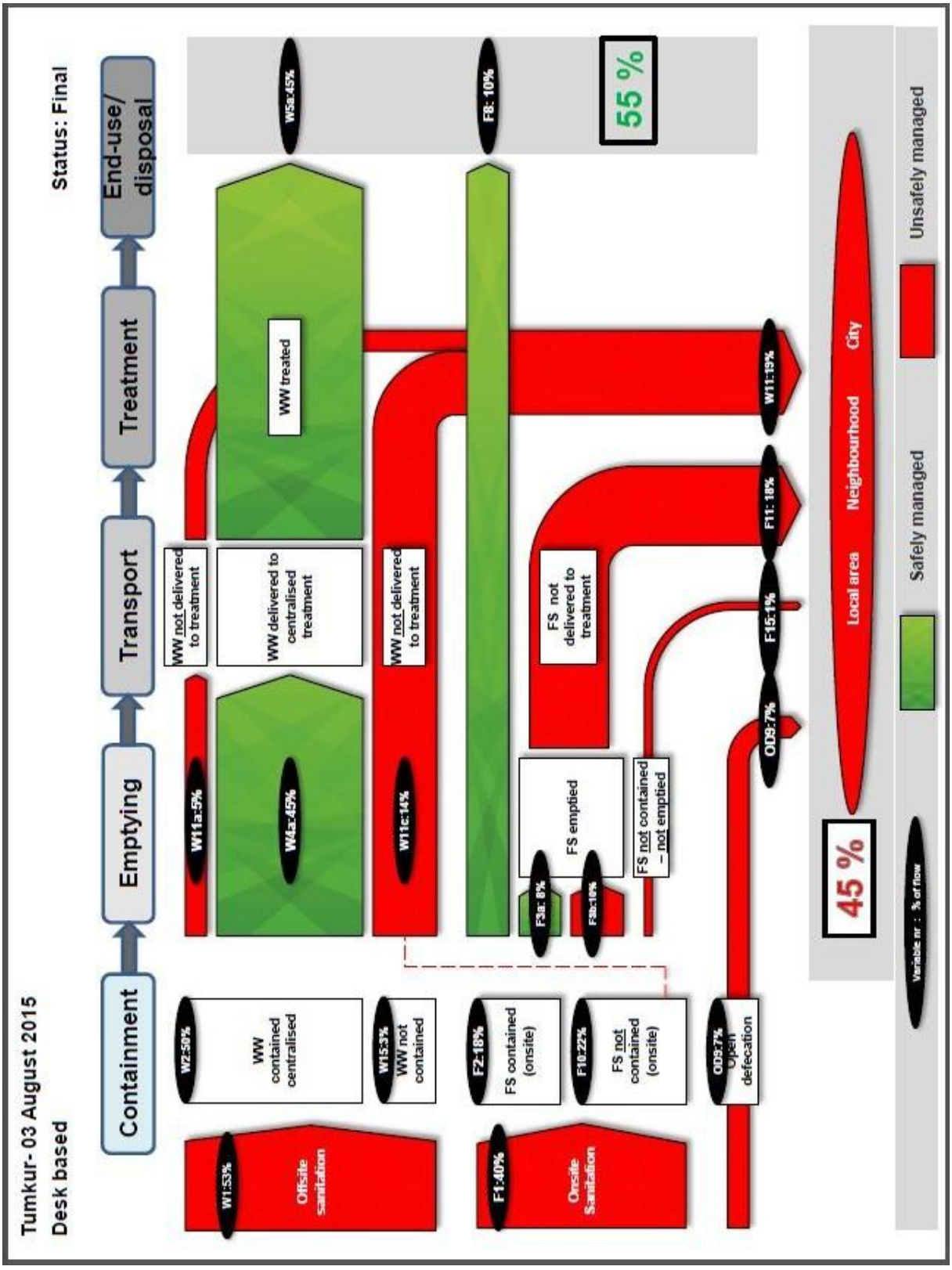

Figure 5: SFD matrix

7.4 Organogram of Tumkur City Corporation

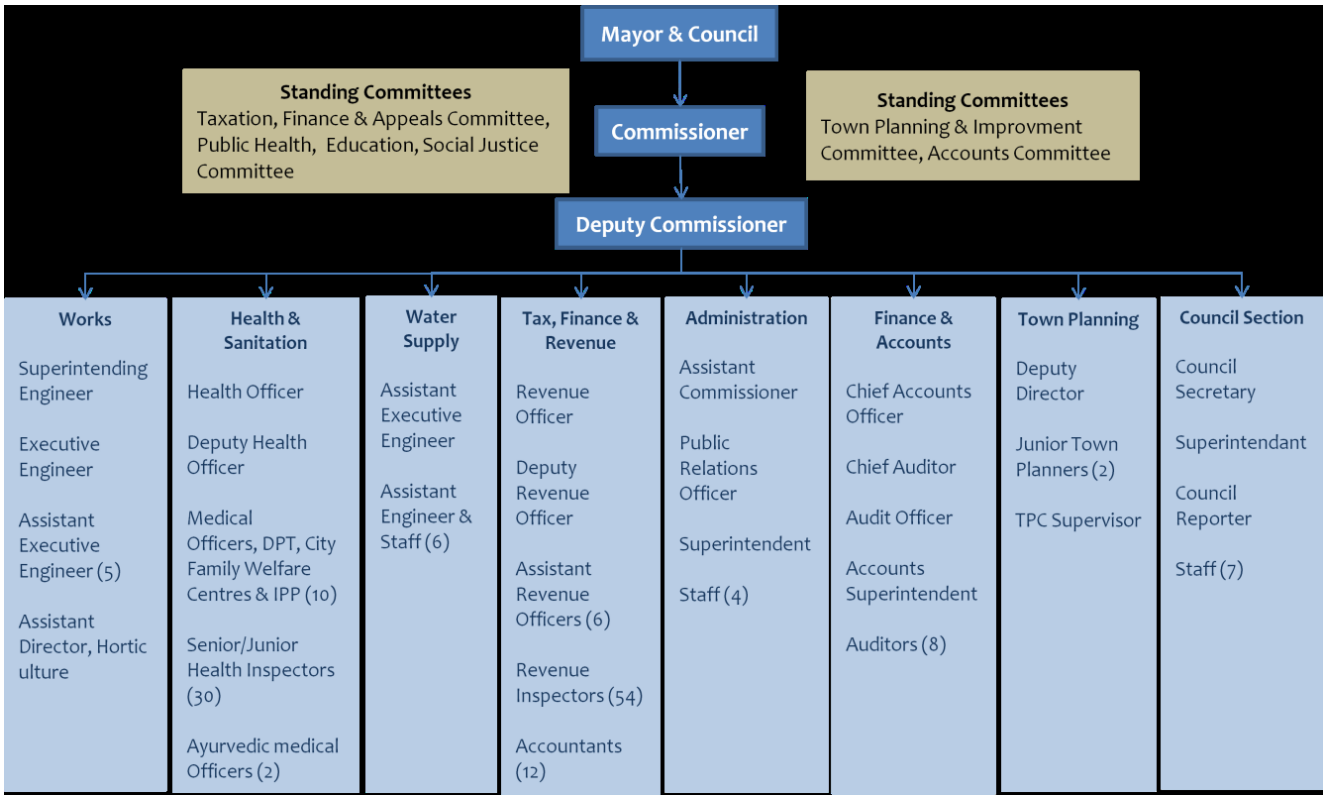

Figure 6: Organogram of Tumkur City Corporation