SFD Report

Muzaffarpur

India

Final Report

This comprehensive level SFD report was prepared by
Centre for Science and Environment (CSE) as a part of the SFD Promotion Initiative.

Date of production: 01/05/2017
Last update: 13/09/2018

SFD Promotion Initiative

sustainable sanitation alliance

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

On behalf of Federal Ministry for Economic Cooperation and Development

UNIVERSITY OF LEEDS

WORLD BANK GROUP Water

GWSP GLOBAL WATER SECURITY & SANITATION PARTNERSHIP

WEDC

Loughborough University

CSE

eawag aquatic research

Sandec Sanitation, Water and Solid Waste for Development

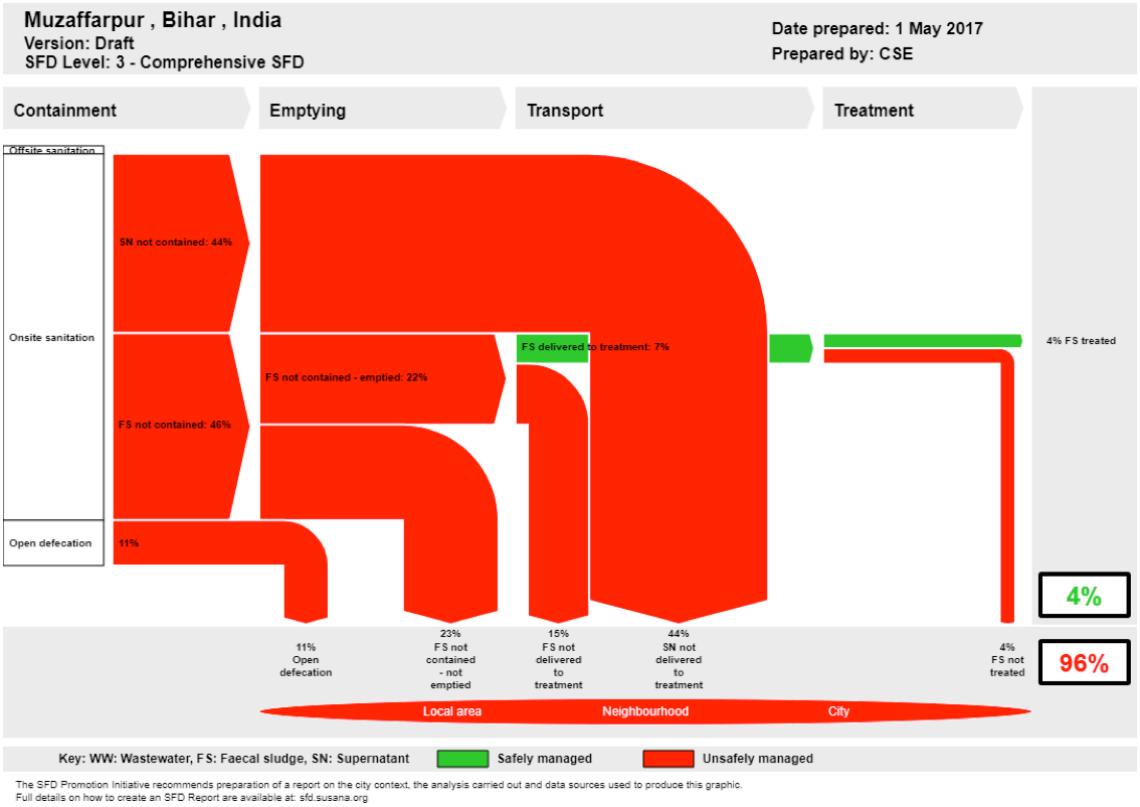
BILL & MELINDA GATES foundation

SFD Report Muzaffarpur, India, 2017

Produced by:
Dr Suresh Kumar Rohilla, CSE
Bhitush Luthra, CSE
Shantanu Kumar Padhi, CSE
Anil Yadav, CSE

This Executive Summary and SFD Report are available from:
www.sfd.susana.org

1. The SFD Graphic



The SFD Promotion Initiative recommends preparation of a report on the city context, the analysis carried out and data sources used to produce this graphic.
Full details on how to create an SFD Report are available at: sfd.susana.org

2. Diagram information

SFD Level:
Comprehensive

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

Status:
This is the final SFD

Date of production:
04/07/2017

3. General city information

Muzaffarpur is a city in Muzaffarpur district in Mithila region of Bihar. It also serves as the headquarters of Muzaffarpur district and Tirhut division. It is the 3rd largest city after Patna and Bhagalpur in Bihar (UD&HD, 2017).

The competitive advantages of Muzaffarpur lie in its excellent connectivity, strategic location and rich agricultural activity in the region. Muzaffarpur is famous for *Shahi lychees*. The district produces nearly one-third of the entire lychee production of the country and 16% of banana production of the state. In horticulture as well, the district is the highest producer of roses, second highest producer of marigold and highest producer of jasmine in the state (UD&HD, 2010). The population of the city is 354,462 with a population density of 13,285 persons per sq.km against 1,132 sq.km of Bihar state as per Census 2011.

Muzaffarpur Municipal Corporation (MMC) covers an area of 26.68 sq.km and is divided into 49 wards. The city is situated on the southern banks of *Burhi Gandak* River, a tributary of River Ganga. The average rainfall during summer and rainy season is 90 mm and 1200 mm respectively. The maximum and minimum temperatures range from 40°C to 6°C throughout the year (MMA, 2012).

4. Service outcome

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

Containment: According to the field-based research there is no functional sewer network present in the city and 89% population is dependent on onsite sanitation systems (OSS) (MMC, 2016). A very small proportion of population in market areas have dilapidated sewer network for discharging grey water which is further connected to nullah. 44% population is dependent on septic tanks (CMO, 2017), effluent from septic tanks discharges into open drain/storm water drain constructed on access roads. Public and community toilets are also connected to septic tank with outlet connected to open drain. 43% population is dependent on tanks with impermeable walls and open bottom also connected to open drain. Lined tanks with impermeable walls and open bottom is also prevalent in the city. During field-based study it was revealed that these tanks are similar to septic tanks but bottom is not lined properly and are connected to open drains which result into increase in desludging period.

Lined pit with semi permeable walls and open bottom are only observed in slums where the toilets are constructed under Swachh Bharat Mission (SBM). These pits are constructed using fabricated rings made of concrete, each ring measures 0.9 m in diameter and 0.2 m in height. 2% of the population has such type of containment system.11% of the population defecate in open due to lack of toilet facilities.

Emptying: Emptying service is provided by both public and private emptiers. To avail the service, an applicant is required to complete the paperwork first and pay a sum of INR 500/trip (7.5 USD) and collect cash receipt. Emptying service is provided within a week of the requisition. Entry for the same is done in record book.

The ULB runs two vacuum tankers, each having capacity of 3,000 litres. There are two private emptiers plying within the corporation area. The emptiers advertise about their services and contact details through local newspapers and business cards.

Emptying is carried out mechanically and there is no instance of manual emptying reported during field-based study. To perform the task of emptying, two operators (one driver and one labour) are required. There is no use of personal protective equipment, exposing workers to the health risk. The government run vacuum tankers are also used for emptying grey water from clogged and dilapidated sewer lines.

Transportation: Tractor mounted vacuum tanker is used for emptying different types of OSS. The average distance travelled by the tanker, for each trip is 10 km (MMC, 2016). On an average two trips are completed per day where the time taken to complete one emptying is nearly 2 hours. A 5 horse power pump is assembled with a tanker for suction of FS. The supernatant (SN) from the septic tank is conveyed through open drains/storm water drains (SWD) to River *Burhi Gandak* in east and *Furdoo* nullah in the south west direction of the city. One of the private emptiers transport emptied FS to his own treatment facility.

Treatment: There is no treatment of FS which is emptied by government vehicles whereas there is a treatment facility in case of FS emptied by private emptier. The treatment facility is owned and run by a private company for producing compost (KII, vacuum tanker owner). FS delivered to the treatment facility is attributed to be from 7% of the population.

Disposal: Unlike private emptiers, municipal corporation has no treatment facility. The ULB emptiers discharge FS at the open fields, storm water drains, canals, nullahs that ends up in *Furdoo* nullah or River *Burhi Gandak* which finally connects to River Ganges.

Figure 1: Discharging of FS in open fields

Indiscriminate discharging of FS by ULB in the neighborhood has often led to brawls with local residents (MMC, 2016).

According to surveys and KIIs conducted in 2016, public latrines are also connected to septic tanks and lined tanks, hence have been incorporated in onsite systems. Since the groundwater level is less than 10 mbgl (CGWB, 2014), the pits are assumed to be not contained.

There is no clear differentiation between the volume of

effluent and solid FS generated from septic tanks, hence to reduce the maximum error, it's assumed to be 50% each. Therefore, 44% of FS is assumed to be effluent/ supernatant that goes into open drains and 22% FS is emptied from tanks whenever full. FS that remains in the tanks and pits is assumed to be 23% and it includes infiltration from tanks and pits. Of the 22% FS that is emptied, only 7% is delivered to a treatment facility and 4% gets treated. As the compost facility is neither properly maintained nor fully functioning facility, it is assumed that 50% of FS delivered to facility is being treated.

It was estimated that 11% of the city still practices open defecation, which was also cross-checked based on field research.

5. Service delivery context

In 2008, the Ministry of Housing and Urban Affairs (MoHUA, GoI) issued the National Urban Sanitation Policy (NUSP). The policy aims to: raise awareness, promote behavior 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 identifies the constitution of multi-stakeholder task force, known as city sanitation taskforce (CSTF) as one of the principal activities to be taken up to start the city sanitation planning process. CSTF has now been renamed as Swachh Bharat City Level Task Force (SBCLTF) (MoUD, 2014)

The Environment (Protection) Act, 1986 and the Water (Prevention and Control of Pollution) Act, 1974 have provisions relating to sanitation services and environmental regulations. It 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 (MoUD, 2013).

In February 2017, MoHUA issued the National Policy on Faecal Sludge and Septage Management (FSSM). The policy aims to set the context, priorities, and direction for, and to facilitate, nationwide implementation of FSSM services in all ULBs such that safe and sustainable sanitation becomes a reality for all in each and every household, street, town and city in India (MoUD, 2017).

There are various schemes launched by central and state government to provide basic civic amenities including improvement of urban sanitation. Swachh Bharat Mission (SBM), *Saat Nischay*, Atal Mission for rejuvenation and urban transformation (AMRUT), Support Programme for Urban Reforms (SPUR) and Smart city. These schemes provide funds for infrastructure development to improve sanitation.

The corporation did a rapid assessment of FSM in city to calculate the funds required for the same. It was estimated that INR 256 lakhs (38.84 million USD) is required for implementation of effective faecal sludge and septage management including operation and maintenance for five years (MoUD, 2016).

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 ULBs. This transfer has resulted in a variety of implementation models, as well as lack of clarity in the allocation of roles and responsibilities between state and local agencies, which sometimes results in implementation (USAID, 2010).

The following stakeholders are responsible for sanitation service delivery in Muzaffarpur.

Table 1: Key stakeholders (Source: Compiled by CSE, 2017)

Key Stakeholders	Institutions/organizations
Public institutions	Minsitry of Housing and Urban Affairs (MoHUA), Public Health and Engineering Department (PHED), Urban Development and Housing Department (UD&HD), Bihar, Reform Support Unit (RSU), Bihar Pollution Control Board (BPCB), Muzaffarpur Municipal Corporation (MMA), Water Resource Department (WRD), Bihar Urban Infrastructure Development Corporation limited (BUIDCO)
NGOs	Participatory Research in Asia (PRIA), Centre for Science and Environment (CSE)
Private Sector	Energy International Pvt. Ltd, Private emptiers, Composting company (SS Trust), SISSO, local masons
Development Partners, Donors	Asian Development Bank and Development for International Development

PHED is responsible for ensuring access to safe water; supply of drinking water to rural areas and development of sanitation facilities, UD&HD performs implementation of schemes supported by the center and state government, MMC is responsible for provision and maintenance of basic services of the city such as water supply, drainage, solid waste management, tax collection, plan approvals, WRD takes care for the development of drainage channels to be used for irrigation purposes. Many private players like Energy International Pvt. Ltd are responsible for operation and maintenance of public and community toilets in the

city. SBCLTF is a multi-stakeholder platform comprising representatives from different sectors of society, including agencies directly responsible for sanitation, agencies indirectly involved or impacted, eminent persons, practitioners, NGOs and sanitary workers.

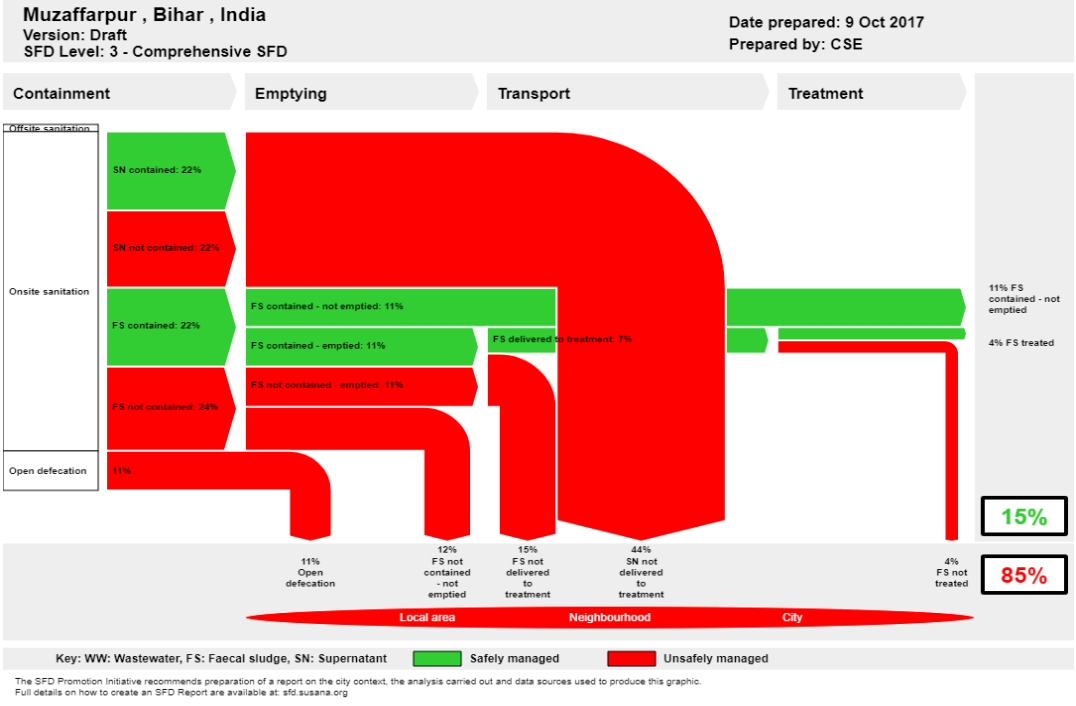
7. Description of Context-adapted SFD

As mentioned in section 5, 89% of the population is dependent on onsite sanitation systems. Out of 89% of the population, 44% of the population is dependent on septic tanks connected to open drain or storm sewer. 43% of the population, dependent on lined tanks with impermeable walls and open bottom connected to open drain, 2% of the population, dependent on lined pits with semipermeable walls and open bottom- all are attributed to be FS not contained.

The only difference suggested in the context adapted SFD is at containment stage for correctly designed septic tanks.

With an earlier assumption of 50% of the proportion of the content of the septic tank is solid FS, generated and collected inside the septic tanks. Rest of the 50% of the content is supernatant, which attributes to 44% (septic tank+ lined tank) of the population that flows through open drains. According to SBCLTF the solid FS collected in the septic tank should be considered contained as it is neither polluting the ground water nor the solid excreta is overflowing in the open drain.

8. Context-adapted SFD graphic



Hence 22% of FS is considered contained (represented green in colour). 11% FS contained is emptied and remaining 11% FS remains in the tank which is contained and never emptied. Nevertheless, the supernatant generated from septic tank connected to open drain is not contained and hence considered to be unsafely managed (represented red in color).

Overall, excreta of 85% population is not managed safely according to the context adapted SFD.

The only difference suggested in the context adapted SFD is at containment stage for correctly designed septic tanks, though connected to open drains, The 'FS not contained' changes from 46% to 24%, 'FS contained' becomes 22%, 'FS contained emptied' and 'FS not contained emptied' both become 11% each, 'FS not contained not emptied' changes from 23% to 12%, and 'SN

not contained' remains 44% when compared to SFD generated through graphic generator.

9. Process of SFD development

Data is collected through secondary sources. The city is visited to conduct the surveys, FGDs and KIIs with relevant stakeholders, to fill in the data gap and to cross-check 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 survey data is quantified and cross-checked with FGDs and KIIs.

The data is fed into the SFD graphic generator tool to calculate the excreta flow in terms of percentage of the population.

Overall, 96% of excreta is unsafely managed, and hence causing pollution in local environment.

10. Credibility of data

Two key sources of data are used; Census of India, 2011 and published documents of relevant departments. Most of the data is then updated by KIIs. Overall four KIIs and three FGDs have been conducted with different stakeholders.

There were three major challenges to develop the SFD. Census and published/unpublished reports were not able to provide (i) up-to-date data on containment (ii) detailed typology of containment and (iii) actual information about FSM services provided to households. For this reason, field based studies were conducted to validate the data provided by secondary sources.

The Census and published/unpublished reports mostly differentiate between systems connected to the user interface, if any, but does not give information about the design of actual containment systems on ground level or about the disposal of septage and wastewater generated. Therefore, a sample household survey was conducted in each ward of the city to identify and cross check the data collected from the secondary sources.

The objective of the survey conducted was to obtain a more accurate measure of how excreta is managed through stages of sanitation service chain (from containment to end-use or disposal).

11. 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
  - Saat Nischay Yojna
  - Central Ground Water Board, Muzaffarpur district, 2013
- KIIs with representatives from
  - Government officials of MMC
  - Energy International Pvt. Ltd (public toilet in charge)
  - Slum improvement committee member
- FGDs
  - MMC staff
  - PRIA employees working in slums
  - Commercial establishments
- Random household surveys

Muzaffarpur, India, 2017

Produced by:
Dr Suresh Kumar Rohilla, CSE
Bhitush Luthra, CSE
Shantanu Kumar Padhi, CSE
Anil Yadav, CSE

Table of contents

Executive summary i
Table of contents vi
List of tables viii
List of figures ix
Abbreviations x
1 City context 1
2 Service outcomes 3
2.1 Overview 3
2.1.1 Sanitation facilities 4
2.1.2 Containment 5
2.1.3 Emptying 6
2.1.4 Transportation 8
2.1.5 Treatment and disposal 9
2.2 SFD matrix 10
2.2.1 SFD matrix explanation 10
2.2.2 Risk of groundwater contamination 11
2.2.3 Discussion of certainty/uncertainty levels of associated data 12
2.3 Context adapted SFD 12
3 Service delivery context description/analysis 14
3.1 Policy, legislation and regulation 14
3.1.1 Policies, legislations and regulations at national level 14
3.1.2 Policies, legislations and regulations at state and ULB level 15
3.1.3 Institutional roles 16
3.1.4 Service provision 16
3.1.5 Service standards 17
3.2 Planning 18
3.2.1 Service targets 18
3.2.2 Investments 19
3.3 Reducing inequity 20
3.3.1 Current choice of services for the urban poor 20
3.3.2 Plans and measures to reduce inequity 21
3.4 Outputs 22
3.4.1 Capacity to meet service needs, demands and targets 22
3.4.2 Monitoring and reporting access to services 22
3.5 Expansion 23
3.5.1 Stimulating demand for services 24
3.5.2 Strengthening service provider roles 24

4 Stakeholder engagement 25
4.1 Key informant interviews 25
4.2 Field observation 25
4.3 Focus group discussions 26
5 Acknowledgements 27
6 References 28
7 Appendix 29
7.1 Stakeholder identification 29
7.2 Tracking of engagement 29
7.3 SFD graphic 30
7.4 SFD brief explanation 31
7.5 Context adapted SFD Graphic 32
7.6 SFD selection grid 33
7.7 SFD calculation grid 34
7.8 Maps 35
7.9 Swachh Bharat City Level Task Force 38
7.10 Photographs during field visit 40

List of tables

Table 1: Population growth rate 1
Table 2: Sanitation technologies and corresponding percentage of population 3
Table 3: Data on Sanitation systems available from 7 Nischay 4
Table 4: Number of emptying trips completed by MMC 8
Table 5: Description of variables used for defining containment systems 10
Table 6: Description of variables used in SFD 10
Table 7: Roles and responsibilities 17
Table 8: Service delivery targets in accordance with SLBs 19
Table 9: Status of CAPEX and OPEX for FSSM 19
Table 10: Investment for sanitation services 20
Table 11: Stakeholder identification 29
Table 12: Tracking of engagement 29
Table 13: Percentage of the population using each system technology and method 31
Table 14: Containment system selection grid 33
Table 15: SFD matrix 34
Table 16: List of SBCLTF 39

List of figures

Figure 1: Ward map of Muzaffarpur....2
Figure 2: A PT in agriculture product market....5
Figure 3: Septic tank observed during field study....6
Figure 4: Application submitted by resident, cash receipt provided by municipal department and entries recorded for emptying....7
Figure 5: Emptying process of a septic tank....7
Figure 6: Tractor mounted tanker used for emptying service....8
Figure 7: Supernatant from septic tanks conveyed to open ground via storm water drains....8
Figure 8: Discharge of FS in open fields by ULB vacuum tanker....9
Figure 9: Toilets constructed under SBM connected to pit in slum....21
Figure 10: CT in Purani Gudri area of ward 40....21
Figure 11: Community toilets in slums....22
Figure 12: SFD graphic....30
Figure 13: Context adapted SFD graphic....32
Figure 14: Drainage map of Muzaffarpur city....35
Figure 15: Environment sensitive areas map of Muzaffarpur city....36
Figure 16: Slum pocket in Muzaffarpur city....37
Figure 17: Official notification of meeting by MMC....38
Figure 18: FGD with MMC officials....40
Figure 19: FGD in slums....40
Figure 20: FGD with 22 SBCLTF members at MMC....41
Figure 21: KII with sanitary inspector and MMC emptiers....41
Figure 22: KII with slum improvement committee member....41
Figure 23: Emptying of clogged storm water drain....42
Figure 24: Septic tank design on house plan and flooded street after rain in the city....42
Figure 25: Household questionnaire used during random survey....43
Figure 26: Survey questionnaire used during emptiers interview....44

Abbreviations

AMRUT	Atal Mission for Rejuvenation and Urban Transformation
BIS	Bureau of Indian Standards
CAPEX	Capital Expenditure
CDP	City Development Plan
CPCB	Central Pollution Control Board
CPHEEO	Central Public Health and Environmental Engineering Organization
CSPs	City Sanitation Plans
CT	Community Toilet
FS	Faecal Sludge
FSM	Faecal Sludge Management
FSSM	Faecal Sludge and Septage Management
GoI	Government of India
HHs	Households
HFA	Housing for All
IHHT	Individual Household Toilet
IHSDP	Integrated Housing and Slum Development Programme
INR	Indian National Rupee
Km	Kilometer
LBD	Length, Breadth and Depth
mbgl	Meter below ground level
mm	Millimeter
m	Meter
MMC	Muzaffarpur Municipal Corporation
N	North
NBC	National Building Code
NFSSM	National Faecal Sludge and Septage Management
NGC	National Ganga Council
NH	National Highway
NIUA	National Institute of Urban Affairs
NMCG	National Mission for Clean Ganga
NUSP	National Urban Sanitation Policy
MoHUA	Ministry of Housing and Urban Affairs
MoUD	Ministry of Urban Development
OD	Open Defecation
O & M	Operation and Maintenance
OPEX	Operational Expenditure
OSS	Onsite Sanitation System
PHED	Pubic Health and Engineering Department
PMAY	Pradhan Mantri Awas Yojna
PT	Public Toilet
SAAP	State Annual Action Plan
SBM	Swachh Bharat Mission (Clean India Mission)
SBCLTF	Swachh Bharat City Level Task Force
SFD	Shit Flow Diagram
SN	Supernatant
Sq.km	Square Kilometer
SLB	Service level Benchmarking
SLIP	Service level Improvement Plan
SMP	Septage Management sub-Plan
SMP	Sewerage Master Plan
SPS	Sewage Pumping Station
SPUR	State Programme for Urban Reforms
Sq.km	Square kilometer
STP	Sewage Treatment Plant
SWM	Solid Waste Management
UD&HD	Urban Development and Housing Department
ULBs	Urban local bodies
USAID	United States Agency for International Development
USD	United States Dollar (1 USD = 66 INR)
WSS	Water Supply and Sewerage
WW	Waste Water

1 City context

Muzaffarpur city lies in Muzaffarpur district in Mithila region of Bihar. It also serves as the headquarters of Muzaffarpur district and Tirhut division. It is the 3rd largest city after Patna and Bhagalpur in Bihar (UD&HD, 2017). Muzaffarpur Municipal area comes under the Musahari block. The block has 117 villages and only one urban centre, i.e. Muzaffarpur.

The competitive advantages of Muzaffarpur lie in its excellent connectivity, strategic location and rich trade and commerce activity in the region. The city is well connected by road and rail within the state and to other cities in the country and to Nepal, which is less than two hours away.

Muzaffarpur serves as the regional wholesale market centre for nearby small towns and villages for supplying various commodities and agricultural/ horticulture/ fruits produce. Muzaffarpur district is famous for lychee not only in India but also internationally for the *Shahi* variety that is grown extensively in this district (MMC, 2009).

The district is the top producer of lychee in India and 16% of the banana production of the state. In horticulture as well, the district is the highest producer of roses, second highest producer of marigold and highest producer of jasmine in the state. Textile mills in the famous *Marwari* community dominate *Suta Patti*. (UD&HD, 2010). The Muzaffarpur Municipal Corporation (MMC) is surrounded by Saran district in West, Vaishali and Samastipur in South, Dharbanga district in east and district Sitamari and East Champaran in North.

As per census 2011, the population of the city is 354,462 with a population density of 13,285 per sq.km which is much higher as compared to the density of Bihar with 1,132 per sq.km. The town has experienced rapid population growth in the last four decades from 54,139 in 1951 to 305,525 in 2001 and 354,462 in 2011 as per provisional census figures (UD&HD, 2010). Refer table below for growth rate pattern:

Table 1: Population growth rate of Muzaffarpur

Year	Population	Decadal growth rate
1951	73,594	-
1961	109,048	48.18%
1971	126,379	15.89%
1981	190,416	50.67%
1991	241,107	26.62%
2001	305,525	26.72%
2011	354,462	16.00%

Source: Census of India, 2011

MMC covers an area of 26.68 sq.km and is divided into 49 wards. Muzaffarpur city is situated on the southern bank of *Burhi Gandak* River and located at 26°07 "North Latitude and 85°27" East Longitude. The soil of the district is alluvial and highly fertile, well drained and sandy type. The average rainfall during summer and rainy season are 90 mm and 1,200 mm respectively. The average maximum and minimum summer temperatures range from 45°C to 34°C respectively while winter temperatures range from 16°C to 6°C (MMA, 2012).

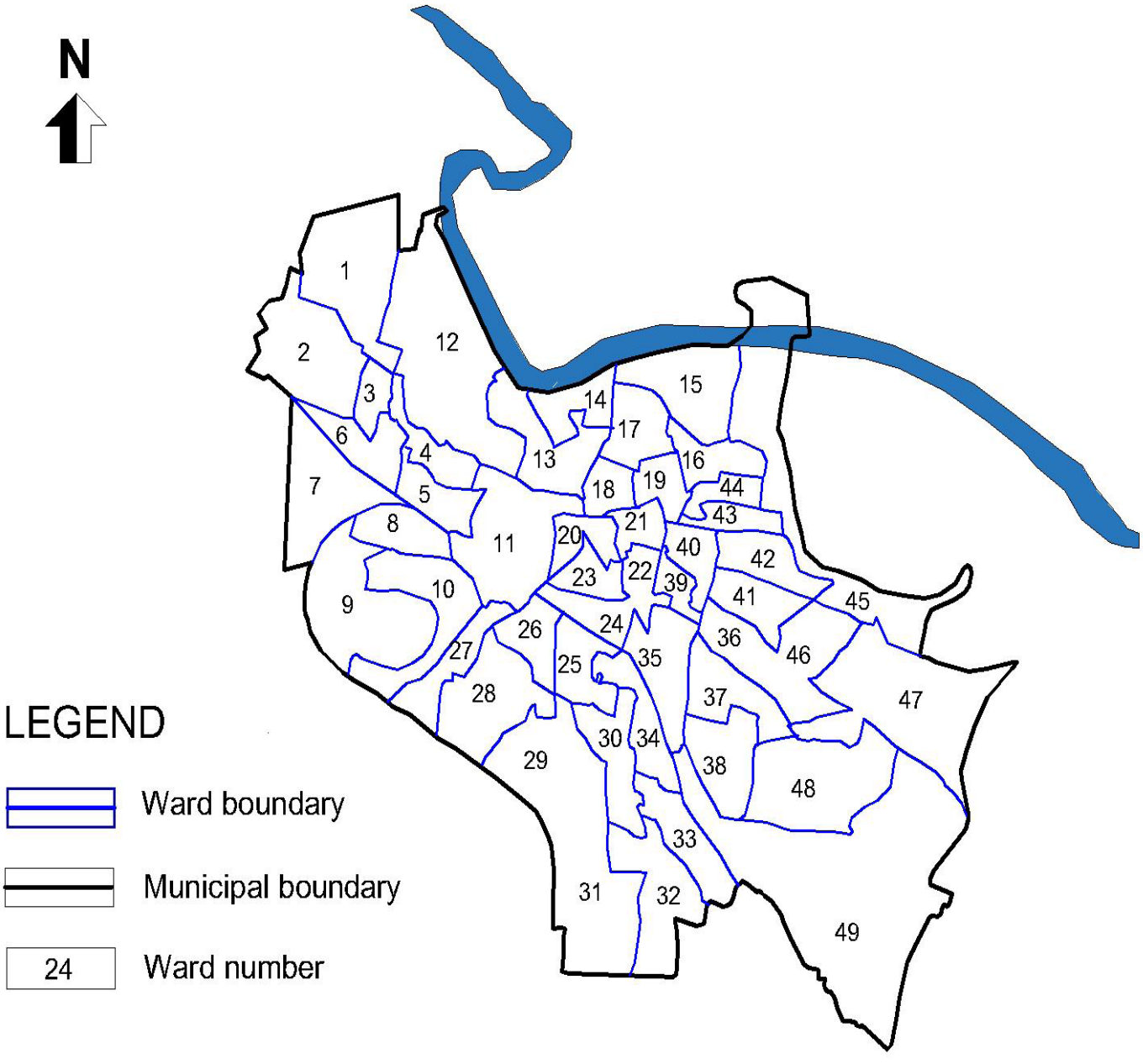


Figure 1: Ward map of Muzaffarpur (Source: CSE, 2017)

2 Service outcomes

The analysis is based on data available from Census 2011, published reports of government, non-profit organizations and reconnaissance HH survey. Data collected from secondary sources is triangulated in the field-based study. Data on the containment is available in Census 2011. Data has been cross-checked and updated by Key Informant Interviews (KIIs) and Focus Group Discussions (FGDs). According to the SFD promotion initiative, definitions of sanitation systems, the types of containments prevalent in the wards are examined through a household (HH) survey (Table 2). Data on emptying, transport, treatment and disposal of FS is collected through KIIs with Urban Local Body (ULB is the local governing body in a city responsible for providing basic infrastructures like water supply and sanitation along with health facilities as per standards and norms, to all the citizens, in Muzaffarpur, the ULB is called Muzaffarpur Municipal Corporation), private emptiers and parastatal body. However, most of the data is qualitative.

2.1 Overview

To start with a relationship between sanitation technologies defined in Census of India and variables defined in the project is established. Then the population dependent on those systems is represented in terms of percentage of the population, as shown in table 2.

Table 2: Sanitation technologies and corresponding percentage of population in Census 2011

S. No.	Sanitation technologies and systems as defined by:		SFD reference variable	Percentage of population
	Census of India	Sanitation systems defined by SFD Promotion initiative		
1.	Piped sewer system	User interface discharges directly to centralized separate sewer	T1A1C6	9.2
2.	Septic tank	Septic tank connected to open drain or storm sewer	T1A2C6	73.1
3.	Other systems	User interface discharges directly to open ground	T1A1C8	2
4.	Pit latrine with slab	Lined pit with semi-permeable walls and open bottom, no outlet or overflow, general situation	T1A5C10	1.5
5.	Pit latrine without slab	Unlined pit no outlet or overflow, general situation	T1A6C10	0.7
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 to “don’t know where”	T1A1C9	0.3
8.	Public latrine	Septic tank connected to open drain or storm sewer	T1A2C6	4.1
9.	Open defecation (OD)	OD	T1B11C7 to C9	8.8

Source: Census of India, 2011

The above table was prepared through a desk based study which provided the preliminary data for triangulation and for understanding the current sanitation situation. The data in table 2 is not used for preparation of SFD graphic. Furtherance, during field-based study, the researchers collected *Saat Nischay* data (Chief Minister’s 7 resolves explained in section 3.5) from Municipal Corporation. The *Saat Nischay* data is considered to be an updated data to be relied on for SFD preparation. Based on *Saat Nischay data*, types of sanitation facility that exists and their technologies and methods beingpracticed along the value chain were studied during field-based study and furtherance considered for preparation of graphic.

Table 3: Data on Sanitation systems available from *Saat Nischay*

Population of Muzaffarpur	**353,878**	
No. of Households	65533	
Types of sanitation facilities	**Population**	**Percentage**
Piped sewer system	1334	0.38
Septic tank	283257	80.04
Pit latrine	4358	1.23
Night soil disposed into open drain	1085	0.31
Public/community toilet	19644	7.04
Open defecation	44200	11

Source: 7 Nischay household data

2.1.1 Sanitation facilities

This section presents on existing sanitation facilities which includes Community toilet (CT)/Public Toilet (PT), institutions, commercial establishments and slums.

CT/PT: The MMC is responsible for the construction of CT and PT within the city. However, the operation and maintenance (O&M) of these toilet complexes is not performed by the corporation. Maintenance of a CT is the responsibility of the local people residing in the community and there is no helping hand from MMC in such cases. Some CTs are poorly managed and are unhygienic due to lack of periodic O&M, whereas, on the other hand, the PTs are functional under the public private partnership of MMC with private bodies like Energy International Pvt. Ltd. Etc. The containment systems are restricted to septic tank with effluent discharging into an open drain that ends up untreated into the River *Burhi Gandak* and *Furdoo nallah*. The containments are generally constructed larger in size measuring 6.7 m x 2.4 m x 1.8 m (LBD) on an average.

Institutional and commercial establishments: There are many prime institutional establishments in the city such as the first college in Muzaffarpur named Langat Singh College, established in 1889, Mahanta Darshan Das Mahila College, Dr B.R. Ambedkar Bihar University with nearly 5,000 students. There are 35 primary schools and around 20 senior secondary schools in the city. Muzaffarpur has a number of health facilities including medical college, hospitals, polyclinic, nursing homes and dispensaries. The corporation runs one ayurvedic and one homoeopathic medicine shop and 3 maternity centres (UD&HD, 2010). Muzaffarpur serves as a market centre for nearby small towns and villages for supplying various commodities. There is around 25 number of private and public markets with more than 4,000 shops (MMC, 2009). The shops in major markets have the facility of toilet with a septic tank. Whereas most of the shops do not have the facility of toilet within premises or anywhere in the market area. There are only 12 PT functional in the city.

In general, all these areas are devoid of the required level of sanitation facilities. The shops in big markets do have individual toilets connected to the septic tank with effluent discharging into open drains.

Figure 2: PT in agriculture product market in Muzaffarpur (Source: Anil/CSE, 2016)

2.1.2 Containment

According to the field-based research conducted during October 2016, it is reported that there is no functional sewer network present in the city. Largely the population is dependent on on-site sanitation systems (OSS) like septic tank and pit latrines (MMC, 2016). HHs deprived of toilets, use CT or practice OD.

Sewerage: According to census 2011 and Saat Nischay data, HHs connected to sewerage network have a share of 9% and 0.3% respectively. But as per field-based research and KII conducted with the city officials, only a very few HHs (<1%) had sewer connections that are now in a dilapidated condition. Moreover, due to the dilapidated condition of sewer, those HHs have moved to onsite containment system. Grey water and storm water from those households are discharged into dilapidated sewer. Thus, the population connected to sewerage has not been considered for SFD generation.

Septic tanks: Population dependent on septic tanks is about 44%, effluent from septic tanks is discharged into open drains/storm water drains. 43% of the population is dependent on lined tanks with open bottom, that are also connected to open drains (as per data analysis based on KII with sanitary inspector, random HH survey, Census 2011 and *Saat Nischay* survey). Larger sizes of septic tank are preferred at the HH level to get rid of frequent emptying. The average size of a septic tank as per random HH survey is 3 m x 1.2 m x 2.1 m (LBD) with two or three chambers.

Lined tank with impermeable walls and open bottom connected to open drain: This type of containment is observed during the field-based study. Households have constructed rudimentary septic tanks with baffle walls but are not lined properly from bottom or not fully functioning as septic tanks connected to open drain.

Figure 3: Septic tanks observed during field study

89% of the population is dependent on onsite sanitation and 11% of the population practice OD. Supernatant (SN) generated from OSS discharges into open drains and ends up in *Burhi Gandak* River or *Furdoo* Nullah.

Pit latrines: These containment systems are only observed in slums where the toilets are constructed under Swachh Bharat Mission (SBM). These pits are constructed using rings made up of concrete. Each ring measures 0.9 m in diameter and 0.25 m in height. It was also found during visit to selected slums that despite being provided with individual toilets by ULB under national mission of SBM, it is not used by households regularly. Upon interview with few slum dwellers it was informed that the reason behind is fear of frequent emptying of the pits which will be an extra burden of expense to any household.

Open Defecation: Few slum dwellers have submitted application under SBM requesting for individual household toilets to the concerned department at the corporation since last 1 year, but they have not been given any fund to construct toilet. OD is still prevalent due to lack of toilet facility

2.1.3 Emptying

Emptying service is provided by both public and private operators. To avail the service from public emptiers, an applicant has to go through following process:

i. Write a letter to the corporation, addressing to the commissioner. The applicant has to specify no of trips that would be required for emptying, houseaddress and contact no.
ii. Then, submitthe application to conservancy department with a payment of 500/trip (7.5 USD) as service charge and receive cash receipt.
iii. Emptying service is provided by corporation within a week of requisition..
iv. Data entry for the same is done in record book.

Private operators: There are two private emptiers plying within the corporation area. The emptiers advertise and market their services in local newspapers and by distribution of their business cards to the HHs. One can directly call on their contact number given in advertisements to avail the service. Emptying service is provided as per availability of the vaccum tanker. It can be done on the same day or after a week of contact. This process is fully informal.

Emptying of containment systems is carried out mechanically and there is no manual emptying reported. To perform the task of emptying, two operators (one driver and one labour) is required. There is no use of PPE while emptying, hence workers are exposed to diseases and extreme threat to health. Choked sewer is cleaned on regular basis from dilapidated sewers by ULB's vacuum tankers.

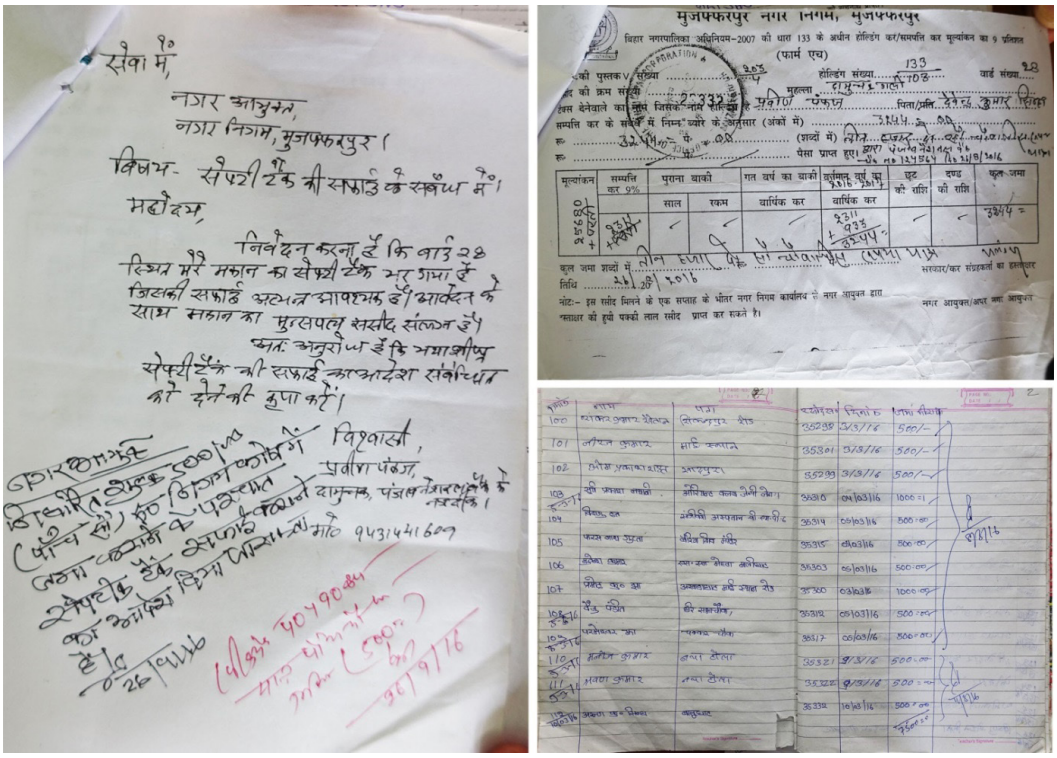


Figure 4: Left to right: Application submitted by resident, cash receipt provided by Municipal department and entries recorded for emptying (Source: Anil/CSE, 2016)

Figure 5: Emptying process of a septic tank (Source: Bhitush/CSE, 2016)

Table 4: Number of emptying trips completed by MMC

Year	No of trips in records
2013-14	509
2014-15	441
2015- Nov 16	234

Source: MMC, 2016

2.1.4 Transportation

Tractor mounted tanker is used for emptying. According to KII conducted with a driver and a labour, the average distance travelled for each trip is 10 km. On an average, 2 trips are completed per day, each trip consumes 2 to 3 hours of service. A pump of 5 horse power is assembled with the vehicle which is used for suction operation. The supernatant (SN) from the septic tank is conveyed through open drains/storm water drains to bigger drains or low lying areas.

Figure 6: Tractor mounted tanker used for emptying service (Source: Amrita/CSE, 2016)

Figure 7: SN from septic tanks conveyed to open ground via storm water drains (Source: Anil/CSE, 2016)

2.1.5 Treatment and disposal

There is no treatment of septage that is emptied by government vehicles. Whereas, there is treatment in case of septage emptied by private operators. As per KII with the owner of private fertilizer company, he adopted the FS emptying business to get raw material for his fertilizer company. The facility is spread over an area of approx. one acre. The plant receives about 6,000 litres of septage per day that is dumped in an unlined drying bed for sun drying. Whereas, there is no treatment of the liquid component thus infiltrates and pollutes the ground water. The sun dried septage is mixed with secondary elements such as oil cake, waste from sugar mills and tobacco dust to further improve the quality of manure. The final product (manure) is sold to farmers for agricultural use at a cost of INR 4000 per tonne (60 USD/tonne).

Unlike the private emptiers, the ULB has no disposal facility. The ULB's emptiers discharge septage wherever, they find open fields, drains, canals/nullahs. These drains end up in *Furdoo* nullah, River *Burhi Gandak* which finally connects with River Ganges. Discharge of septage by ULBs in the neighbourhoodoften leads to brawl of emptiers with local residents (MMC, 2016).

Figure 8: Discharge of FS in open fields by ULB vacuum tanker (Source: Anil/CSE, 2016)

2.2 SFD matrix

The final SFD graphic of Muzaffarpur is presented in appendix 7.3

2.2.1 *SFD matrix explanation*

Definition and estimation of different variables (used to make SFD) are explained below in table 5 and 6. Referring to the table 3, the final data considered for SFD graphic has been collated in the Table 5.

Table 5: Description of variables used for defining containment systems

S.no.	Variables	Description (city context)	Percentage of population
1	T2A2C6	Septic connected to open drain or storm water drain	44
2	T1A4C6	Lined tank with impermeable walls and open bottom, connected to an open drain or storm sewer	43
3	T2A5C10	Lined pit with semi permeable walls and open bottom, no outlet or overflow, where there is 'significant risk' of ground water pollution	2
4	T1B11 C7 TO C9	Open defecation	11

Source: CSE, 2017

Table 6: Description of variables used in SFD

System type	Variables	Description (city context)	Percentage of population
Onsite	SN not contained	SN from the onsite sanitation technology (T2A2C6 and T1A4C6) discharges into open drains/ground hence is not contained	44
	SN not delivered to treatment	SN from the onsite sanitation technology (T2A2C6 and T1A4C6) that is conveyed through open drains and ends up in River *Burhi Gandak*, low lying areas or open ground	44
	FS not contained	FS from the onsite sanitation technology (T2A2C6, T1A4C6 and T2A5C10), where FS is not contained either due to infiltration in ground and or due to effluent discharging in open drain	46
	FS not contained – emptied	Where FS is not contained, which is emptied, using motorized emptying equipment	22
	FS delivered to treatment	FS that is transported to treatment facility by the private emptiers	7
	FS treated	FS treated at privately owned treatment facility 'SS Trust', using sludge drying bed technology	4
	FS not delivered to treatment	FS that is discharged at non-confirming places such as storm water drains, open fields and nullah	15
	FS not contained – not emptied	FS that remains in the tank. It also includes the infiltrate.	23
OD	Open Defecation	With no user interface, users defecate in water bodies or on open ground consequently the excreta is not contained.	11

Source: CSE, 2017

According to 7 Nischay data nearly 80% of the population has individual household toilets connected to septic tanks. Though random field survey and key informant interviews revealed that around 50% of these tanks do not qualify to be called as septic tanks and are merely lined tanks with impermeable walls and open bottom. Roughly 7% of the population is dependent on public toilets and 50% of the tanks connected to these toilets are assumed to be connected to septic tanks and the other 50% connected to lined tank with impermeable

walls and open bottom. According to 7 Nischay data, 1.3% population is dependent on pits, this number is updated based on the toilets installed under Swachh Bharat Mission, and it is estimated that 2% of the population is dependent on lined pit with semipermeable wall and open bottom.

Offsite sanitation systems
According to 7 Nischay data, 0.4% of the city is dependent on piped sewer systems and user interface discharging directly into open drain or open ground is 0.3%. But from the field based study, it was observed that core areas of the city, marginally market areas have shallow sewer network which is in a dilapidated condition. These are shallow sewers and only carrying grey water and supernatant from septic tanks. Most of these sewers do not end up in trunk sewers rather are blocked due to unplanned infrastructure. The WW from these sewers is emptied by emptiers whenever the stretch of sewer gets full. The emptied WW is discharged just like rest of the FS by MMC.

Onsite sanitation systems
According to 7 Nischay data, 89% of the population is dependent on OSS, of which, 80.04% use septic tanks, and 2% use pits, and 7.04% use public latrines. Out of 89% population dependent on OSS, 44% are dependent on septic tanks connected to open drains and 43% of population is dependent on lined tanks with impermeable walls and open bottom connected to open drains and only 2% on lined pits.

FS is considered not contained when the FS infiltrate pollutes the high ground water table or if the supernatant from the septic tank flows through open drain. In Muzaffarpur, 89% population is dependent on onsite systems connected to open drain. There is no clear differentiation between the volume of SN and solid FS generated from septic tank connected to open drain, hence to reduce maximum error it is assumed to be 50% each, therefore, the SN is 44%.

FS not contained is attributed to 46% population who use the systems: septic tank connected to open drain (22%), lined tank with impermeable walls and open bottom connected to open drain (22%) and lined pit with semipermeable walls and open bottom (2%).

It is estimated that only 50% of population is using the tanks with emptying, and pits are not yet emptied. Out of the 46% solid FS (not contained), 22% is emptied (11% from septic tank connected to open drain + 11% from lined tank with impermeable walls and open bottom connected to open drain). 7% FS (not contained) that is emptied gets delivered to the treatment plant. Assuming that only 50% is treated it is estimated that 4% FS gets treated and 4% FS is not treated.

Open Defecation
According to 7 Nischay data, 11% population practices open defecation.

Overall, 4% FS is safely managed and 96% FS is unsafely managed.

2.2.2 *Risk of groundwater contamination*

The SFD assessment includes the risk of groundwater pollution as an important factor in determining whether excreta is contained or not contained. If the risk of contamination to groundwater is low then FS is considered “contained”. The type of onsite sanitation technology in use also has an influence on the infiltration of liquid into the groundwater and therefore on the potential risk of groundwater pollution.

The source of drinking water is only ground water. 53% of population has piped water supply. Water is supplied through a water supply network comprising of 214 kms of pipeline and 7 water reservoirs/overhead tanks. (MMA, 2017). Areas where there is no piped water supply are using hand pumps, bore wells and water tankers supplied by the MMC. The ground water level is 9.4 m as recorded in the month of May 2016 (MMA, 2017).

In the district, the main aquifer materials consist of fine to medium sand or fine sand mixed with silt with occasional *kankar* (fine stone) and gravels. Precipitation is the main source of ground water recharge in Muzaffarpur district. The data reveals that the ground water of the area is general alkaline in nature as pH value ranges from 7.60 to 8.65. The entire district is occupied by alluvium. The main granular zones are found within a depth of 60-100 m. The detailed study of chemical data; of ground water indicates; that water of the shallow aquifers of the area is good and potable for drinking, industrial as well as agriculture uses. The research also shows that there is no ground water related issues and problems in the district (CGWB, 2013). The containment systems T1A4C6 and T2A5C10 are considered not contained because of possible infiltration of FS into ground water.

2.2.3. Discussion of certainty/uncertainty levels of associated data

There were three major challenges to develop the SFD. Census, 2011, was not able to provide completely (i) up-to-date data on containment (ii) detailed typology of containment and (iii) actual information about FSM services provided to households. For this reason, field-based studies were conducted to validate the data and triangulation of data provided by secondary sources.

The Census, 2011, mostly differentiate between systems connected to the user interface, if any, but does not give information about the design of actual containment systems on ground level or about the disposal of septage and waste water generated. Therefore, random household survey was conducted in some of the wards of the city to identify and cross check the data collected from the Census. The recent door to door socio economic survey where data collection in each and every HH was conducted by MMC under the state scheme *7 Nischay* has up to date database subject to FSM service chain which is considered as the most reliable data source for production of SFD. CSE's representative also conducted the KIIs, FGDs and site visits.

The assumption regarding the volume of FS emptied as compared to FS generated has a high impact on the overall SFD. A reliable method for estimating quantities of FS generated on a citywide scale do not yet exist, and it is complicated because the containment size and emptying period greatly vary. Since there is no clear differentiation between the volume of effluent/supernatant and septage generated from septic tanks and lined tanks, hence it's assumed to be 50% each. Based on the random survey, it is assumed that respondents getting their OSS emptied within 15 years are using their systems with emptying and respondents getting their OSS emptied after 15 years are using their system without emptying. In the matrix, it is assumed that 50% of the population gets their containment systems emptied when full.

The objective of the survey conducted was to obtain a more accurate measure of how excreta is managed through stages of sanitation service chain (from containment to end-use or disposal). To reduce the uncertainty around the data collected, the draft SFD was prepared based on the analysis done and was presented to the Swachh Bharat City Level Task Force (SBCLTF) members (22 nos) and they validated the graphic and the report. Details on SBCLTF can be seen in appendix 7.7.

2.3 Context adapted SFD

According to the SBCLTF, SFD generated by the graphic generator is not sufficiently visualizing the actual situation at containment stage of sanitation chain. According to the stakeholders the properly designed septic tanks, which are regularly emptied, should be considered contained even if the supernatant is discharged into open drains. Hence, a context adapted city specific SFD graphic is manually corrected to convey the true picture of the excreta management in the city.

Please refer Appendix 7.5 for the context adapted SFD graphic. There is no major change done in the graphic. The only difference suggested in this context is at containment stage, i.e. for correctly designed

septic tanks. Out of 89% of the population, dependent on onsite sanitation system, 44% of the population is dependent on septic tanks connected to open drains or storm sewer. 43% of the population, dependent on lined tank connected to open drains.

With an earlier assumption of 50% of the proportion of the content of the septic tank is solid FS, rest of the 50% is assumed to be SN, which attributes to 22% of the population, that flows through open drains. According to SBCLTF the solid FS collected in the septic tank (attributed to 22% population) should be considered contained as it is neither polluting the ground water nor the solid excreta is overflowing in the open drain. Hence 22% of FS is considered contained (represented green in colour). 11% FS contained is emptied and rest 11% FS remains in the tank which is contained and never emptied. Nevertheless, the supernatant generated from septic tank connected to open drain is not contained and hence considered to be unsafely managed (represented red in colour).

The only difference suggested in the context adapted SFD is at containment stage for correctly designed septic tanks, though connected to open drains, The 'FS not contained' changes from 46% to 24%, 'FS contained' becomes 22%,'FS contained emptied' and 'FS not contained emptied' both become 11% each, 'FS not contained not emptied' changes from 23% to 12%, and 'SN not contained' remains 44% when compared to SFD generated through graphic generator. and 'SN not contained' remains 44% when compared to SFD generated through graphic generator.

Overall, excreta of 85% population is not managed safely according to the context adapted SFD. The graphic is well received by the stakeholder's group and city's authority has agreed that the context adapted SFD graphic is representing much closer picture to the ground conditions.

3 Service delivery context description/analysis

3.1 Policy, legislation and regulation

3.1.1 *Policies, legislations and regulations at national level*

In 2008, the Ministry of Housing and Urban Affairs (MoHUA), formerly known as 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 city wide 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 O&M of all sanitary facilities. Furthermore, it explicitly states that cities and states must issue policies and technical solutions that address on-site sanitation, including the safe confinement of FS (USAID, 2010). The objectives of NUSP are to be realized through CSPs and state sanitation strategies. NUSP identifies the constitution of the multi-stakeholder task force as one of the principal activities to be taken up to start the city sanitation planning process. As per the requirement of CSP, a major role is to be played by the members of institutions, organizations, individuals, NGOs, academics, media representatives, local councillors, industry owners, consultants, representatives of private sector, etc. Constitution of SBCLTF formerly known as City Sanitation Task Force (CSTF) is facilitated by drawing members from these groups in consensus with citizens who will be constantly supporting the CSP preparation by analyzing the strengths and competencies required to overcome the current situation and for better sanitation facilities (MoUD, 2014).

The advisory note on septage management in urban India, issued by MoHUA in 2013, recommends supplementing CSPs with a Septage Management Sub-Plan (SMP) be prepared and implemented by cities. Septage refers here broadly to not only faecal sludge removed from septic tanks but also that removed from pit latrines and similar on-site toilets. This advisory provides references to the Central Public Health and Environmental Engineering Organization (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 ULBs to plan and implement SMPs.

The Environment (Protection) Act, 1986 and the Water (Prevention and Control of Pollution) Act, 1974 have provisions relating to sanitation services and environmental regulations. It 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 and 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 and insanitary latrines - Laying strong emphasis on rehabilitation of manual scavengers. The broad objectives of the act are to eliminate insanitary latrines, prohibit the employment of manual scavengers and the hazardous manual cleaning of sewer and septic tanks, and to maintain a survey of manual scavengers and their rehabilitation (MoSJE, 2014).

In February 2017, MoHUA issued the National Policy on Faecal Sludge and Septage Management (FSSM). The policy aims to set the context, priorities, and direction for, and to facilitate, nationwide implementation

of FSSM services in all ULBs such that safe and sustainable sanitation becomes a reality for all in each and every household, street, town and city in India (MoUD, 2017).

The Fourteenth Finance Commission (FC-XIV) was constituted by the President of India under Article 280 of the Constitution on 2 January 2013 to make recommendations for the period 2015-20. Its assignments include distribution of revenue between union and state; devising formula for grant; suggesting method to augment resources for local bodies; and taking care of any matter referred to it (NIUA, 2015).

Model Municipal Building Bye-laws 2016 prepared by Town and Country Planning Organization (TCPO). Building Byelaws 2016 is used to regulate coverage, height, building bulk, and architectural design and construction aspects of buildings so as to achieve orderly development of an area. They are mandatory in nature and serve to protect buildings against fire, earthquake, noise, structural failures and other hazards. It includes chapters on green buildings and sustainability provisions, rainwater harvesting, wastewater (WW) reuse and recycle, installation of solar roof top photo voltaic norms, revised norms for adequate toilet facilities for women and public conveniences in public buildings and mandatory provisions for segregated toilet facilities for visitors in public buildings (TCPO, 2016).

In February 2017, MoHUA issued the National Policy on faecal sludge and Septage Management (FSSM). The policy aims to set the context, priorities, and direction for, and to facilitate, nationwide implementation of FSSM services in all ULBs such that safe and sustainable sanitation becomes a reality for all in each and every household, street, town and city in India (MoUD, 2017).

The Fourteenth Finance Commission (FC-XIV) was constituted by the President of India under Article 280 of the Constitution on 2 January 2013 to make recommendations for the period 2015-20. Its assignments include distribution of revenue between union and state; devising formula for grant; suggesting method to augment resources for local bodies; and taking care of any matter referred to it (NIUA, 2015).

Model Municipal Building Bye-laws 2016 prepared by Town and Country Planning Organization (TCPO). Building Byelaws 2016 is used to regulate coverage, height, building bulk, and architectural design and construction aspects of buildings so as to achieve orderly development of an area. They are mandatory in nature and serve to protect buildings against fire, earthquake, noise, structural failures and other hazards. It includes chapters on green buildings and sustainability provisions, rainwater harvesting, wastewater (ww) reuse and recycle, installation of solar roof top photo voltaic norms, revised norms for adequate toilet facilities for women and public conveniences in public buildings and mandatory provisions for segregated toilet facilities for visitors in public buildings (TCPO, 2016).

3.1.2 Policies, legislations and regulations at state and ULB level

Draft Urban Sanitation Strategy, 2010

The state has prepared a draft Urban Sanitation strategy (USS) which construes upon the overall framework of the NUSP. The objective of the strategy is to encourage cities to prevent open defecation, provide potable water in adequate quantity and safely manage WW thereby prioritizing sanitation and developing individual action plans suited to local conditions. The strategy aims at motivating the ULBs for planning, execution and operation and maintenance of all works related to water supply, sewerage, solid waste management and sanitation works; henceforth promoting a healthy competition amongst the ULBs by awarding the best performing ULBs. The USS promotes water management in ULBs with ensuring effective disposal of WW generated from all toilets by aiming for 100% sewerage system with the treatment of sludge before disposal. The state intends to consolidate all plans under the CSP.

Bihar Municipal Act, 2007
The Bihar Municipal Act frames the responsibilities of the ULBs in the state of Bihar towards sanitation, but there is no specific responsibility towards the management of onsite sanitation system.

Bihar Building Bye-laws, 2014
The Bihar municipal Act, 2007 and section – 81 (2)(w) of the Bihar Urban Planning and Development Act, 2012, the Government of Bihar notified the Bihar Building Bye-Laws 2014, which is enforced to all the municipal areas of the state. As per the bye-laws, the building plan will only be approved if the plan includes a septic tank in the design. If anyone is found to have approved building plan in deviation of building bye-laws shall be liable to be prosecuted and shall be liable to pay fine of Rupees fifty thousand or sentence to imprisonment for a period which may extend to one year or both (BBBL, 2014).

The 5th State Finance Commission of Bihar is a committee pertaining to the state of Bihar, established with a purpose of reviewing the financial implementations of the state. It is constituted by the State Government under clause (1) of Article 243-1 and clause (1) of Article 243-Y of the Constitution of India, along with the provisions of the Bihar Panchayat Raj Amendment Act, 2011 (SFCB, 2014).

3.1.3 Institutional roles

The MoHUA 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. 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 norm setting 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 ULBs. This transfer has resulted in a variety of implementation models, as well as a lack of clarity in roles and responsibilities of state and local agencies, resulting in large gaps in implementation (USAID, 2010).

Management and delivery of urban basic services in Muzaffarpur is governed by various institutions. The institutions responsible for policy making, service provision and regulation of urban services are summarized in Table 7.

3.1.4 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 (ULBs) is in charge of operation and maintenance (O&M) (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 even subsidize operating costs (Planning commission, 2002).

Table 7: Roles and responsibilities

Institution	Roles and responsibilities
Public Health and Engineering Department (PHED)	Ensuring access to safe water; supply of drinking water to rural areas and development of sanitation facilities; constant monitoring of quality of drinking water supply; ensuring participation of communities in schemes involving drinking water supply and sanitation; reforming water supply and sanitation sector.
Urban Development and Housing Department (UD&HD)	Implementation of schemes supported by the centre and state government respectively, such as the National Mission for Clean Ganga and *Saat Nischay Yojna*.
Reform Support Unit (RSU)	Execute/implement the projects supported by DFID-SWASTH in the state of Bihar. Till now Schemes of 82 crores (820 million) has been taken up under financial aid plan of DFID-SWASTH programme to assist PHED in the field of Water supply and Sanitation
Bihar Pollution Control Board (BPCB)	• Planning programme for prevention and control of pollution in the state • Laying down standards of treatment of sewage and trade effluents • Evolving methods of disposal, utilisation of sewage and trade effluents on land and agriculture • Inspection of treatment plant • Conduction and participation in Research and Development relating to water pollution
Water Resource Department (WDR)	Administrative control of all four Command Area Development Agencies via Sone, Kosi, Gandak and Kiul-Badua-Chandan command area agencies have been brought under WRD to provide the optimum benefit of the major and medium irrigation projects to the beneficiaries' committees. Development of drainage systems falls under its 10 multi-dimensional functions.
Muzaffarpur Municipal Corporation (MMC)	Overall management of the civic services in the city. Public sanitation, solid waste management, public health and education

Source: (CSE, 2016)

3.1.4 Service provision

Furthermore, when no separate utility exists, there is no separate allocation 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).

The MMC is solely responsible for public health, sanitation, conservancy, solid waste management, construction of individual, CT, PT and faecal sludge management (FSM). However, emptying and treatment service is also provided by private emptiers.

3.1.5 Service standards

1. Service Level Benchmarks (SLB), 2008: Issued by the MoUD 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.
   III. Set out guidelines on how to operationalize this framework in a phased manner. The 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 -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. General standards are notified with respect to parameters for safe discharge to inland surface water/public sewers/land for irrigation/ marine coastal areas.
3. Code of Practice for Installation of Septic Tanks, 1985: Issued by BIS. It is a national standard setting body of India. The code specifies standards and design consideration for installation of septic tanks.
4. Manual on Sewerage and Sewage Treatment, Second Edition, 2013: This manual has been developed by CPHEEO. It provides detailed design and guidelines for various technologies of WW management.

3.2 Planning

3.2.1 Service targets

State governments must put in place targets for delivery of essential services provided by the local bodies for four services viz., water supply, sewerage, solid waste management and storm water drains on lines of handbook for SLB by MoUD. State government must notify or cause all ULBs to notify by the end of a fiscal year the service standards and targets (PAS, 2009-16).

The SBM, one of the flagship programmes of the government of India, launched on October 2nd, 2014 by the MoHUA. SBM-Urban aims to eliminate open defecation (OD) by the year 2019, eradicate manual scavenging, capacity augmentation of ULBs and generate awareness about sanitation and its linkage with public health. The SBM (urban) aims to ensure that no new insanitary toilets are constructed during the mission period and that pit latrine should be converted into sanitary latrines. The target group for construction of household units of toilets thus is (i) 80% of urban households engaging in (OD), remaining 20% of households practicing (OD) are assumed to be catered by community toilets due to constraints of space (ii) all households with insanitary latrines (iii) all households with single-pit latrines (MoUD, 2014). Target is to construct 15,176 nos. of individual household toilets (IHHT) in city with containment (SBM, 2017).

The state government has decided to prepare Master Plans for all important cities in the state. The city has prepared Master Plan vision 2027 following the approach to create balance between the natural, economic and social environment, responsive use of natural resources and sensitive areas, protection of cultural heritage and also address the safety and security concerns of the citizens. The plan gives strong proposals for sewerage network for black and grey water management. It is proposed to design and undertake the sewerage works for a period of at least 30 years. An estimation of 132 MLD of WW to be treated by Sewage Treatment Plant (STP) (MMC, 2009).

The objective of sewerage master plan for Muzaffarpur city is 100% network coverage and treatment at STP for the ultimate design year 2037 with the base year being 2017 and midyear 2027. The project also promises to construct 137.17 km of drainage network throughout the city (MMA, 2012). Muzaffarpur city also falls under Smart city scheme of GoI. Goal 3 of the scheme states that every household will be connected to a functional sanitation system (MoUD, 2015).

Table 8: Service delivery targets in accordance with SLBs

Sanitation service chain	Parameter	National benchmark	Timeframe to achieve benchmark
Containment	Coverage of toilets	100%	2019
Transport	Coverage of sewer network services	100%	2031
	Collection efficiency of the sewerage network	100%	2031
Treatment	Adequacy of sewage treatment capacity	100%	2031
	Quality of sewage treatment	100%	2031
End-use/disposal	Reuse and recycling	20%	2031
Other	Cost recovery	100%	2031
	Efficiency of collection of charges	100%	2031
	Redressal of customer complaints	80%	2031

Source: Adapted from (MoUD, 2008), (MoUD, 2010)

According to rapid assessment of FSM in city done by MMC, they would need 34 emptying trucks, which will improve the emptying services provided by them. Each vehicle is expected to complete 2 trips per day with an average distance of round trip being 28 km. Along with the emptying trucks, the MMC also needs 2 or more FSTPs in the municipal area, which are expected to treat 314 cum/day of septage, initially and 347 cum/day after a period of 5 years (MoUD, 2016).

3.2.2 Investments

Muzaffarpur city falls under various schemes and programmes of state and national government. This has made funding available for more than a half a dozen programmes. Table 10 shows the investments under national and state government schemes.

Table 9: Status of CAPEX and OPEX for FSSM

S.no	Component	CAPEX (INR in lakhs)	OPEX (INR in lakhs)	TOTAL (INR in lakhs)
1	Faecal Sludge Management	5,854.14 (8.7 million USD)	5,583.73 (8.3 million USD)	11,437,87 (17.1 million USD)
2	Liquid Waste Management	1,514.15 (2.2 million USD)	1,514.06 (2.2 million USD)	14,199.21 (4.4 million USD)
3	FSSM Total	18,539.29 (28 million USD)	7,097.79 (10.75 million USD)	25,637.09 (38.5 million USD)

Source: MoUD, 2016

Table 10: Investment for sanitation services

S.no	Programme	Fund allocated for	Total fund			Remarks
			Status	Amount (INR)	Year	
1	SBM	Community toilet (4)	Sanctioned	3.87 lakhs (5819 USD)	2015-16	--
2		Individual HH toilet (15176)	Fund allocated	6 Crores (0.9 million USD)	2017	6 Cr. for all projects under SBM. It only talks about the construction of toilets.
3	AMRUT	Parks renovation	Sanctioned	5 Crores (0.75 million USD)	2015-16	The said amount expected for Muzaffarpur, mainly for Parks renovation
4	Saat Nischay	Drainage channels	Sanctioned	6 Crores (0.9 million USD)	2016-17	Total project cost is 65 crore for all the 7 sectors for FY 2016-17. 2 crores sanctioned for roads, drains and other development works. 7 crore sanctioned for the renovation of roads, drains, street, parks, ghats etc.
5	PMAY	Construction of 610 dwelling units for urban poor in first phase	Sanctioned	---		1st phase for the in-situ up-gradation of slums. Work order was given for 1st phase. DPR for 1300 HHs in 2nd phase submitted, funds likely to be released in FY 2016-17
6	DFID for Urban Reforms (SPUR)	Basic infrastructure, road, drain, Community Hall, Individual Toilets, Lighting etc.	Sanctioned	2 Crores (0.3 million USD)	FY 2014-15 and 2015-16	In-situ slum up gradation: Surveys have been completed for all slums and DPRs prepared to develop basic infrastructure,
7	SMP	STPs	Proposed	6.3 Crores (0.94 million USD)	2016-17	Target to implement in year 2037. The project is cancelled and no further work will be done
8	National thermal power corporation	Water management	Sanctioned	7 Crores (1 million USD)	2016-17	District administration is the monitoring body whereas the implementation is from MMC
10	MMC budget	Sewerage system and FSTP	Proposed and approved in MMC budget	130 Crores (19.5 million USD)	2017-18	--

Source: (MOUD, 2015) (UD&HD, 2017) (MMC, 2009)

3.3 Reducing inequity

3.3.1 *Current choice of services for the urban poor*

There are a total of 137 slum pockets within the city with a population of 77,456 (MMC, 2016). A fair number of slum dwellers own the facility of the individual household toilet. Most (approx. 70%) of the toilets are built under the SBM scheme which provides single toilet unit with containment system (MoUD, 2017). During sample survey, it was noted that the slum dwellers do not use toilets built under SBM due to fear of frequent emptying of the containment system. Pits constructed under SBM in urban poor settlements measures 0.9

m deep and 0.9 m diameter, this size is small as compared to pits in other cities of India. This pushes the residents to practice OD on railway tracks or any other open spaces. Death of people in accidents on railway tracks during OD is also reported. (SIC, 2017).

Figure 9: Toilets constructed under SBM connected to pit in slum (Source: Anil/CSE, 2016)

CTs are functional in slums but lack basic facilities such as water, electricity, physical infrastructure etc. The containment of CT was found to be dilapidated and there are negligible operation and maintenance of these CTs built by the MMC (FGD, 2016).

A well-functioning CT was seen during the sample survey in urban poor settlement of ward 40. The CT has 11 seats connected to septic tank with outlet connected to an open drain (refer figure 10).

Figure 10: CT in Purani Gudri area of ward 40 (Source: Anil/CSE, 2016)

3.3.2 Plans and measures to reduce inequity

Schemes of the central and state government like SBM, Pradhan Mantri Awas Yojna (PMAY)/Housing for All (HFA) and *Saat Nischay* (7 resolves) also provide basic services to the urban poor. SBM urban aims to eradicate OD before 2019, provides a grant of 12000 INR (181.81 USD) per HHs for construction of individual toilet with containment system. It also aims to construct community toilets primarily in low income and/or informal settlement where land is a constraint for construction of IHHT.

PMAY/HFA (Urban) project is aimed at urban areas with following components: (i) Slum rehabilitation of slum dwellers with participation of private developers using land as a resource; (ii) Promotion of affordable housing

for weaker section through credit linked subsidy; (iii) Affordable housing in partnership with public and private sectors; and (iv) Subsidy for beneficiary-led individual house construction or enhancement.

PMAY/ HFA aims to construct 610 HHs in 1st phase for the in-situ up gradation of slums. The houses will be equipped with the facility of an individual toilet with containment system (MoUD, 2015).

All houses built or expanded under the mission should essentially have toilets facility. The mission has provision of civic infrastructure as per applicable state norms/CPHEEO norms/BIS code/NBC for connection sewer, if existing or has to be made through convergence of other national or state schemes (MHUPA, 2016).

Figure 11: Community toilets in slums (Amrita/CSE, 2016)

3.4 Outputs

3.4.1 Capacity to meet service needs, demands and targets

Municipal expenditures in India account for 1.1% of the country's GDP, compared to 6.9% in South Africa and 9.7% in Switzerland. ULBs therefore rely mainly on national or state grants (AFD, 2014). In the context of MMC, the major source of income (both revenue and capital) is through grants from Finance Commission and the remaining is generated through taxes and user charges.

Though there is handsome amount of funding available from Central and State government under schemes like SBM, AMRUT, *Saat Nischay* and Smart City. The municipal corporation suffers the problem of quality and quantity of manpower.

3.4.2 Monitoring and reporting access to services

Data on service levels should be collected, documented and reported to MoUD according to the format prescribed by SLB framework.

The progress of toilet coverage gets reflected in SBM-Urban dashboard on the website. Of 4,041+ municipalities in 650+ districts, 3,802 ULBs are active. 75 million plus cities are being monitored separately.

The city manager informed that a decent database of all the septage emptying services is there in records. Door to door socio economic HH survey conducted under the *Saat Nischay Yojna* has the entire required sanitation related database in detail. This data can be used for future planning on the identified interventions. Updated and detailed GIS database is developed for spatial planning and management of services.

Before construction of the house, people are supposed to get their house plan approved by MMC, and the plan should include a well-designed septic tank connected to soak pit. Still, 43% of households have constructed rudimentary tanks that are open from the bottom. This indicates the lack of capacity at MMC to do a proper inspection of containment systems during construction of houses.

3.5 Expansion

In 2016, MoUD initiated a rapid assessment of 131 flagship cities to estimate the budgetary requirement for implementing Faecal Sludge and Septage Management (FSSM) in selected cities across the country, supported by the National Alliance for Faecal Sludge and Septage Management (NFSSM). The flagship cities include 100 smart cities, 12 cities in Ganga basin and others across India. A declaration was signed for cities journey beyond Open Defecation Free (ODF) - mainstreaming effective FSSM by key decision makers and NFSSM alliance members.

AMRUT, a mission to provide basic services (e.g. water supply, sewerage, urban transport) to households and build amenities in cities to improve the quality of life for all. The cities are required to submit Service Level Improvement Plan (SLIP) documents (includes details on funding of specified projects by ULB) to the state. The state will then prepare State Annual Action Plan (SAAP) document compiling all the details given in SLIPs. SAAP will then be forwarded to the MoUD for sanction of funds. It has been decided to divide the projects into two phases. The Mission also has a capacity building and reforms component that is designed to bring in improvements in service delivery, mobilization of resources.

Saat Nischay Yojna (Seven resolves)
The Bihar state govt. scheme '*Saat Nishchay*' (seven resolves) initiated in 2015 aims for the social economic development of urban areas. This scheme offers development in seven sectors, three of the 7 resolves includes construction of drainage, toilets in all houses for ODF state till 2019 and providing clean piped water drinking supply within 5 years. The target is to construct a total of 7,667 toilets of which 746 units are completed (UD&HD, 2016).

The main objective of the scheme is to strengthen the state's infrastructure and to improve socio economic status. To execute this mission a special team has been set up by the state government. The team includes experts from all the sectors and they will work over this mission in Bihar. (PDD, 2017). The 7 resolves are road connectivity and storm water drainage system, continuous electricity, clean drinking water and sanitation, toilet in every home, youth employment and skill development, better access to higher education, women empowerment through reservation.

Objectives under *Shauchalay Nirmaan, Ghar Ka Sammaan* (toilet in every home) is to make Bihar healthy, hygienic and free from OD where each household would be equipped with a toilet. Almost 1.72 lakh toilets would be constructed under this scheme. Whereas in *Ghar Tak Pakki Gali–Naaliyan* (road connectivity and storm water drainage system) the objective is to make paved roads. This would also be accompanied by constructing lined drainage networks in each habitation. Fund allocated for this sector is INR 78 crores (170 thousand USD) (CMO, 2017). The mission targets to achieve the goals by 2019.

3.5.1 Stimulating demand for services

It is recognized that the end objectives and corresponding benefits of SBM & NMCG cannot be achieved without proper management of faecal sludge and septage across the sanitation service chain. Further, it is well understood that sewerage coverage will not meet the complete sanitation needs in all areas, and a strategy which is a combination of OSS and off-site (decentralized and centralized) must co-exist in all cities and must be given equal attention. However, the current policies are not explicit enough and also do not provide an outcome-focused direction on this issue (MoUD, 2017).

The following activities can stimulate demand for services:

- Awareness generation on septic tank construction, regular desludging of septic tanks through awareness campaigns
- Capacity building for ULB staff on septage management
- Awareness campaigns on ill effects of environmental degradation because of disposal of untreated septage into the local environment.
- Skill development of local masons and plumbers
- Monitoring and regulation of private emptiers

3.5.2 Strengthening service provider roles

Funding is estimated for septage management initiatives under rapid assessment for FSSM supported by the MoHUA, GoI through NFSSM. These funds can be used to buy vacuum tankers, building treatment facility, etc. MMC has to make use of these funds to strengthen the services.

Emptying services are provided by ULB and private players. There are 2 private operators plying in the city. These emptiers can be given license to make emptying a legal service. The only two public vacuum tankers are not sufficient to cater demands of emptying service for the city as these vacuum tankers are also engaged in the emptying of clogged drains. The private emptiers can be used as a helping hand to cater demand. It was witnessed that the workers were lacking professionalism for their job. Personal protective equipments (PPE) could be provided to avoid contact with pathogens and training should be given to the emptiers.

SBM majorly provides funds for access to toilets but thereafter lacks funds for treatment and disposal of sewage and FS throughout the service chain. The service delivery of sewage and FS treatment and disposal can be met through converging the national flagship programmes – SBM and AMRUT. The ULB can take the benefit of the programmes and strengthen the services along the value chain and achieve the goals of both programmes.

4 Stakeholder engagement

4.1 Key informant interviews

The KIIs were conducted with the stakeholders having a role or interest in sanitation and FSM services within the city. The relevant departments were contacted through e-mail, letter, call and fax prior to visit to the concerned departments. The purpose of the SFD study and depth of data required was conveyed through an introductory letter to respective departments. A total of 8 KIIs were conducted with members of MMC, septic tank emptiers, shopkeepers, slum dwellers, local masons, PT owners, local residents of the city. Apart from KIIs, survey was also conducted, which included interviews with a representative from NGOs, institutions and other commercial establishments. Indeterminate information was available prior to the field-based research about the type of containment, emptying service, transportation and disposal of sewage generated by the city. The visit enabled in enhancing data collection through gathering progress details of SBM and data collected in 7(*Saat) Nishchay* survey. Interview with the private emptiers and other stakeholders provided additional insight into the service delivery context.

4.2 Field observations

In order to understand the variety/typology of OSS, random surveys were conducted. The city has no underground drainage network at present. During KII with shopkeeper at the whole sale market of *Suda Patti,* he informed that sewerage network does exist in this part of the city but is not functional at present. Near about 90% of the population have tanks as containment systems but almost half of these have collapsed. The urban poor has built the facility of toilets under the national/state scheme. These toilets have pit systems as containment. It was observed during site visits that these toilets are not in use by the residents. The reason for not using the toilets is the fear of frequent desludging as the pits are only 0.9 m in depth. Institutional and commercial areas have septic tanks connected to open drains within the premises. PTs are also present in commercial areas and were found to be in good condition and hygienic.

Emptying services are given by both public and private players. There is only one small scale private treatment facility present in the city that treats FS and converts it into manure. The owner of the treatment facility showed interest to treat the entire septage of the city if truck loads are delivered to his facility. WW and SN transported through drains, gets collected in low lying areas within the city and overflows in River *Burhi Gandak* (a tributary of River Ganga) located north of the city or *Furdoo* nullah in the south that connects to River *kubra Gaon.*

Many drains do not have an outlet, there are others which are choked with solid waste and are always in need of emptying, that is provided by the FS emptying vacuum tankers. WW overflowing from drains can be seen at many places. The river receives most of the WW generated in the city. During monsoon, the situation gets much worse as the WW flows out of drains which create flooding on main roads and access roads. Many of the slum dwellers still have no access to toilet facilities. The absence of drainage channels in slums results in clogging of WW causing serious risk to health. Poor management of WW causes foul smell which often becomes reason and subject of argument within the neighborhood.

There were still many cases found where no actions were taken even after submission of application for building toilet a year ago. It was noted that there is lack of knowledge among the slum dwellers when it comes to avail the benefit of state and central schemes like SBM. Application process seems complex to them and complaints are not looked after in city corporation office even after submission of forms.

4.3 Focus group discussions

The FGDs were conducted to complement, validate and challenge data collected during literature review and interviews. A total of 4 FGDs were conducted with members of the municipal corporation, local NGO Participatory Research in Asia (PRIA) working closely with slums, IT department of the corporation. The questionnaires for FGDs were prepared in English, but the interviewer asked the questions, translating in Hindi language.

The findings from the FGD sessions revealed information that increased the understanding of the sanitation and septage management in the city. FGDs were useful in data triangulation. The primary survey helped in validating secondary data and data provided by different stakeholders. It resulted in actual and true SFD of the city.

Stakeholders were identified and task force was formulated and notified under the mandate by NUSP (refer appendix 7.8 for more details). An FGD was conducted with the SBCLTF's members and the draft SFD was presented and analyzed. SBCLTF's members validated the collected data and the final SFD graphic (SBCLTF, 2017).

5 Acknowledgement

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 thank the entire team form MMC City Manager, Sanitary Inspector, *Bahalkhanna* Incharge for providing all the required secondary and primary data.

Special thanks to Mr Anil Kumar, Mr Biswas, Mr Rajeev Kumar, Mr Tripurari from PRIA, Bihar who are working in the urban slums, they helped us in arranging site visits. We also thank Ms Amrita Bhatnagar from CSE who assisted us throughout our visit to the city during data collection. Special thanks to Dr Suresh Kumar Rohilla, Programme Director, CSE, for his supervision and guidance at every step of the assessment and report writing.

6 References

- BBBL, 2014. Bihar Building Bye Laws 2014. Government of Bihar.
- BIS. 2005. National Building Codes. Bureau of Indian Standards, Government of India.
- BMB. 2007. The Bihar Municipal Bill, Government of Bihar.
- CGWB. 2013. Ground Water Information Booklet, Muzaffarpur District, Bihar State. Muzaffarpur.
- CMS. 2016. Viksit Bihar ke Saat Nischay. [online]. [Accessed 17 Mar 2017]. Available from World Wide Web: <http://cmbihar.in/users/home.aspx#>
- CSE. 2011. Policy Paper on Septage Management in India. New Delhi: Centre For Science and Environment (CSE).
- MMA. 2012. Draft Report for Sewerage Management Plant for Muzaffarpur city, Bihar. Muzaffarpur.
- MMC. 2016. FGD with Muzaffarpur Municipal Corporation functionaries. Muzaffarpur.
- MMC. 2016. FGD with SBSLTF of Muzaffarpur Municipal Corporation. Muzaffarpur.
- MMC. 2016. KII with Sanitary Inspector of MMC. Muzaffarpur.
- MMC. 2009. MASTER PLAN VISION 2027. Muzaffarpur.
- MoSJE. 2014. The Prohibition of Employment as Manual Scavengers and their Rehabilitation Act, 2013 [18th September, 2013]. Ministry of Social Justice and Empowerment, GoI.MoUD. 2013. Advisory Note: Septage Management in Urban India. New Delhi: Government of India.
- MoUD. 2013. Septage Management in Urban India. Ministry of Urban Development, Government of India.
- MOUD. 2014. Guidlines for Swachh Bharat Mission. Ministry of Urban Development, Government of India.
- MoUD. 2015. India smart city mission. Muzaffarpur.
- MoUD. 2016. Rapid Financial Estimate for FSSM Infrastructure for the city of Ramnagar. Ministy of Urban Development, Government of Inida.
- MoUD. 2017. Natioanl Policy on Faecal Sludge and Septage Management.
- NIUA. 2005. Status of Water Supply, Sanitation And Solid Waste Management in Urban Areas. New Delhi: National Institute of Urban Affairs (NIUA).
- NIUA. 2015. Report of The Fourteenth Finance Commission (2015-2020). [online]. [Accessed 19 January 2017]. Available from World Wide Web: <https://smartnet.niua.org/content/1aa83088-04ef-4e97-be11-9d4d93abc210>
- PDD. 2017. Planning and Development Department. All central government schemes. [online]. [Accessed 16 March 2017]. Available from World Wide Web: <http://www.pradhanmantriyojana.co.in/nitish-kumar-seven-resolves-saat-nischay-bihar/>
- Planning commission. 2002. India Assessment 2002 – Water supply and Sanitation.
- PRIA. 2016. FGD with employees of PRIA NGO. Muzaffarpur.
- Private Enterprises. 2017. Interview with owner of private fertilizer company for FS treatment. SS Trust. January. 2017.
- Government of India.SINCHAI BHAWAN, Patna. Major Functions Of The Department. [online]. [Accessed 3 March 2017]. Available from World Wide Web: <http://wrd.bih.nic.in/>
- TCPO. 2016. Model Building Bye-Laws. Town and Country Planning Organisation, Ministry of Urban Development, Government of India.
- UD&HD. 2010. City Development Plan (2010-30). Muzaffarpur.
- UD&HD. 2016. Sauchalaya nirmaan, ghar ka samman (Toilet in all houses scheme). Patna.
- UD&HD. 2017. KII with ME officer. Urban Development and Housing Department, Patna.
- UD&HD. 2017. About Muzaffarpur City. [online]. [Accessed 11 Mar 2017]. Available from World Wide Web: <http://muzaffarpur.biharurban.in/Content/356/529>
- USAID. 2010. A Rapid Assessment of Septage management in Asia: Policies and Practices in India, Indonesia, Malaysia, the Philippines, Sri Lanka, Thailand and Vietnam. Bangkok: United States Agency for International Development (USAID).

7 Appendix

7.1 Stakeholder identification

Table 11: Stakeholder identification

S.L No.	Stakeholder group	In context of Muzaffarpur
1	City Council/ Municipal authority/Utility	Muzaffarpur Municipal Corporation
2	Ministry in charge of urban sanitation and sewerage	Urban Development and Housing Department, Bihar
3	Ministry in charge of urban solid waste	
4.	Ministries in charge of urban planning finance and economic development	
5	Ministries in charge of environment protection	Department of Environment and Forest
6	Ministries in charge of health	Department of Health
7	Service provider for construction of onsite sanitation technologies	Muzaffarpur Municipal Corporation
8	Service provider for emptying and transport of faecal sludge	
9	Service provider for operation and maintenance of treatment infrastructure	
10	Market participants practising end-use of faecal sludge end products	N/A
11	Service provider for disposal of faecal sludge (sanitary landfill management)	Muzaffarpur Municipal Corporation
12	External agencies associated with FSM services: eg: NGOs, academic institutions, donors	CSE

Source: CSE, 2017

7.2 Tracking of engagement

Table 12: Tracking of engagement

S.no	Name of Organization	Designation	Date of Engagement	Purpose of engagement
1	Muzaffarpur Municipal Corporation	City Manager	06-10-16	FGD
2		Mechanical Engineer	06-10-16	
3		Senior Tax officer	06-10-16	
4		Assistant	07-10-16	
5	Participatory Research in Asia (PRIA)	Animator	07-10-16	FGD
6		Animator	07-10-16	
7		Animator	07-10-16	
8		Animator	07-10-16	
9		Animator	07-10-16	
10		Animator	07-10-16	
11		Animator	07-10-16	

12	Local Market	Local shopkeeper	07-10-16	KII
13	Muzaffarpur Municipal Corporation	Bahalkhana In charge	08-10-16	
14		Sanitary Inspector	08-10-16	
15		Septic tank emptier (driver)	08-10-16	
16		Septic tank emptier (labor)	08-10-16	
17		Public toilet in charge	08-10-16	
18	Energy international Pvt. Ltd.	Public toilet in charge	08-10-16	
19	Slum improvement member (SIC formed by PRIA)	Slum improvement member	08-10-16	
20	Muzaffarpur Municipal Corporation	Clerk	08-10-16	FGD
21		Clerk	08-10-16	
22		Clerk	08-10-16	
23		Head clerk	08-10-16	
24	SBCLTF	Members	22-09-16	FGD
24	Private service provider	Owner	08-10-16	KII

Source: CSE, 2017

7.3 SFD graphic

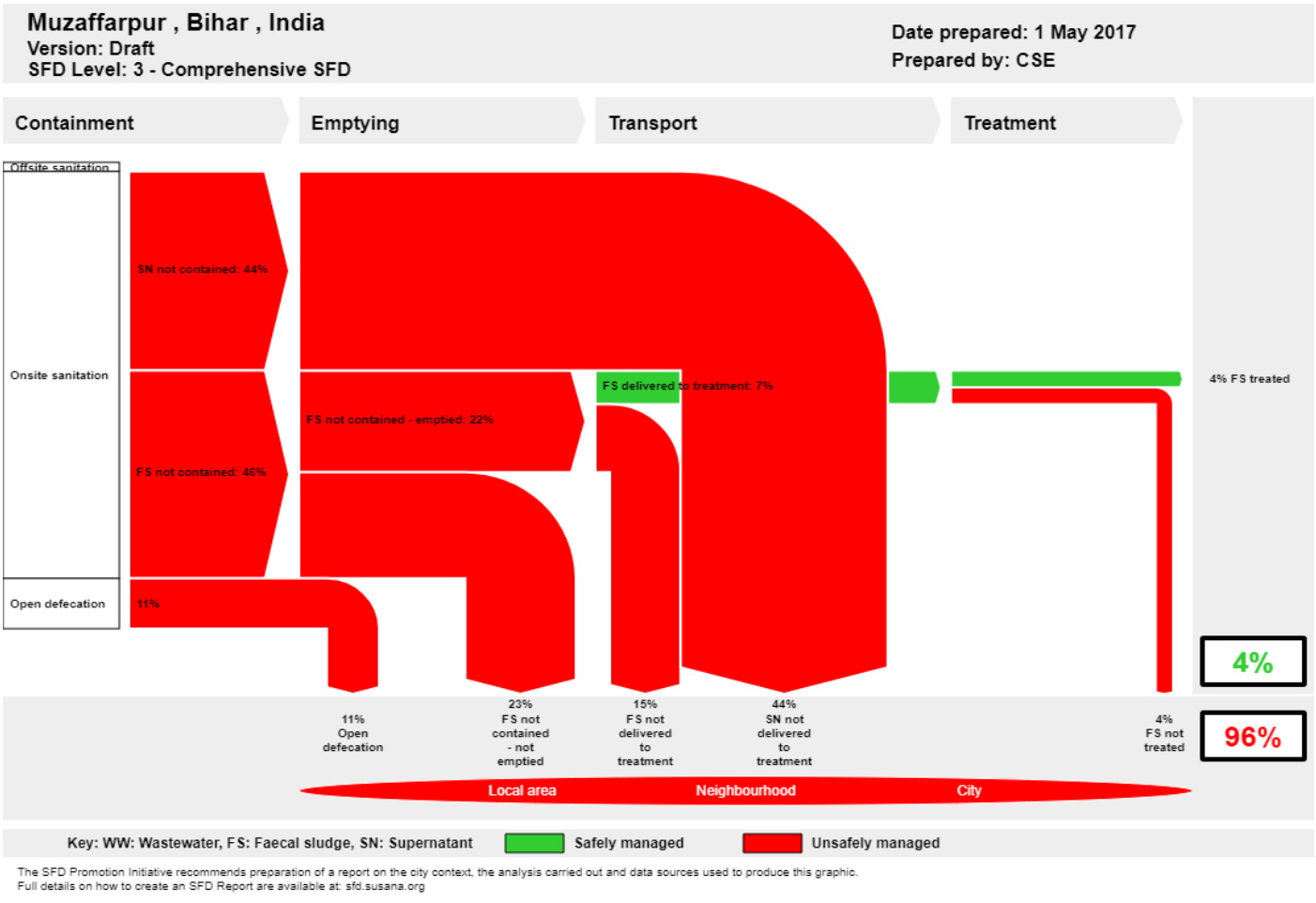


Figure 12: SFD graphic (Source: SFD graphic generator)

7.4 SFD brief explanation

Table 13: Percentage of the population using each system technology and method

System Type	Containment	Emptying	Transport	Treatment	End-use/ disposal
Offsite	The city does not have offsite system, only a few places there are shallow sewers that are not functional				
Onsite	T12A2C6: 44% of population is dependent on septic tank connected to open drain. T1A4C6: 43% of population is dependent on lined tank with impermeable walls and open bottom connected to open ground. T2A5C10: 2% of population is dependent on lined pit with semi-permeable walls and open bottom.	Since there is no clear differentiation between % of septage and supernatant, it is assumed to be 50% each. SN is estimated to be 44% and FS not contained comes out to be 46% From KIIs, FGDs and field surveys, it is estimated that 50% of the population is getting their systems emptied, hence 22% of FS gets emptied. 23% of the population don't get their systems emptied within 15 years and are hence assumed to be using their systems without emptying.	44% SN is conveyed through open drains into bigger nullah and eventually to Ganga River No treatment facility exists hence no FS is transported to treatment plant in case of emptying done by the government vehicles. The FS collected by private emptiers is transported to private treatment facility. FS delivered to treatment plant is calculated to be 7%.	No treatment facility exists if FS is collected by public vehicles. Therefore, FS discharged untreated is 15%. Out of 7% FS transported by private players treat 4% of FS gets treated.	All the FS emptied ends up in local area without any treatment if emptied by public players. The treated FS is converted to manure and sold to farmers at cost of Rs. 4 per kg.
OD	11% of population practice Open defecation.				

Source: CSE, 2016

7.5 Context-adapted SFD graphic

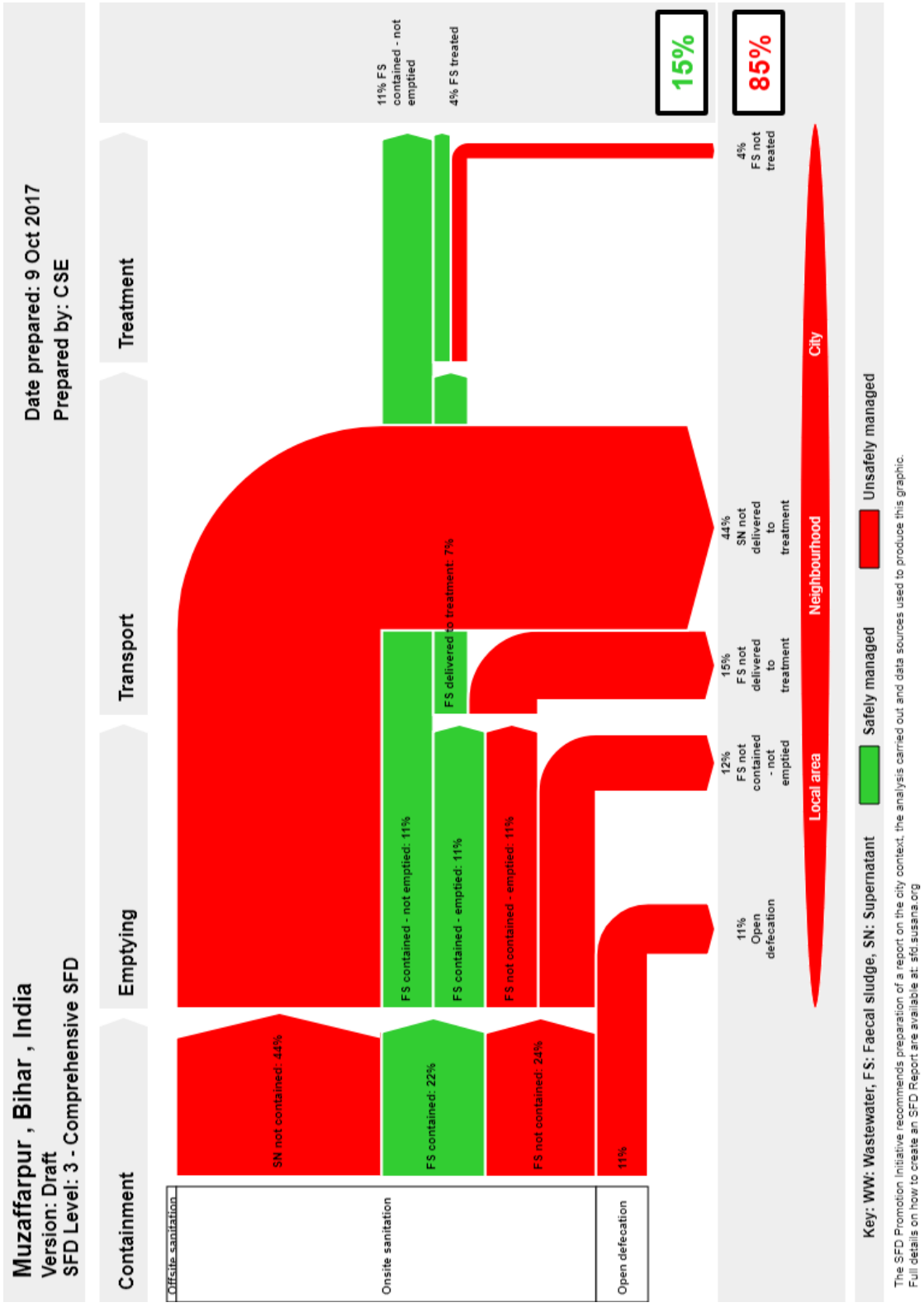


Figure 13: Context adapted SFD graphic (Source: CSE)

7.6 SFD selection grid

Table 14: Containment system selection grid

List A: Where does the toilet discharge to? (i.e. what type of containment technology, if any?)	List B: What is the containment technology connected to? (i.e. where does the outlet or overflow discharge to, if anything?)									
	to centralised combined sewer	to centralised foul/separate sewer	to decentralised combined sewer	to decentralised foul/separate sewer	to soakpit	to open drain or storm sewer	to water body	to open ground	to 'don't know where'	no outlet or overflow
No onsite container. Toilet discharges directly to destination given in List B					Significant risk of GW pollution Low risk of GW pollution					Not Applicable
Septic tank					Significant risk of GW pollution Low risk of GW pollution	T1A2C6				
Fully lined tank (sealed)					Significant risk of GW pollution Low risk of GW pollution					
Lined tank with impermeable walls and open bottom	Significant risk of GW pollution Low risk of GW pollution	Significant risk of GW pollution Low risk of GW pollution	Significant risk of GW pollution Low risk of GW pollution	Significant risk of GW pollution Low risk of GW pollution	Significant risk of GW pollution Low risk of GW pollution	T1A4C6				Significant risk of GW pollution Low risk of GW pollution
Lined pit with semi-permeable walls and open bottom	Not Applicable									T2A5C10 Low risk of GW pollution
Unlined pit										Significant risk of GW pollution Low risk of GW pollution
Pit (all types), never emptied but abandoned when full and covered with soil										Significant risk of GW pollution Low risk of GW pollution
Pit (all types), never emptied, abandoned when full but NOT adequately covered with soil										
Toilet failed, damaged, collapsed or flooded										
Containment (septic tank or tank or pit latrine) failed, damaged, collapsed or flooded										
No toilet. Open defecation	Not Applicable							T1B11 C7 TO C9		Not Applicable

7.7 SFD calculation grid

Table 15: SFD matrix

Muzaffarpur , Bihar , India, 1 May 2017. SFD Level: 3 - Comprehensive SFD
Population: 353878
Proportion of tanks: septic tanks: 50%, fully lined tanks: 50%, lined, open bottom tanks: 50%

System label	Pop	F3	F4	F5	S4e	S5e
System description	Proportion of population using this type of system	Proportion of this type of system from which faecal sludge is emptied	Proportion of faecal sludge emptied, which is delivered to treatment plants	Proportion of faecal sludge delivered to treatment plants, which is treated	Proportion of supernatant in open drain or storm sewer system, which is delivered to treatment plants	Proportion of supernatant in open drain or storm sewer system that is delivered to treatment plants, which is treated
T1A2C6 Septic tank connected to open drain or storm sewer	44.0	50.0	34.0	50.0	0.0	0.0
T1A4C6 Lined tank with impermeable walls and open bottom, connected to an open drain or storm sewer	43.0	50.0	34.0	50.0	0.0	0.0
T1B11 C7 TO C9 Open defecation	11.0					
T2A5C10 Lined pit with semi-permeable walls and open bottom, no outlet or overflow, where there is a 'significant risk' of groundwater pollution	2.0	50.0	0.0	0.0		

Source: SFD graphic generator, 2016

7.8 Maps

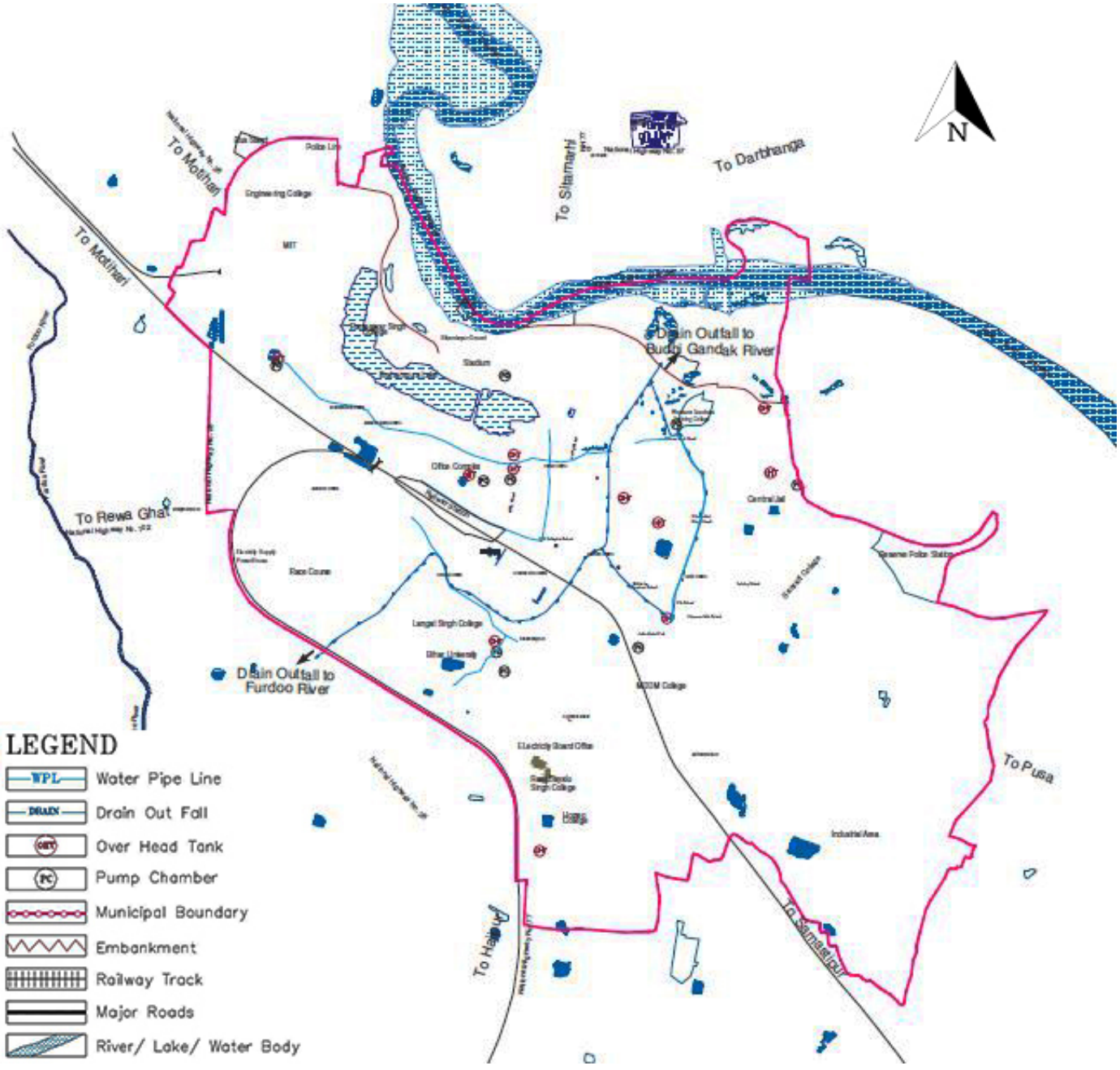


Figure 14: Drainage map of Muzaffarpur city (Source: MMC, 2009)

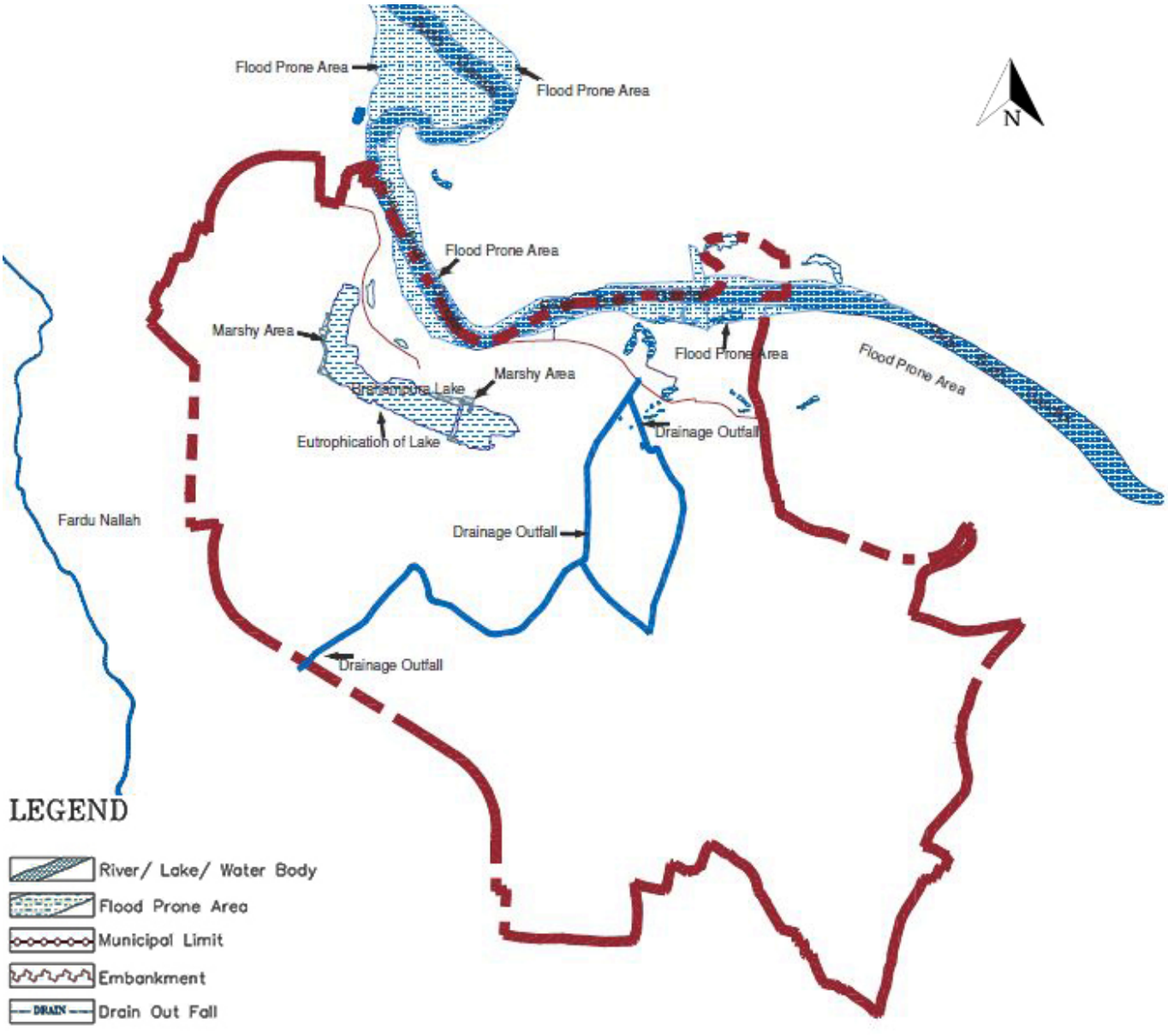


Figure 15: Environment sensitive areas map of Muzaffarpur city (Source: MMC, 2009)

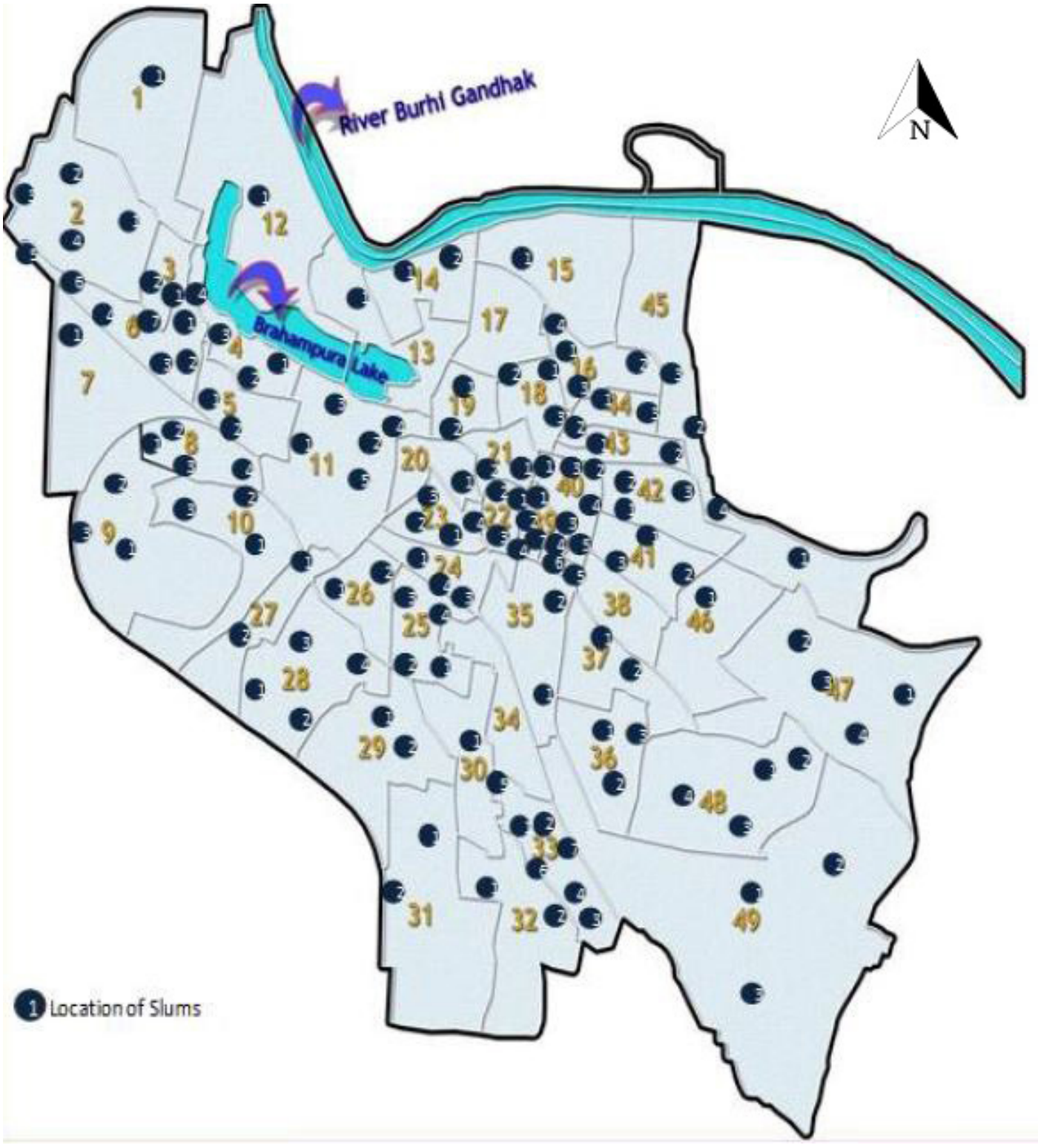
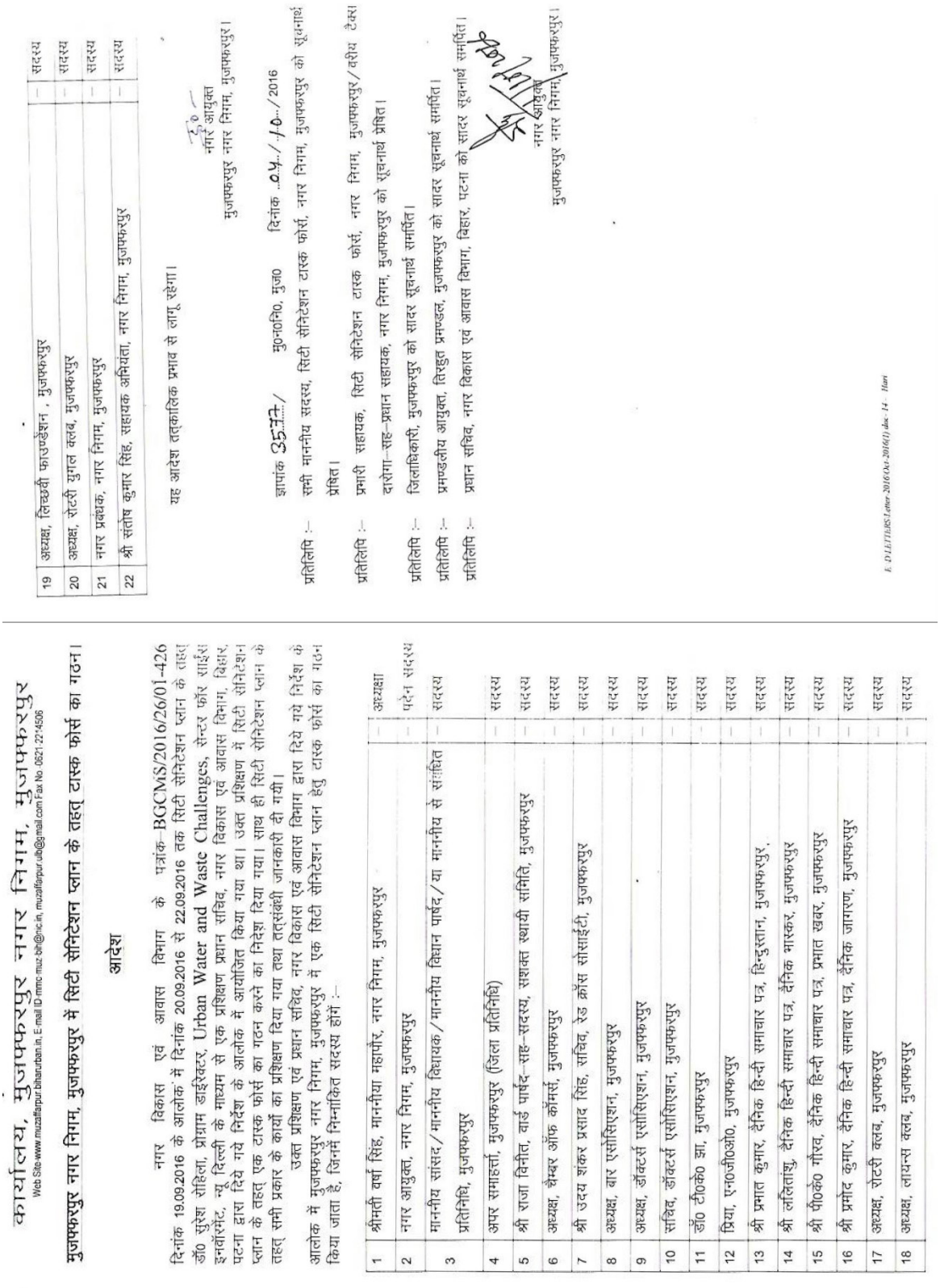


Figure 16: Slum pocket in Muzaffarpur city (Source: MMC, 2009)

7.9 Swachh Bharat City Level Task Force



कार्यालय, मुजफ्फरपुर नगर निगम, मुजफ्फरपुर
Web Site-www.muzaffarpur.bihardurban.in, E-mail ID-nmc-muz-bih@nic.in, muzaffarpur.ulb@gmail.com Fax No. 0621-2214506

मुजफ्फरपुर नगर निगम, मुजफ्फरपुर में सिटी सेनिटेशन प्लान के तहत् टास्क फोर्स का गठन।

आदेश

नगर विकास एवं आवास विभाग के पत्रांक-BGCMS/2016/26/01-426 दिनांक 19.09.2016 के आलोक में दिनांक 20.09.2016 से 22.09.2016 तक सिटी सेनिटेशन प्लान के तहत् डॉ0 सुरेश सोहिला, प्रोग्राम डाइरेक्टर, Urban Water and Waste Challenges, सेन्टर फॉर साईंस इनवॉरमेंट, न्यू दिल्ली के माध्यम से एक प्रशिक्षण प्रधान सचिव, नगर विकास एवं आवास विभाग, बिहार, पटना द्वारा दिये गये निर्देश के आलोक में आयोजित किया गया था। उक्त प्रशिक्षण में सिटी सेनिटेशन प्लान के तहत् एक टास्क फोर्स का गठन करने का निदेश दिया गया। साथ ही सिटी सेनिटेशन प्लान के तहत् सभी प्रकार के कार्यों का प्रशिक्षण दिया गया तथा तत्संबंधी जानकारी दी गयी।

उक्त प्रशिक्षण एवं प्रधान सचिव, नगर विकास एवं आवास विभाग द्वारा दिये गये निर्देश के आलोक में मुजफ्फरपुर नगर निगम, मुजफ्फरपुर में एक सिटी सेनिटेशन प्लान हेतु टास्क फोर्स का गठन किया जाता है, जिनमें निम्नांकित सदस्य होंगे :-

1	श्रीमती वर्षा सिंह, माननीया महापौर, नगर निगम, मुजफ्फरपुर	अध्यक्षा
2	नगर आयुक्त, नगर निगम, मुजफ्फरपुर	पदेन सदस्य
3	माननीय सांसद/माननीय विधायक/माननीय विधान पार्षद/या माननीय से संबंधित प्रतिनिधि, मुजफ्फरपुर	सदस्य
4	अपर समाहर्त्ता, मुजफ्फरपुर (जिला प्रतिनिधि)	सदस्य
5	श्री राजा बिनीत, वार्ड पार्षद-सह-सदस्य, सशक्त स्थायी समिति, मुजफ्फरपुर	सदस्य
6	अध्यक्ष, चैम्बर ऑफ कॉमर्स, मुजफ्फरपुर	सदस्य
7	श्री उदय शंकर प्रसाद सिंह, सचिव, रेड क्रॉस सोसाईटी, मुजफ्फरपुर	सदस्य
8	अध्यक्ष, बार एसोसिएशन, मुजफ्फरपुर	सदस्य
9	अध्यक्ष, डॉक्टर्स एसोसिएशन, मुजफ्फरपुर	सदस्य
10	सचिव, डॉक्टर्स एसोसिएशन, मुजफ्फरपुर	सदस्य
11	डॉ0 टी0के0 झा, मुजफ्फरपुर	सदस्य
12	प्रिया, एन0जी0ओ0, मुजफ्फरपुर	सदस्य
13	श्री प्रभात कुमार, दैनिक हिन्दी समाचार पत्र, हिन्दुस्तान, मुजफ्फरपुर,	सदस्य
14	श्री ललितांशु, दैनिक हिन्दी समाचार पत्र, दैनिक भास्कर, मुजफ्फरपुर	सदस्य
15	श्री पी0के0 गौरव, दैनिक हिन्दी समाचार पत्र, प्रभात खबर, मुजफ्फरपुर	सदस्य
16	श्री प्रमोद कुमार, दैनिक हिन्दी समाचार पत्र, दैनिक जागरण, मुजफ्फरपुर	सदस्य
17	अध्यक्ष, रोटरी क्लब, मुजफ्फरपुर	सदस्य
18	अध्यक्ष, लायन्स क्लब, मुजफ्फरपुर	सदस्य
19	अध्यक्ष, लिच्छवी फाउण्डेशन, मुजफ्फरपुर	सदस्य
20	अध्यक्ष, रोटरी युगल क्लब, मुजफ्फरपुर	सदस्य
21	नगर प्रबंधक, नगर निगम, मुजफ्फरपुर	सदस्य
22	श्री संतोष कुमार सिंह, सहायक अभियंता, नगर निगम, मुजफ्फरपुर	सदस्य

यह आदेश तत्कालिक प्रभाव से लागू रहेगा।

नगर आयुक्त
मुजफ्फरपुर नगर निगम, मुजफ्फरपुर।

ज्ञापांक 3577 /- मु0न0नि0, मु0प0 दिनांक 05 /10/2016

प्रतिलिपि :- सभी माननीय सदस्य, सिटी सेनिटेशन टास्क फोर्स, नगर निगम, मुजफ्फरपुर को सूचनार्थ प्रेषित।

प्रतिलिपि :- प्रभारी सहायक, सिटी सेनिटेशन टास्क फोर्स, नगर निगम, मुजफ्फरपुर/वरीय टैक्स दारोगा-सह-प्रधान सहायक, नगर निगम, मुजफ्फरपुर को सूचनार्थ प्रेषित।

प्रतिलिपि :- जिलाधिकारी, मुजफ्फरपुर को सादर सूचनार्थ समर्पित।

प्रतिलिपि :- प्रमण्डलीय आयुक्त, तिरहुत प्रमण्डल, मुजफ्फरपुर को सादर सूचनार्थ समर्पित।

प्रतिलिपि :- प्रधान सचिव, नगर विकास एवं आवास विभाग, बिहार, पटना को सादर सूचनार्थ समर्पित।

नगर आयुक्त
मुजफ्फरपुर नगर निगम, मुजफ्फरपुर।

E:\DATA\HRS\Letter 2016\Oct-2016\(1).doc - 14 - Hari

Figure 17: Official notification of meeting by MMC (Source: MMC, 2017)

Table 16: List of SBCLTF

S.No	Name	Designation	Organisation
1	Varsha Singh	Mayor	MMC
2	Ramesh Prasad Ranjan	Municipal Commissioner	
3		Member of legislative assembly	
4		Additional collector	District Representative
5	Raja Vineet Kumar	Member E.S.C	MMC
6	Purshotam Lal Poddar	Director	Chamber of Commerce Muzaffar-pur
7	Uday Shankar Prasad Singh	Sercetary	Red Cross Society
8		Director	Bar Association Muzaffarpur
9		Director	Dr. Association Muzaffarpur
10	Sachin		Dr. Association Muzaffarpur
11	D. K. Jha		Muzaffarpur
12		PRIA	N.G.O Muzaffarpur
13	Prabhat Kumar	Reporter	Hindustan Times, Muzaffarpur
14	Lalitanshu	Reporter	Danik Bhaskar, Muzaffarpur
15	P.K. Gaurav	Reporter	Prabhat Khabar, Muzaffarpur
16	Pramod Kumar	Reporter	Dainik Jagran, Muzaffarpur
17		Director	Rotary Club Muzaffarpur
18		Director	Lion Club Muzaffarpur
19		Director	Lichavchi Foundation Muzaffarpur
20		Director	Rotary Couple Club Muzaffarpur
21	Ravish Chandra Verma	City manager	MMC
22	Santosh Kumar Singh	Assistant Engineer	

Source: MMC, 2017

7.10 Photographs during field visit

Figure 18: FGD with MMC officials (Source: HT reporter, 2016)

Figure 19: FGDs in slums (Source: Anil/CSE, 2016)

Figure 20: FGD with 22 SBCLTF members at MMC (Source: Naveen/CSE, 2016)

Figure 21: KII with sanitary inspector and MMC emptiers (Source: Amrita/CSE, 2016)

Figure 22: KII with slum improvement committee member (Source: Bhitush/CSE, 2016)

Figure 23: Emptying of clogged storm water drain (Source: Anil/CSE, 2016)

Figure 24: Septic tank design on house plan and flooded street after rain in the city (Source: Anil/CSE, 2016)

7.11 Household survey questionnaire

CENTRE FOR SCIENCE AND ENVIRONMENT, NEW DELHI
Focus Group Discussion (FGD)
QUESTIONNAIRE

Date: ___/ ___ / ___, **Area Name:** _____, **Ward:**_____,

Co-ordinates:_____, **No. of Participants (4-10)** _____

Group Profile
No. of Male: No. of Female:

Respondents	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Gender										
Age										
Marital Status ((U/M)										
Household size										
Social category (G, OBC, SC, ST										
House Structure (P,K, SP)										
Latrine facility (IT, ST, CT, PT, ODF)										
IT: Individual Toilet, ST: Shared toilet, CT: Community Toilet, PT: Public Toilet, ODF: Open Defecation										
Who constructed toilet (SF, Govt.,Pvt.,NGO)										

Respondents	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Does the current state of toilet cause trouble (Y/N)? State reasons??										
Do all females use toilet (Y/N)?										
Do all males use toilet (Y/N)?										
Do all children use toilet (Y/N)?										
Types of toilet (ISP, Western)										
ISP: Indian Squatter Pan										
Kind of flushing (PF/CF)										
PF: Pour Flush, CF: Cistern Flush										
User interface connected to(S,ST,PL,OD, OG,LIC/O,LSC/ O)?										
S: Sewer, ST: Septic Tank, PL: Pit Latrine, OD: Open Drain, OG: Open Ground, LIC/O: Lined tank impermeable/Semipermeable walls with closed/open bottom,										
Details of the tank										
Circular/rectangular/Square (C/R/S)										
Length: Breadth: Depth										
Comment:										

2

Figure 25: Household questionnaire used during random survey (Source: CSE, 2016)

7.12 FS emptiers questionnaire

CENTRE FOR SCIENCE AND ENVIRONMENT, NEW DELHI

Septic tank Cleaner Survey

Date: ...../Nov/2016 Time: ..... Place: .....

1. Owner name & Mob. No. .....
2. De-sludging process (Manual/Mechanical/Semi M.M) .....
3. Reasons for adopting the process.....
4. Type of vehicle used for transportation (Tractor/Truck/trolley/others)

   .....
5. Price of vehicle.....
6. Type of ownership (Own vehicle /hire from others) .....
7. Number of vehicles (total in your area). . .....
8. Capacity of vehicles .....
9. Typical age of Vehicles .....
10. Vehicle Assembling point.....
11. Vehicle Details.

New or second hand	
Mileage	
Durability of vehicle (Max.)	
Capacity of pump (in HP)	
Location of pump on vehicle	
Tank maintenance details (if any rupture etc.)	
Tank durability (max.)	

12. Typical No of trips per day .....
13. Average distance per trip.....
14. Area of responsibility.....
15. Fees charge/trip.....
16. Time taken for desludging activity.....
17. Where is sludge dumped .....
18. Where should be disposal site to be located? .....
19. Official dumping site for city.....
20. Reuse for sludge .....
21. Total Quantity of faecal sludge received per day per trip (Approx.).....
22. Septic tank location (top place used for any activity or unused).....
23. Septic Tanks details (Capacity, dimension, materials used for construction, Inlet and outlet baffle etc.....
24. Areas having highest demand for sludge clearing .....
25. Frequency of desludging per household.....
26. Fees Charges /Trip (Competitors) .....
27. NO. Of private Operators in your area .....
28. Are you maintaining any register/produce any bill for payment? .....
29. Is the current practice suitable for the you (Suggest any changes)

    .....
30. Major issue running in the business

    .....
31. Safety Measures if any during desludging process .....
32. Marketing Strategy.....
33. Why you are doing this work?

    .....

Figure 26: Survey questionnaire used during emptiers interview (Source: CSE/2016)

FOR SFD INFORMATION CONTACT

Centre for Science and Environment
41, Tughlakabad Institutional Area, New Delhi 110 062
Ph: +91-11-40616000 Fax: +91-11-29955879
E-mail: sfdhelpdesk@cseindia.org Website: www.cseindia.org