SFD Promotion Initiative

Delhi
India

Final Report

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sustainable sanitation alliance

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On behalf of Federal Ministry for Economic Cooperation and Development

UNIVERSITY OF LEEDS

WORLD BANK GROUP Water

wsp water and sanitation program

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eawag aquatic research

Sandec Sanitation, Water and Solid Waste for Development

Bill & Melinda Gates foundation

SFD Report Delhi, India, 2016

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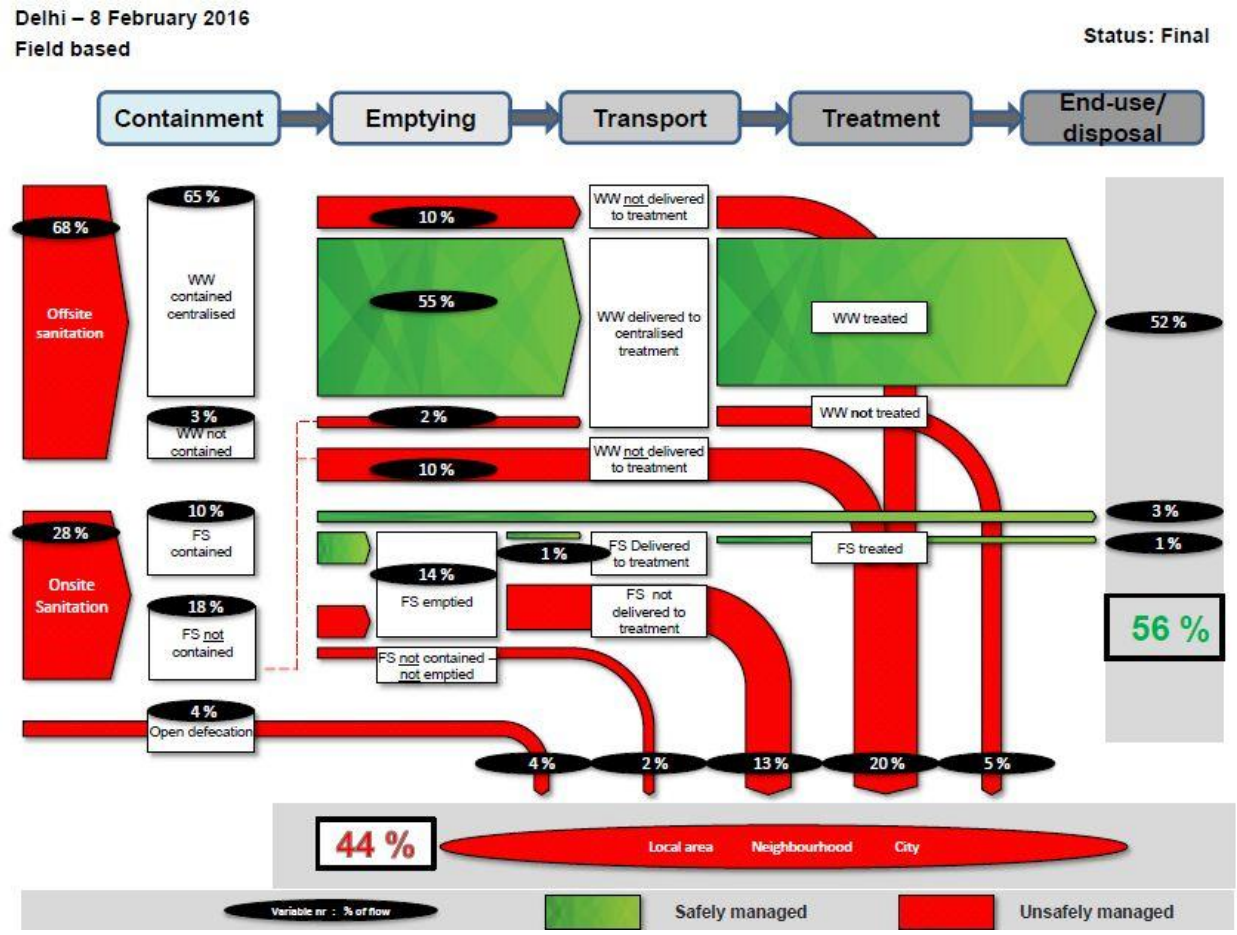
1. The Diagram



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3. General city information

Delhi is the capital of India, the largest democracy of the world. It is officially known as the National Capital Territory (NCT) of Delhi, The NCT of Delhi is a special union territory of India jointly administered by the Central government, the NCT elected government, three municipal corporations, New Delhi Municipal Council and Delhi Cantonment Board.

The population of NCT of Delhi as per the Census 2011 is 16,787,941. The density of city is 11,320 persons per sq.km. Total slum population is 1,785,390 which is 10.6% of the total population (Census of India, 2011). The floating population is around 0.4 to 0.5 million. NCT of Delhi comprises of an area of 1484 sq.km.

Delhi Urban Agglomeration has been chosen for the current study. It comprises of population of 16,349,831.

4. Service delivery context

In 2008, the Ministry of Urban Development (MoUD) issued the National Urban Sanitation Policy (NUSP). The policy aims to: raise awareness, promote 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). Furthermore, it explicitly states that cities and states must issue policies and technical solutions that address onsite sanitation, including the safe confinement of faecal sludge (FS) (USAID, 2010).

The objectives of NUSP are to be realized through CSPs and state sanitation strategies. As of now there are very few cities which have finalized their CSPs. This remains a major drawback in implementation of NUSP.

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

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

5. Service outcomes

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

Containment: According to the field based study and census, 2011, 68% of the city population is dependent on offsite sanitation system. Nearly 28 % is dependent on onsite sanitation systems. Rest 4% of the population practices open defecation. Generally low to middle income group households have single chamber septic/fully lined tanks. Double chamber septic tanks are prevalent in middle to high income groups and apartments. Due to space constraints, households are compelled to have minimal sanitation facilities within their premises. Due to non availability of sewerage network, fully lined tanks in few unplanned settlements in Delhi are designed with an outlet connected to open drains. Containment system is maintained by individual owners and drains are maintained by Municipal Corporation of Delhi (MCD). According to the survey, size of a septic tank/ fully lined tanks in individual houses ranges from 3 to 8 m^3, the size of a septic tank in office or apartment buildings are much larger and vary widely in size depending on the users.

Emptying: In Delhi, septage emptying services are not managed or regulated by the state government. Recently, DJB has initiated a step towards regularization of private emptying service and issued a public notification on procedure of acquiring license for private emptiers. Households are dependent on private service providers for OSS emptying service. According to survey conducted with private emptiers it is estimated that 350-400 vacuum tankers are running in the city. Private emptiers work in informal way either in unions or individuals. The emptying vehicle used is a tractor or a mini truck with a tank attached. The emptying fee ranges from INR 500 to 3000 (7.36 - 44.16 USD). It depends upon the factors like size of tank, length of pipe used to reach the septic tank and distance travelled for emptying service.

Transport: The sewerage network comprises of 7,000 km of sewers including trunk sewers and branch sewers (peripheral/internal sewers). This includes main trunk sewers of total length of 192 km (DJB, 2014). Septage is generally transported through truck or tractor mounted vacuum tankers. During the Focus Group Discussions (FGDs) with private emptiers, it was reported that at-least two trips are done per day and the service is provided within 10 km radius to make business economically viable. Effluent from the OSS is generally discharged in storm water drain/open drain.

Treatment: It is reported that Delhi's sewage generation is 3800 MLD (CPCB, 2015). According to the CPCB the overall treatment capacity of the STPs is 3049 MLD and operational capacity is 2671 MLD (CPCB, 2015). According to DJB's press release; 30 STPs are operational and are treating 2025 MLD of wastewater (WW) which also includes WW from intercepted open drains (DJB, 2015). There is no separate septage treatment plant. During FGDs with private emptiers in Dwarka, it is reported that emptiers in Dwarka sector-18 discharge septage to the Pappan Kallan STP.

End-use/ disposal: Presently, Delhi Jal Board supplies about 639 MLD of treated WW to the power plants, CPWD, DDA and flood control and irrigation department. Treated sewage is supplied for various non potable purposes in Delhi (DJB, 2014a). The treated sewage is sold at INR 7 per KL (DJB, 2015a). Yamuna River is the major receptacle of treated, partly treated and untreated sewage. Septage is indiscriminately disposed off in the low lying areas, vacant plots, water bodies, agricultural fields. No soak pit is connected to septic tanks for the disposal of effluent.

According to Census of India 2011, FGDs and key informant interviews (KIIs) it was estimated that around 68% of the city is dependent on offsite systems, population connected to sewerage network is 65% and user interface directly discharging in open drain or open ground is only 3%. Based on field research it was estimated that 95% of public latrines are connected to sewerage network, hence added accordingly in the offsite systems. Most of the sewage and septage with or without treatment ends up into Yamuna River via three main drains, (i) Najafgarh drain, (ii) Shahdara drain and (iii) Supplementary drain.

According to Census 2011, around 28% of the city is dependent on onsite sanitation systems (OSS), out of which around 26.7% is dependent on septic tanks and 2% on pits. But according to the survey and KIIs it is estimated that around 18% of the city is dependent on lined tanks connected to open drain/open ground and 10% on pits and lined tanks without overflow. 5% of public latrines are connected to lined tanks and hence are incorporated in onsite systems. These tanks connected to open drain are not contained but pits are contained as the groundwater table is more than 10m bgl.

There is no clear differentiation between the volume of effluent and septage generated from tanks, hence to reduce the maximum error it is assumed to be 50% each. Therefore, 9% of FS i.e. effluent from tanks goes into open drains and the rest is emptied from tanks whenever full. Some FS is always left in the tanks and is assumed to be 2% in the case of tanks connected to open drains. Whereas FS from pits and tanks without overflow is considered contained and is calculated as 3%, it includes infiltration of water as well.

6. Overview of stakeholders

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

The following stakeholders are responsible for sanitation service delivery in Delhi

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

Key stakeholders	Institutions / organizations
Public institutions	Municipal Corporation of Delhi (MCD), New Delhi Municipal Council, Delhi Cantonment Board, Delhi Jal Board (DJB), Delhi Urban Shelter Improvement Board (DUSIB), Central Pollution Control Board (CPCB), Delhi Pollution control Committee (DPCC), Delhi Development Authority (DDA) Urban Development Department (UDD)
Private sector	Private emptiers
NGOs	Sulabh International Social Service Organisation (SISSO)

DJB is responsible for planning, designing, construction of sewerage system and maintenance of sewerage network.

DMC is responsible for public health, sanitation, conservancy, and solid waste management services are delivered by Health and Sanitation Department of MCD.

DUSIB is assigned the role of looking after the slums by way of provision of civic amenities and their resettlement.

DDA is responsible for implementation of city master plan, development of commercial buildings and residential colonies/townships.

CPCB is responsible for monitoring and evaluation of STPs, drainage and Yamuna River.

SISSO is responsible for operation and maintenance of public toilets.

7. Credibility of data

Two key sources of data are used; Census of India 2011 and Inventorization of Sewage Treatment Plant by Central Pollution Control Board (CPCB). Most of the data is then updated by Key Informant Interviews (KIIs) and Focus Group Discussions (FGDs). Overall, 30 KIIs and

4 FGDs were 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 different types of user interfaces or between septic tanks and pit latrines but not about the design of the actual containment systems on ground level. Therefore, a sample household survey was conducted in OSS dependent wards of the city to identify and cross check the data collected from the Census, 2011.

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).

8. 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 crosscheck the data collected.

To start with, a relationship between sanitation technologies defined in Census of India and that defined in the project is established. The survey data is quantified and crosschecked with FGDs and KIIs.

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

Overall, 56% of excreta is safely managed in the city and rest 44% is unsafely discharged into the environment.

9. List of data sources

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

- Published reports and books:
  - Census of India 2011, House listing and housing data, Government of India
  - Service levels in water and sanitation sector, MoUD, 2012
  - Inventorization of Sewage Treatment Plant by CPCB, 2015

- KIIs with representatives from
  - Government agencies: DJB, DUSIB, CPCB
  - Service providers: SISSO
  - New Delhi railway station Health Inspector,
  - Community representatives
  - Local masons

- FGDs
  - DJB
  - Private emptiers

- Survey
  - Educational institutions
  - Commercial establishments

Delhi, India, 2016

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Table of contents

List of tables

List of figures

Abbreviations

AAP	Aam Aadmi Party
ASP	Activated Sludge Process
BGL	Below Ground Level
BPL	Below Poverty Line
BIO-FOR	Biological Filtration Oxygenated Reactor
BIS	Bureau of Indian Standard
CDP	City Development Plan
CETP	Common effluent treatment plant
CGWB	Central Ground Water Board
CPCB	Central Pollution Control Board
CPHEEO	Central Public Health and Environmental Engineering Organisation
CPR	Centre for Policy Research
CPWD	Central Public Works Department
CSE	Centre for Science and Environment
CSP	City Sanitation Plan
DDA	Delhi Development Authority
DJB	Delhi Jal Board
DPCC	Delhi Pollution Control Committee
DRDO	Defence Research Development Organisation
DUSIB	Delhi Urban Shelter Improvement Board
EA	Extended Aeration
EDMC	East Delhi Municipal Corporation
EWS	Economically Weaker Section
FS	Faecal Sludge
GNCTD	Government of National Capital Territory of Delhi
INR	Indian Rupees (1 USD= 68.8 INR)

*JJ*C	*Jhuggi Jhopadi* Clusters
MBR	Membrane Biological Reactor
MCD	Municipal Corporation of Delhi
MoEF	Ministry of Environment and Forest
MoUD	Ministry of Urban Development
NCR	National Capital Region
NCT	National Capital Territory
NDMC	North Delhi Municipal Corporation
NGO	Non-governmental Organization
NIUA	National Institute of Urban Affairs
OP	Oxidation Pond
OSS	On-site Sanitation System
SBR	Sequential Batch Reactor
SDMC	South Delhi Municipal Corporation
SFCPoA	Slum Free City Plan of Action
SISSO	Sulabh International Social Service Organisation
SLB	Service Level Benchmarks
SMP	Septage Management Plan
STP	Sewage Treatment Plant
SWM	Solid Waste Management
UA	Urban Agglomeration
UDD	Department of Urban Development
USAID	United States Agency for International Department
USD	United States Dollar
WTP	Water Treatment Plant
WSSD	Water Supply and Sanitation Department
WW	Waste Water
WWTP	Waste Water Treatment Plant

1 City context

Delhi is the capital of India, the largest democracy of the world. It is officially known as the National Capital Territory (NCT) of Delhi. The NCT of Delhi is a special union territory of India jointly administered by the Central government, the NCT elected government, three municipal corporations, New Delhi Municipal Council and Delhi Cantonment Board. Delhi is the biggest trading center and the largest center for small industries in northern India; it attracts migrants from neighboring states and other parts of the country.

Delhi is rapidly emerging as a world-class metropolis. It has one of the fastest growing economies in the country and it has the largest commercial center in northern India. The per capita income of Delhi is estimated to be INR 219,979. Delhi's economy is driven by the services sector which provides employment to 58% of the labour force (GNCTD, 2014).

The population of NCT of Delhi is 16,787,941 and Delhi Urban Agglomeration (UA) is 16,349,831 persons. Delhi UA has been considered for the current study. The annual average exponential growth rate of population of Delhi was the highest (6.42%) during 1941-1951 due to large-scale migration from Pakistan to India after partition in 1947. As per the 1991 census, the annual growth of Delhi's population during 1981-91 (4.25%) was almost double the national average (2.16%) (GNCTD, 2014). The overall population density of Delhi has increased from 9340 persons per sq.km in 2001 to 11,320 persons per sq.km in 2011.

Table 1: Population growth rate

Census year	Population	Growth rate (%)
1971	40,65,698	
1981	62,20,406	53
1991	94,20,644	51.4
2001	13,850,507	46.3
2011	16,787,941	21.6

(Source: Census of India, 2011)

The city is located in northern India between the latitudes of 28°-24'-17" and 28°-53'-00" North and longitudes of 76°-50'-24" and 77°-20'-37" East. It has an area of 1,483 sq. km. It shares borders with the Uttar Pradesh and Haryana state. Delhi lies in the fertile Northern Plains of India. The main features of Delhi are the Aravalli outcrops and the Yamuna River. The Aravalli outcrops are covered with forest called the Ridges. The Yamuna is the main source of drinking water for the citizens of Delhi. There is a forest cover of nearly 11.5% of the total area in Delhi (UDD, 2006).

Delhi has a semi arid climate, with hot summers, average rainfall and moderate winters. Mean monthly temperatures range from 14.3° C in January to 34.5° C in June. However, the temperatures go up-to 40-45° C in summers and fall down to 4-5° C in winters. The annual precipitation is about 711 mm recorded largely during the monsoon months (July – September). Dust storms are frequent during the summer months leading to an immense build-up of particulate matter in the atmosphere (UDD, 2006).

Figure 1: Ward map of Delhi

2 Service delivery context description/analysis

2.1 Policy, legislation and regulation

2.1.1 Policies, legislations and regulations at national level

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

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

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

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

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

According to Constitution of India, water and sanitation is a state subject. Statutory powers are conferred to the state for making laws on water and sanitation. The NCT Delhi does not have a state sanitation policy, but the state follows the approaches advocated in the NUSP.

In 2002, the Government of NCT Delhi amended the 1998 Delhi Water Board Bill, which delegated responsibilities related to water supply, sewerage and sewage disposal and drainage. It also positioned the Delhi Water Board in an advisory role to the Delhi Municipal Corporation and the Delhi Cantonment Board. In addition, provisions in this amendment regulate the exploitation of groundwater, relevant user fees and the installation or deepening of tube wells.

The Delhi Jal Board (DJB) notified the Delhi Water Board Septic Tank Waste Management Regulations 2015 under Delhi Water Board Act-1998 for the collection, transportation and disposal of septage. As per the regulations, septage shall be collected and transported only by an agency/individual having a valid license issued by DJB. Working without a valid license or/and dumping the septic tank waste at any non-designated location will be punishable as per law. The regulations have established criteria for procuring license. The license will be issued only to the individuals or agencies with a leak-proof, odor and spill proof transporting vehicle equipped with a proper vacuum/suction and discharging arrangement. The emptying fee will be prescribed by the DJB. The licensee is responsible for taking all the safety measures including provision of gas detectors, gas masks, protective gear, oxygen mask with oxygen cylinder and first aid box etc. The licensee will be obliged to dispose septage only at the designated locations notified by the DJB.

Each Municipal council/corporation is entitled to make its own bylaws for various aspects of city governance and Building Bylaws. The *Delhi Municipal Corporation Act of 1957* and its amendments represent most of the bylaws relevant to sanitation in the NCT. Under this act, the Commissioner is responsible for providing public latrines and urinals, and must approve the building of latrines or urinals, whether they use a service or a flush system for any premises (DMC, 1957). In addition, this act rules that any new building must have latrine and bathing accommodations.

Toilets, bathrooms and kitchens are part of a building and are governed by Building Bylaws. The office of the development authority is responsible for issuing permits for construction of new buildings and/or repairs/renovation of old buildings (DDA, 1983). A permit is not required for minor alternations, as laid out in the bylaws. In order to obtain a permit, one must submit all plans and ownership documents or the like to the authority for approval of all relevant bodies.

The Delhi Cleanliness and Sanitation Bylaws were created by the Municipal Corporation of Delhi in 2009. The Bylaw outlines the responsibilities of the Municipal Corporation vis-à-vis keeping the city clean and outlaw certain unsafe sanitation practices including open defecation and urination. Under these bylaws, the Municipal Corporation is required to provide community toilets for slums and equip public places with latrine facilities.

2.1.3 Institutional roles

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

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

The governance of NCT Delhi is shared responsibility of the union, state and the local governments. The shared responsibility of the governments in this context implies certain responsibilities and competence of each of the governments. The local governance structures in Delhi are loaded with the responsibilities of development and maintenance of the city to a larger extent. Service delivery to the people in the city is ensured and facilitated by the local governments. There are many overlapping areas where the state and the local governments are involved. The union government has its own jurisdiction over the governance of the city.

Delhi is governed through three different local bodies having their own geographical demarcation and areas of operation. The New Delhi Municipal Council is one of the structures of local governance. The jurisdiction of the council falls within the major areas of central Delhi. This area is considered important given its geographical jurisdiction. This is an area where the President resides, the parliament assembles and the cabinet meets. Its area of jurisdiction includes the headquarters of all major government offices and ministries of the Union government. The New Delhi Municipal Council is under the control of the Union government. The Delhi Cantonment Board is another local body of governance in Delhi. It was created through an Act called, "The Cantonment Act 1924". It looks after an area where armed forces are stationed. The Cantonment Board is under the Ministry of Defence. The municipal corporation of Delhi was established in 1958, under the provision of an Act of Parliament, known as "The Delhi Municipal Corporation Act 1957".

The Municipal Corporation of Delhi, the second largest civic body, was trifurcated in the year 2012 into the South Delhi Municipal Corporation (SDMC - 656.91 sq.km), the North Delhi Municipal Corporation (NDMC- 636.37 sq.km) and the East Delhi Municipal Corporation (EDMC – 105.98 sq.km) (MCD, 2015).

Management and delivery of urban basic services in Delhi is governed by various institutions. The following table provides roles and responsibilities of various institutions responsible for policy making, service provision and regulation of urban services.

Table 2: Roles and responsibilities

Institution	Roles and responsibilities
Urban Development Department (UDD)	Formulates policy, provides funds, monitors and coordinates the activities of the ULBs which include the Municipal Corporation of Delhi, the New Delhi Municipal Council, Delhi Jal Board and Trans Yamuna Area Development Board.
Delhi Jal Board (DJB)	Supply of portable water in National Capital Territory and also responsible for sewerage services including development of network for collection, treatment, and disposal of sewage. It is responsible for project planning, capital investment, project execution as well as O&M.
Delhi Urban Shelter improvement Board (DUSIB)	Providing civic amenities in *Jhuggi Jhopadi* Clusters (JJCs), in-situ development and relocation of JJCs, operation and management of night shelters, establishing and managing pay-and-use community toilet complexes.
Delhi Cantonment Board	Regulates development in the Cantonment Area. Functions as Municipal Authority; construction, alteration and maintenance of latrines, urinals and sewerage networks and regulating their use. Overall management of the civic services in the area.
Delhi Pollution Control Committee (DPCC)	DPCC acts as a regulatory body in respect of NCT Delhi for implementation of various environmental / pollution control Laws enacted by the Parliament and notified by MoEF, Govt. of India.
Central Pollution Control Board (CPCB)	CPCB looks at the compliance at the national level, monitoring of water quality of the Yamuna and discharging drains at various locations. The DPCC, in effect is the primary agency in the NCT, to carry out the regulatory work relating to prevention and control of water and air pollution.
Delhi Development Authority (DDA)	Master planning, land development, housing, development of commercial complexes, sports facilities, parks etc.
Municipal Corporation of Delhi (MCD)	Overall management of the civic services in the city. Public sanitation, solid waste management, public health and education.
New Delhi Municipal Council	The New Delhi Municipal Council area comprises of the territory that has been described as Lutyen's Delhi and which has historically come to be regarded as the seat of central authority in Union of India. Council role is management of the civic services. Public sanitation, solid waste management, public health and education.
Irrigation and Flood Control Department	Construction, strengthening and maintenance of marginal embankments including flood protection works, monitoring of the flood situation in the river basin during the floods.

Several institutions are involved in management of sanitation activities with varying roles. While most of the state level institutions are responsible for policy setting, oversight and monitoring, DJB and MCD are responsible for actual implementation. The role of various institutions is overlapping many times.

2.1.4 Service provision

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

Furthermore, when no separate utility exists, there is no separation of accounts for different activities within a municipality. Some states and cities have non-typical institutional arrangements. For example, in Rajasthan the sector is more centralized and the state government is also in charge of operation and maintenance, while in Mumbai the sector is more decentralized and local government is also in charge of planning and investment (NIUA, 2005).

In Delhi, public health, sanitation, conservancy, and solid waste management services are delivered by Engineering Department of MCD. Water supply and sewerage is the responsibility of DJB. It is also responsible for licensing private emptiers, tariff setting, identification of disposal sites, and construction of infrastructure to receive and treat septage. Licensed private emptiers are responsible for emptying. The private emptier has to pay INR 1000/- (15 USD) as licensing fees and INR 10000 (147 USD) as performance guarantee which is valid for three years.

2.2 Planning

2.2.1 Service targets

A sewerage master plan has been prepared by DJB for design horizon of 2031. This plan includes construction of 9807 km sewer lines, 101 pumping stations, 75 waste water treatment plants (WWTP) with 374 MGD capacity. According to the SLBs, the benchmark for coverage of sewerage system is 100%. The Swachh Bharat Mission (SBM) aims to eliminate open defecation by 2019. The provision of individual toilets to households is the main component of the mission. SBM plans to build 16,000 toilets including community and public toilets by 2019 (DUSIB, 2015).Delhi Jal Board aims to increase use of recycled water to 40 per cent from the present 25 per cent. DJB is planning a city-wide network for supply of recycled water from WWTPs to different areas of the city (TOI, 2015).

Table 3: 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, 2012 and MoUD, 2014)

2.2.2 Investments

The sewerage master plan proposes an investment of INR 100,770million for construction of sewer lines, pumping stations, WWTPs etc. The grand total investment of INR 194,400 million is required by considering escalation factor of 8.5% (DJB, 2014). The project will be completed in four phases. The component wise investment required and phasing has been given in table 4 and 5.The investment planned under SBM in 2014-2015and 2015-2016 is INR 75.3 million and INR 5.2 million respectively (MoUD, 2016).

Table 4: Proposed investments for sewerage network

S.No.	Proposals	Cost in INR (millions)
1	Sewerage Network (9807 km length)	65,440
2	Waste water pumping station	9,190
3	Waste water treatment plants (374 MGD Capacity)	26,140
Total		100,770

(Source: Sewerage Master Plan-2031, 2014)

Table 5: Phasing of investments

Year	Anticipated Investment required (INR in millions)
Up to 2016	15,115.4
2016-2021	45,346.3
2022-2027	30,230.9
2027-2031	10,077

(Source: Sewerage Master Plan-2031, 2014)

2.3 Reducing inequity

2.3.1 Current choice of services for the urban poor

According to Census of India, 2011, the slum population of Delhi is 1,785,390 (10.6% of total population) residing in 6,343 slums. Out of these, underground sewerage system has been available in the 16.30% of the slums whereas 30% of the slums are dependent on onsite sanitation and the rest are dependent on community toilets or practicing open defecation (GNCTD, 2015). Less space availability in slums does not allow for indoor toilets thus residents are dependent on community toilet complexes constructed by DUSIB. These CTCs have facilities for toilet and bathing both for male and female with nominal charges of INR 5 and INR 10 for toilet and bathing respectively.

DUSIB is responsible for construction of community toilets in slums. The operation and maintenance has been given to various agencies and NGOs.

2.3.2 Plans and measures to reduce inequity

The Slum Free City Plan of Action (SFCPoA) of Delhi proposed various measures for improvement of slums. The total project cost is estimated INR 152,200 million over the five year implementation period commencing from 2015-16 and ending with 2019-20. Around INR 600 million has been allocated for sewerage and sanitation sector.

According to the Aam Admi Party (AAP) manifesto published before state election in 2015, AAP will build two lakh toilets across Delhi: about 1.5 lakh toilets in slums and JJ clusters and 50,000 toilets in public spaces, of which 1 lakh toilets will be for women. These toilets will be concentrated in public spaces and slum areas. AAP will construct eco-toilets to save water (AAP, 2015).

There is a provision for in-situ development of slums. Slum dwellers will be provided plots or flats in the same location as the existing slums. If that is not possible, they will be rehabilitated in the closest possible location. Until such rehabilitation is completed, the slums will not be demolished under any circumstances. Facilities for drinking water, sanitation and cleaning of sewage canals will be provided in all slums.

2.4 Outputs

2.4.1 Capacity to meet service needs, demands and targets

ULBs have insufficient financial resources. 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 financial year 2013-2014, the total revenue and expenditure of DJB was INR 19,263 million and INR 31,509.7 million respectively. This has a huge gap of INR 1,224,670 million. Around 98% of revenue comes from state government as grant (GNCTD, 2014a). DJB passed its annual budget for the fiscal year 2015-16 amounting to INR 35,948.3 million which consisted of plan budget of INR 14,300 million and non-plan budget of INR 21,648.3 million. The majority of funds for capital works of infrastructure come from different central and state government's schemes and external lending from bilateral agencies.

2.4.2 Monitoring and reporting access to services

The SLBs have to be revised yearly. Data on service levels should be collected, documented and reported to MoUD according to the format prescribed by SLB framework. Service level improvement plans (SLIPs) are prepared with yearly targets. It has to be reviewed each year and progress has to be monitored. The planning documents like City Development Plan (CDP) and CSP have to be reviewed once in 5 years. This gives an opportunity to monitor the progress on service level improvement.

According to *Septic Tank Waste Management Regulations 2015* of DJB, the private emptiers have to install GPS system; this enables DJB officials to track the emptiers. Emptiers have to dispose septage only in designated sites, licensing may monitor and regulate emptiers. At present, DJB has invited applications from private emptiers for granting licenses. There is no database of private emptiers with DJB. Sanitary inspectors have to inspect the design of septic tanks and their adherence to standards at the time of construction. The construction of septic tank adhering to the standards is not enforced.

2.5 Expansion

2.5.1 Stimulating demand for services

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
- Skill development of local masons
- Monitoring and regulation of private emptiers

DJB is in the process of regularizing the emptying services. But, there are no plans for taking up responsibility of emptying.

2.5.2 Strengthening service provider roles

Private emptiers are the only service provider for the emptying services. DUSIB is responsible for construction, operation and maintenance of community toilets. Community toilets in the slums can also be built and maintained based on the Sulabh International Social Service Organisation (SISSO) model. Partnership with SISSO in providing emptying service in slums can improve efficiency of services. DJB can take up emptying services.

Funding is available for septage management initiatives under AMRUT programme. These funds can be used to buy vacuum tankers, building treatment facility etc., As DJB is a parastatal, it is not eligible for funding from this programme. But, the municipal corporations (NDMC, SDMC and EDMC can make use of these funds to take up emptying services.

2.5.3 Service standards

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

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

3. Code of Practice for Installation of Septic Tanks, 1985: Issued by Bureau of Indian standards, national standards 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 Central Public Health and Environmental Engineering Organization (CPHEEO).It provides detailed design and guidelines for various technologies of wastewater management.

3 Service outcomes

3.1 Overview

Two key sources of data are used; Census of India, 2011 and Inventorization of Sewage Treatment Plant (STP) by Central Pollution Control Board (CPCB), 2015. Most of the data is then updated by survey, published/unpublished documents, Key Informant Interviews (KIIs) and Focus Group Discussions (FGD). Data on containment is available in the Census. Data on type of containment actually prevalent in the wards according to SFD promotion initiative is updated through survey. Data on emptying and transport of septage is collected through KIIs with private emptiers. Data on transport and treatment of sewage is collected through published/unpublished reports and news article. This section presents the range of infrastructure/ technologies, methods and services designed to support the management of FS and WW through sanitation service chain in Delhi.

To start with, a relationship between sanitation technologies defined in Census of India and the variables defined in the project is established. Then the population dependent on those systems is represented in terms of percentage of population, as shown in Table 6.

Table 6: Sanitation technologies and contribution of excreta in terms of percentage of population

S.No.	Sanitation technologies and systems as defined by:		SFD reference variable	Percentage of population
	Census of India	SFD promotion initiative		
1	Piped sewer system	User interface discharges directly to centralized separate sewer	T1A1C2	57.6%
2	Septic tank	Septic tank connected to open drain or storm sewer	T1A2C6	26.7%
3	Other systems	User interface discharges directly to open ground	T1A1C8	1.0%
4	Pit latrine with slab	Lined pit with semi-permeable walls and open bottom, no outlet or overflow, general situation	T1A5C10	1.7%
5	Pit latrine without slab	Unlined pit no outlet or overflow, general situation	T1A6C10	0.2%
6	Night soil disposed into open drain	User interface discharges directly to open drain or storm drain	T1A1C6	2.3%
7	Service latrine	User interface discharges directly to ‘don’t know where’	T1A1C9	0.02%
8	Public latrine	User interface discharges directly to centralized separate sewer Septic tank connected to open drain or storm sewer	T1A1C2 T1A2C6	7%
9	Open defecation	Open defecation	T1B11C7 TO C9	3.5%

3.1.1 Sanitation facilities

This section presents on existing sanitation facilities: community/public toilets, institution, industries and commercial establishments.

Community toilets/ public toilets: NDMC, SDMC, EDMC, DUSIB, New Delhi Municipal Council and Delhi Cantonment Board are responsible for the construction of public/ community toilets. 3000 public pay-and-use toilets and free public toilets are currently being operated and maintained by an NGO, SISSO popularly known as Sulabh complex and Sulabh*Souchalya*(SISSO, 2015).In pay-and-use toilets,INR 5 is charged for a use per individual. 1,500 public/community toilets are operated and maintained by the Municipal Corporations/Council. At present,DUSIB has 536 community toilets.There are three types of community toilets provided by DUSIB:

1. Mobile toilet vans
2. Prefabricated toilets
3. Conventional toilets

The toilets constructed by DUSIB are outsourced to NGOs for operation and maintenance (DUSIB, 2015). User charge is INR 1 for one use per adult. Out of 536 community toilets, 354are connected to sewer network, 106 connected to septic tank, 18 are connected to nullah, and no data is available on discharge of 58 community toilets. On a pilot scale, few toilets of night shelters are installed with DRDO developed bio-digester toilets. Approximately 95-97% of community/public toilets are connected to sewerage network (SISSO, 2015. DUSIB, 2015).

Institutions and commercial establishments

Delhi is hub for various institutions like public and private offices, educational institutions, hotels, restaurants and market. The city is poised to be one of the largest conglomerations of professional services in the world, due to the globalization of services and the explosive growth potential it entails. A survey has been conducted to observe the sanitation facilities available in markets, malls, schools and New Delhi railway station (Please refer appendix 7).

Due to the lack of data on excreta generated from institutions, industrial areas, restaurants and hotels. These establishments have not been taken into consideration for production of SFD. Whereas excreta generated from community/public toilets and residential area is considered for the SFD production.

3.1.2 Containment

Overall, 68% of the city population is dependent on offsite sanitation system. Nearly 28% is dependent on onsite sanitation systems. Rest 4% of the population practices open defecation.

Sewerage network

According to the field based study, 65% of the population is dependent on sewerage systems. According to CPCB reports 34 STPs based on various technologies is explained in table 7: -

Table 7: STPs in Delhi: technology and status

City/town	STP location	Status (Operational/Non-Operational)	Technology (ASP/ OP/SBR/MBR/ etc)
Akshardham	STP Akshardam	Operational	MBR
Kondli	STP Kondli Phase-I	Operational	ASP
	STP Kondli Old Phase-II	Operational	ASP
	STP Kondli Phase-III	Operational	ASP
	STP Kondli New Phase-IV	Operational	ASP
Papankalla	STP Papankalla	Operational	ASP
Nazafgarh	STP Nazafgarh	Operational	EA
Yamuna Vihar	Yamunavihar Phase-I	Operational	ASP
	Yamunavihar Phase-II	Operational	ASP
Rithla	Rithla Old	Operational	ASP
	Rithla New	Operational	ASP
Rohini	Rohini Sec-25	Operational	ASP
Okhla	Okhla Phase-I	Operational	ASP
	Okhla Phase-II	Operational	ASP
	Okhla Phase-III	Operational	ASP
	Okhla Phase-IV	Operational	ASP
	Okhla Phase-V	Operational	ASP
	Okhla Phase-VI	Operational	ASP
Keshopur	KeshopurNilothi-I	Operational	ASP
	KeshopurNilothi-II	Operational	ASP
	KeshopurNilothi-III	Operational	ASP
	KeshopurNilothi-IV	Operational	ASP
Coronation	Coronation Pillar-I	Operational	Trickling Filtration
	Coronation Pillar-II	Operational	ASP
Narela	Narela-I	Operational	ASP
	Narela-II	Operational	ASP
VasantKunj	VasantKunj-I	Operational	ASP
	VasantKunj-II	Operational	ASP
Dr. Sen Nursing Home Nalla	Dr. Sen Nursing Home Nalla	Operational	Bio-Far
Delhi Gate Nalla	Delhi Gate Nalla	Operational	Bio-Far
Mehrauli	Mehrauli	Operational	ASP
Ghitorni	Ghitorni	Non-Operational	ASP
Timarpur	Timarpur	Operational	OP
Chilla	Chilla	Operational	SBR

(Source: CPCB, 2015)

Septic tanks/ fully lined tanks

During the field based survey a wide range of containment systems were found. Therefore, the system which is correctly designed, properly constructed and satisfies BIS standards of the septic tank are considered to be septic tanks for the study. The containment system which is either properly constructed fully lined tank with impermeable walls and base or poorly designed septic tank,and rarely emptied, do not perform the intended treatment,

acting as a sealed vault and serve as holding tanks are considered fully lined tanks for the study.

Generally low to middle income group households have single chamber septic/fully lined tanks. Double chamber septic tanks are prevalent in middle to high income groups and apartments. It is reported that 76.3% of urban settlements are unplanned (CPR, 2015). Due to space constraints, households are compelled to have minimal sanitation facilities within their premises. Due to non availability of sewerage network, fully lined tanks in few unplanned settlements in Delhi are deliberately designed with an outlet connected to open drains. Containment system is maintained by individual owners and drains are maintained by MCD. Awareness about operation and maintenance of septic tanks is sub-optimal.

The sizes and designs of septic tank/fully lined tanks vary from one place to another. Type and size of containment are largely influenced by (BMGF, 2011):-
i) Space availability
ii) Cost
iii) Local construction standards
iv) Skills of mason

According to the survey, size of a septic tank/ fully lined tanks in individual houses ranges from 3 to 8 m^3, the size of a septic tank in office or apartment buildings are much larger and vary widely in size depending on the number of users.

Other types of containment systems observed during the field based survey are fully lined tank with no outlet or overflow and lined pit with semi-permeable (honeycombed) walls and open bottom with no outlet or overflow. Even though it is not common, it was observed that some containment systems in Delhi are collapsed and damaged, discharges directly to open drains and open ground.

Figure 2: Type of discharge from household (Source: Anil/CSE, 2015)

Figure 3: Type of containment systems observed during field based study (Source: Anil/CSE,2015)

3.1.3 Emptying services

In Delhi, septage emptying services are not managed and regulated by the state government. Recently, DJB has initiated a step towards regularization of private emptying service and has put up a public notification on procedure of acquiring license for private emptiers (discussed in detail in chapter 2). Households are dependent on private service providers for OSS emptying service. Emptying frequencies vary across city depending upon the type and size of containment and road access to the household. Emptying is done only when the tank is overloaded or chocked.

It is reported that few households have never emptied their containments till now. The reasons are (BMGF, 2011):-
i) Many households owning septic tanks/fully lined tanks have migrated only about eight to ten years ago in search of employment opportunities and shifted from open defecation practices to relatively safer option of using septic tanks/fully lined tanks.
ii) People with higher affordability construct oversized septic tanks to avoid frequent emptying (an option pushed by local masons).
iii) Lack of awareness about the need for periodical emptying.

According to survey conducted with private emptiers it is estimated that 350-400 vacuum tankers are running in the city. Private emptiers work in informal way either in unions or individuals. The emptying vehicle used is a tractor or a mini truck with a tank attached (refer figure 4 and 5).

The tanks are fabricated in Faridabad and Sampla in Haryana, a metal fabrication manufacturing workshops hub near Delhi. Pumps and hose pipes are separately bought and then assembled or fitted to the unit. There is a suction pump mounted on the tractor which produces vacuum pressure to pump out the fecal sludge from the tank. The accessories used are hose pipe of about 10-15 meter length and a pump mounted on the tractor. The vacuum tanker with capacity of $3m^3$, $5m^3$ and $6m^3$ are available in the city.

Figure 4: Truck mounted vacuum tanker (Source Anil/CSE, 2015)

Figure 5: Tractor mounted vacuum tanker(Source Anil/CSE, 2015)

Figure 6: Emptying process followed by private service provider (Source: Anil/CSE, 2015)

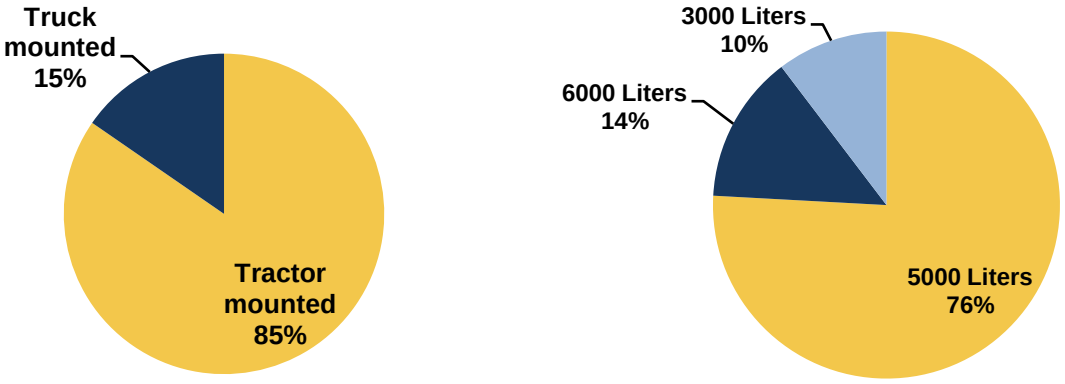

Figure 7: Type of vacuum tankers and their capacity

The emptying fee ranges from INR 500 to 3000 (7.36 - 44.16 USD). It depends upon the factors like size of tank, length of pipe used to reach the septic tank and distance travelled for emptying service.

Transportation

The sewerage network comprises of 7,000 km of sewers including trunk sewers and branch sewers (peripheral/internal sewers). This includes main trunk sewers of total length of 192 km (DJB, 2014). For sewage management, Delhi is divided into six drainage zones of Okhla, Keshopur, Rithala-Rohini, Coronation pillar, Shahdara and Outer Delhi. 76 sewage pumping stations (SPS) at various locations of Delhi pumps sewage to STPs.

Septage is generally transported through truck or tractor mounted vacuum tankers. During the FGD with private emptiers, it was reported that at-least two trips are done per day and the service is provided within 10 km radius to make business economically viable. Effluent from the OSS is generally discharged in storm water drain/open drain.

It is a complex situation, in Delhi, owing to the combination of a number of natural and man-made drainage systems; large natural drains; storm water drains along roads; and combined sewer-cum-storm water drains (sometimes as a bypass arrangement for blocked sewer lines). Most of the water collected through different drainage systems finally gets discharged into the river Yamuna. The length of natural drains in the city is 350 km carrying discharge of 1000 m^3, whereas the total length of drains is 1700 km spread over 12 municipal zones. The BOD levels of waters in 90 % of city drains indicate that the discharge is comparable to a range of weak to strong domestic sewage. The main issues related to the sector are (UDD, 2006):

- Storm water drains carry considerable quantities of raw and untreated effluents
- Lack of maintenance, leading to chocked drains.
- Lack of coordination in planning and construction of roads and drains

3.1.4 Treatment

It is reported that Delhi's sewage generation is 3800 MLD (CPCB, 2015). According to the CPCB the overall treatment capacity of the STPs is 3049 MLD and operational capacity is 2671 MLD (CPCB, 2015). According to DJB's press release; 30 STPs are operational and are treating 2025 MLD of wastewater (WW) which also includes WW from intercepted open drains (DJB, 2015).

There is no separate septage treatment plant. During FGDs with private emptiers in Dwarka, it is reported that emptiers discharge septage to the Pappankalla (Dwarka) STP.

3.1.5 End use/ disposal

Presently, Delhi Jal Board supplies about 639 MLD of treated WW to the power plants, CPWD, DDA and flood control and irrigation department. Treated sewage is supplied for various purposes in Delhi (Refer table 8 for more details) (DJB, 2014a). The treated sewage is sold at INR 7 per KL (DJB, 2015a).

Presently the sludge generated from activated sludge process is digested and dewatered on sludge drying beds/mechanical dewatering. The quantity of sludge generated from STPs has become a challenge to DJB. Due to the volume of sludge generated is much higher than the requirement for urban landscape and agriculture space available. This dried sludge, is henceforth available free of cost to the intending consumers from DJB's STPs (DJB, 2015a).

Table 8: Treated sewage supply for various purposes

Sl. No.	Details	Units of treated sewage reused (MLD)	Percentage of treated sewage reused
1	Treated effluent supplied from Keshopur STP for irrigation purposes	135	56.60
2	From Okhla STP to CPWD and irrigation department for horticulture/irrigation purpose	166.5	29.60
3	From Coronation Pillar STP for DDA golf course at Bhalswa, Gammon India for construction purposes. Minor irrigation department at Palla	54	70.59
4	From Rithala STP to PPCL for their plant at Bawana and NDPL for their plant at Rohini	121.5	62.79
5	From Vasant Kunj to Sanjay Van	22.5	100
6	From Mehrauli STP to Garden of Seven Senses	9	66.67
7	From Delhi Gate and Sen Nursing Home STP to PPCL	18	83.16
8	From Nilothi STP to Flood Control and Irrigation Deptt. for Irrigation purposes	72	100
9	From Dwarka STP to DDA for Irrigation purposes	36	50
10	From Commonwealth Games Village STP to Common Wealth Games Complex for non-potable purposes	4.5	100
	Total	**639**	**51**

Yamuna River is the major receptacle of treated, partly treated and untreated sewage. In the past decade or so, many urban poor settlements have mushroomed in the Yamuna flood plain area and the sanitation infrastructure inadequacy has become pronounced.

Septage is indiscriminately disposed in the low lying areas, vacant plots, water bodies, agricultural fields. No soak pit is connected to septic tanks for the disposal of effluent.

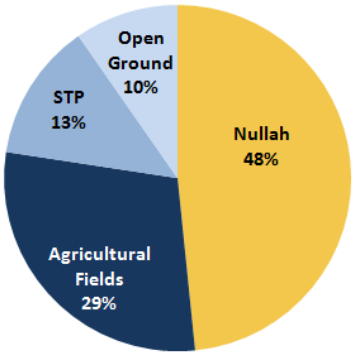

Figure 8: Disposal of septage

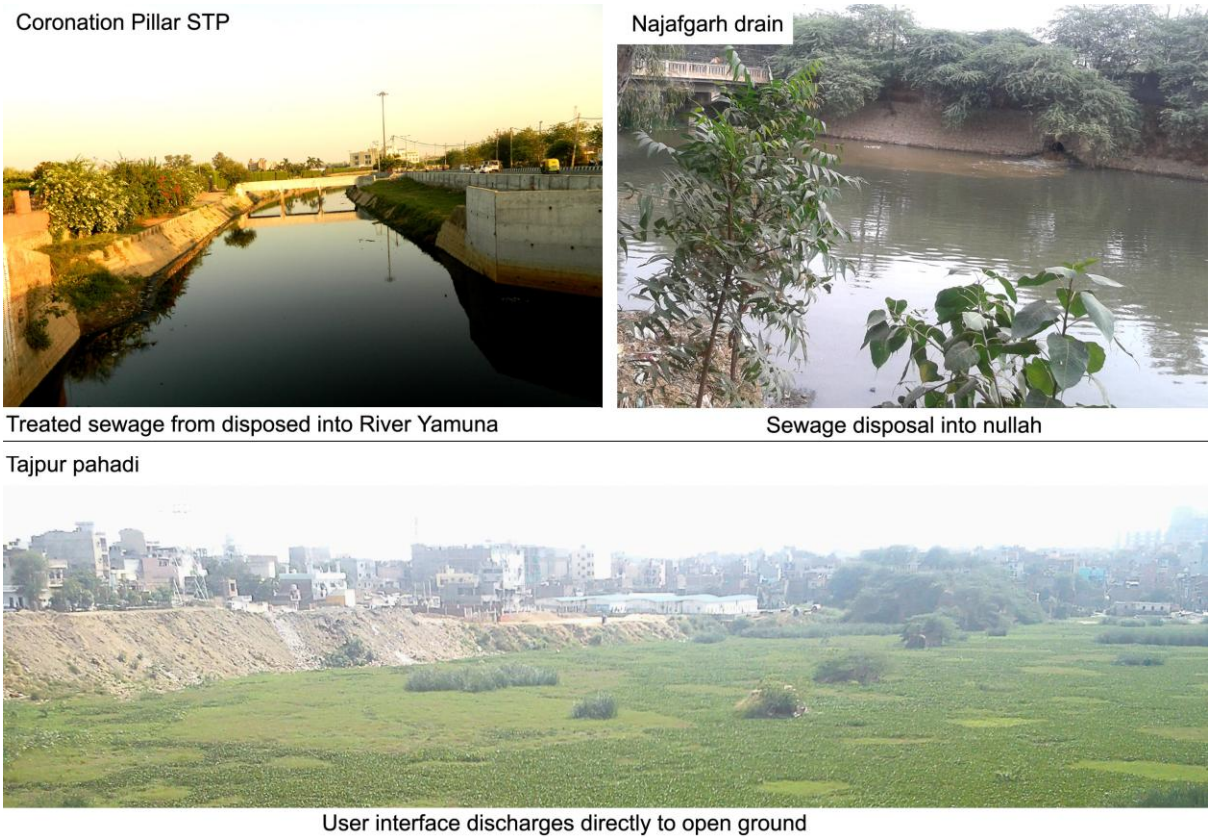

Figure 9: Sewage disposal in the environment (Source: Anil/CSE, 2015)

Figure 10: Septage disposal in the environment (Source: Anil/CSE, 2015)

3.1.6 Risk of contamination of groundwater

Currently, Delhi sources the majority of its drinking water from the Yamuna River, but considering the city's population growth and projections of future water scarcity, groundwater too represents an important resource. It is also, however, under threat. The areas under the tail end of supply chain are generally overexploited. Most of the districts in the NCT are overexploiting their groundwater resources (Shekhar et al.). The region's shallow aquifers (from 5 to 10 m), are usually quite saline, hence use is limited to the deeper aquifers, which vary between 20-50 m (CPCB, 2007). The water table has been steadily declining for years and a 4 m decline has been observed over the last few decades (CPCB, 2007). Much of the city is paved, which prevents natural groundwater recharge, and leads to storm water runoff to the Yamuna.

Many industrial activities are taking place in the peri-urban areas, which releases pollutants including insecticides and plastics into the environment (CPCB, 2007). In addition, fluoride levels are quite high in the south and southwest districts of the city, which are typically home to deeper aquifers, and the release of domestic effluents into open unlined drains has led to unsafe levels of nitrates in some parts of Delhi (Shekhar et al). A CPCB study showed that the levels of faecal coliforms and iron in Delhi's groundwater were also above the BIS standards for drinking water (CPCB, 2008).

The Quaternary deposits constitute the major repository of ground water. Total ground water resources in the NCT Delhi are estimated around as 28156.32 ha m (Central Ground Water Board). The annual extraction of ground water is estimated around 47945.18 ha m.

About 81.9% households of Delhi have now access to piped water supply. Water Production during the summer season is being maintained at 830 - 835 million gallons per day consistently. Water is supplied through a water supply network comprising of 11,350 kms long pipelines and now 105 underground reservoirs will be functioning for rationalized distribution of supply in Delhi (DJB, 2015a). Refer Table 19 in appendix for more details.

3.2 SFD matrix

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

3.2.1 SFD matrix explanation

According to Census of India 2011, FGDs and KIIs it was estimated that around 68% of the city is dependent on offsite systems. Population connected to sewerage network is 65% and user interface directly discharging in open drain or open ground is only 3%. Based on field research it was estimated that 95% of public latrines are connected to sewerage network, hence added accordingly in the offsite systems. Most of the sewage and septage with or without treatment ends up into Yamuna River via three main drains, (i) Najafgarh drain, (ii) Shahdara drain and (iii) Supplementary drain.

According to Census 2011, around 28% of the city is dependent on onsite sanitation systems (OSS), out of which around 26.7% is dependent on septic tanks and 2% on pits. But according to the survey and KIIs it is estimated that around 18% of the city is dependent on lined tanks connected to open drain/open ground and 10% on pits and lined tanks without overflow. Around 5% of public latrines are connected to lined tanks and hence are incorporated in onsite systems. These tanks connected to open drain are not contained but pits are contained as the groundwater table is more than 10mbgl.

There is no clear differentiation between the volume of effluent and septage generated from tanks, hence to reduce the maximum error it is assumed to be 50% each. Therefore, 9% of FS i.e. effluent from tanks goes into open drains and the rest is emptied from tanks whenever full. Some FS is always left in the tanks and is assumed to be 2% in the case of tanks connected to open drains. Whereas FS from pits and tanks without overflow is considered contained and is calculated as 3%, it includes infiltration of water as well.

According to Census 2011, FGDs and KIIs it is estimated that around 3.5% of the population still practices open defecation. Definition and estimation of different variables (used to make SFD) are explained below.

Containment system:

Census divides sanitation systems into eight types of containment systems but field based research revealed that there are around 13 types of systems prevalent in Delhi. The septic tanks prevalent in the city are not adhering to the design prescribed by Bureau of Indian Standards (BIS). All the 13 types of systems are listed below.

Table 9: Containment systems and corresponding percentage of population using these systems

S. no.	Containment	SFD reference variable	Percentage of population
1	User interface discharges directly to open ground	T1A1C8	1.0
2	Septic tank connected to open drain or storm sewer	T1A2C6	6.6
3	Lined tank with impermeable walls and open bottom, connected to an open drain or storm sewer.	T1A4C6	0.1
4	Fully lined tank (sealed) connected to an open drain or storm sewer	TIA3C6	10.5
5	User interface discharges directly to open drain or storm drain	T1A1C6	2.3
6	Fully lined tank (sealed), no outlet or overflow	T1A3C10	5.7
7	User Interface discharges directly to a centralised foul/separate sewer	T1A1C2	65.1
8	Septic tank connected to open ground	T1A2C8	0.5
9	Open defecation	T1B11C8	3.7
10	Lined pit with semi-permeable walls and open bottom, no outlet or overflow, general situation	T1A5C10	2.7
11	Lined tank with impermeable walls and open bottom, no outlet or overflow, where there is a 'low risk' of groundwater pollution.	T1A4C10	1.1
12	Septic tank connected to don’t know where	T1A2C9	0.4
13	Unlined pit, no outlet or overflow, where there is a low risk of groundwater pollution.	T1A6C10	0.2

The calculation tool can incorporate only ten containment systems for one SFD hence the similar systems were combined together to form 10 systems. The systems which were combined together are coded with same colors in the above table.

The new systems, their schematic reference and corresponding percentage of the population is listed in the table 10.

Table 10: Estimation for the SFD matrix calculations on containment

Type of System	SFD reference variable	Description of sanitation containment system	Containment systems schematics reference	Percentage of population
Offsite systems	**T1A1C6**	User Interface discharges directly to open drain or storm sewer	Reference L4	2.3
	T1A1C2	User Interface discharges directly to a centralised foul/separate sewer	Reference L1	65.1
	T1A1C8	User interface discharges directly to open ground	Reference L5	1
Onsite systems	**T1A3C6**	Fully lined tank (sealed) connected to an open drain or storm sewer	Reference L8	10.5
	T1A2C6	Septic tank connected to open drain or storm sewer	Reference L8	6.6
	T1A3C10	Fully lined tank (sealed), no outlet or overflow	Reference L10	5.7
	T1A2C8	Septic tank connected to open ground	Reference L9	0.9
	T1A4C6	Lined tank with impermeable walls and open bottom, connected to an open drain or storm sewer.	Reference L8	0.1
	T1A5C10	Lined pit with semi-permeable walls and open bottom, no outlet or overflow, general situation	Reference L11	4.1
Open Defecation	**T1B11C7 to C9**	Open defecation	Reference L20	3.7

Table 11: Description and estimation of variables used in SFD for containment systems

Variable	Description	Estimated percentage of population
W2	WW contained centralized (offsite)	65
W15	WW not contained (offsite)	3
F2	FS contained (onsite)	10
F10	FS not contained (onsite)	18
OD9	Open defecation	4

According to the field based research W2 is estimated to be around 65% and W15 is estimated to be 3%. T1A1C2 feeds into W2 and T1A1C6 and T1A1C8 feeds to W15. F2 is estimated to be around 10% which includes T1A3C10 and T1A5C10. F10 is estimated to be around 18% which constitutes of T1A3C6, T1A2C6, T1A2C8 and T1A4C6. Since there is no clear demarcation in the amount of solid FS generated and effluent/infiltration generated from an onsite system, it is assumed to be 50% each. The percentage of population using their systems with emptying is estimated based on the field based research. Percentage of population defecating in open i.e. OD9 is estimated to be around 4%.

Table 12: Description and estimation of variables used in SFD for emptying and transportation

Variable	Description	Estimated percentage of population
W11a	WW not delivered to centralized treatment plant	10%
W4a	WW contained delivered to treatment plant	55%
W11c	WW not contained not delivered to treatment plant	10%
W4c	WW not contained delivered to treatment plant	2%
W11	WW not delivered to treatment	20%
F3a	FS contained- emptied	7%
F3b	FS not contained- emptied	7%
F3	FS emptied	14%
F8	FS contained- not emptied	3%
F15	FS not contained- not emptied	2%
F11	FS not delivered to treatment	13%
F4	FS delivered to treatment plant	1%

Emptying and Transportation:

According to Census and field based research W4a is estimated to be 55%. It implies that sewage of 55% population of Delhi is reaching STP. W11a and W11c is estimated to be around 10% each. W11a accounts for majorly leakage and sewage that does not reach STP. W11c accounts for the wastewater conveyed in open drains. Some drains are intercepted to treat the WW at STP hence W4c is estimated to be 2%. The septic tanks/tanks connected to open drain is not contained hence the effluent (9% FS) from these tanks is also added to W11c and W4a. In total the WW not delivered to treatment plant i.e. W11 (=W11a+W11c) comes out to be 20%.

The FS emptied from contained systems (T1A3C10 and T1A5C10), i.e. F3a is estimated to be 7% and FS emptied from not-contained systems (T1A2C6, T1A3C6, T1A4C6 and T1A2C8) is also estimated to be 7%. In total FS emptied i.e. F3 (=F3a+F3b) comes out to be 14%. There is some FS always left in tanks and pits and some FS infiltrates as water into the ground, for contained systems it is defined as F8 and estimated to be 3%. For not-contained systems it is defined as F15 and is estimated to be around 2%. Some FS finds its way to the STP hence F4=1%.

Table 13: Description and estimation of variables used in SFD for treatment and disposal

Variable	Description	Estimated percentage of population
W5a	WW treated at centralized treatment plants	52%
F5	FS treated	1%

Treatment and disposal:
Delhi has the highest numbers of STPs in India. It is estimated that WW of 52% of population of Delhi is getting treated, hence W5a=52%. Based on the field based research W12a was estimated to be 5%, which means that WW of 5% population is not getting treated though it is reaching the STP. F11 is estimated to be 13%, which implies that majority of FS that is emptied is discharged untreated in local environment. Some FS is getting co treated with sewage at STP and is estimated to be 1%, hence F5=1%. All the WW and FS with or without treatment is disposed in Yamuna River.

It can be concluded that excreta of 56% population is managed safely in Delhi and 44% of excreta is discharged in environment untreated.

3.3 Discussion of certainty/uncertainty levels of associated data used for the SFD matrix

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 different types of user interfaces or between septic tanks and pit latrines but not about the design of the actual containment systems on ground level. Therefore, a sample household survey was conducted in OSS dependent wards of the city to identify and cross check the data collected from the Census, 2011.

There is uncertainty in the data collected through survey as well. The data was collected from 283 households, which is a very small sample to represent the whole city. Though it was made sure that 5-10 households from selected wardsare surveyed, representing households from planned and unplanned areas and different socio economic backgrounds. No other agency was hired for the survey, CSE's representative conducted the KIIs, FGDs and primary surveys.

According to CPCB reports there are 34 operational STPs (CPCB, 2015). According to DJB press release 30 STPs are running at 17 locations (DJB, 2015). The quantity of wastewater generated and treatment figures were slightly different DJB reports and CPCB reports, this is due to the reports published at different timeline. To prepare an SFD latest sewage generation figure i.e. 3831 MLD and treatment 2250 MLD is taken, which is summarized in the table:-

Table 14: Data on generation, capacity and treatment (in MLD)

	CPCB	**DJB**
Sewage generation	3831	3087
Treatment capacity	2693	2676
Treatment	1950	2250

Assumption regarding the amount of FS emptied as compared to FS generated has high impact on the overall SFD. 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 varies. However, based on survey, it is assumed that, respondents getting their OSS emptied within 6 years are using their systems with emptying and respondents getting their OSS emptied after 6 years are using their system without emptying.

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).

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. Overall, 30 KIIs were conducted with different stakeholders like government functionaries, emptiers, masons and community representatives (see appendix 7.2). Apart from KIIs, survey was also conducted, which included interviews with representative from NGOs, institutions, New Delhi Railway Station 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, published and unpublished reports like CDP, Slum Free City Plan of Actions (SFCPoA) etc. Interview with the private emptiers and other stakeholders provided additional insight into the service delivery context.

4.2 Field observations

In order to get a better picture of variety/typology of onsite sanitation system primary surveys were conducted. Sample was carefully chosen to get good spatial representation from each ward of OSS dependence based on Census, 2011 (please refer figure 15). At-least 5-10 households were surveyed in each of the selected wards of Delhi. It was made sure that respondents from slums are surveyed as well. The surveyor also recorded the field observations related to sanitation. Such surveys, observations and KIIs helped to produce a more credible and accurate SFD, provides qualitative data and perhaps more precise quantitative data relating to the service delivery. Some of the observations are listed below. It was observed that few economically weaker section (EWS) households have poorly constructed toilets. The toilet is generally constructed for females in the house, male members and kids practice open defecation. The containment system varies according to the economic section of the society. Due to such variation of containment system in the city, it was decided on the field to conduct survey with OSS dependent wards of the municipal area. A visit was done to observe the various disposal points of sewage and septage in the city. Observation in the city also helped in sample selection as it gave a better understanding of the city context.

It was observed that septic/fully lined tanks are largely connected to open drains or the open grounds. It was also observed during the survey that residential area of few wards have self-financed sewer system. It was reported that the existing sewer network have deficiencies at some places, hence there is an overflow from sewers into storm water drains. Households have damaged or collapsed containment systems (septic tanks, fully lined tanks, partially lined tanks) and hence not functioning as containment, but releasing faecal sludge in to open drain or storm sewer. During the survey it was found that some households have properly constructed septic tanks. In some cases, due to lack of knowledge on emptying period, the tanks were emptied more frequently than recommended period by BIS. Range of emptying period observed during field based survey is listed below:-

Table 15: Range of emptying period

Containment	Range of emptying period
Septic tanks	6 months – 7 years
Fully lined tank connected to open drain	1 year – 25 years
Fully lined tank with no outlet overflow	1 month – 3 months
Lined pit with semi-permeable walls and open bottom	5 years – 15 years

During the survey with private emptiers it was observed that, in emptying business few operators hire vehicles from other operators based on the demand. Tractors mounted vacuum tankers are more preferable over trucks because tractors are available at low cost with low operation and maintenance cost. Moreover, tractor can be easily driven through narrow lanes as compared to truck mounted vehicles.

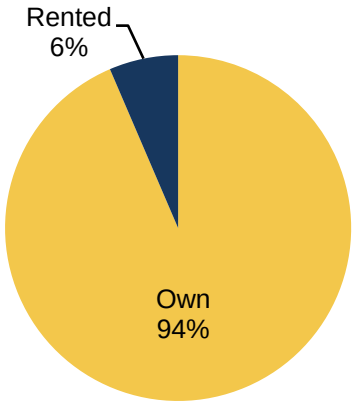

Figure 11: Vehicle ownership

The emptying fee ranges from INR 500 to INR 3000. During the FGDs and the survey with private emptiers it was learnt that the emptying fee varies. The below given pie-chart shows the range of emptying fee charged by emptiers.

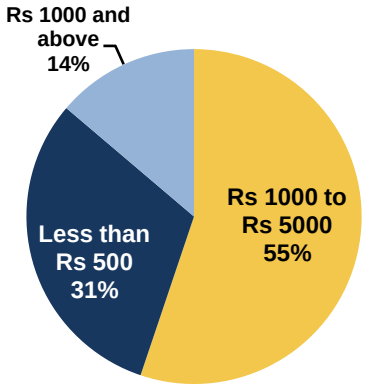

Figure 12: Emptying fee

The average distance travelled for discharging the collected septage is 5 km. Emptiers generally don't travel more than 5 km for disposal, to save time, fuel and money.

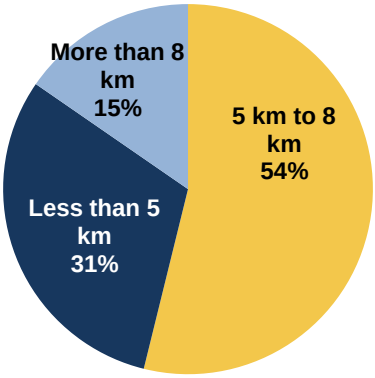

Figure 13: Average distance travelled by emptying vehicle

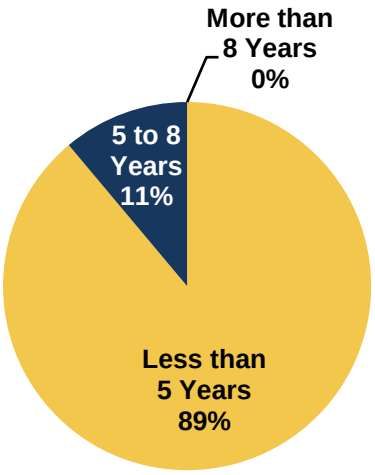

Figure 14: Age of vehicle

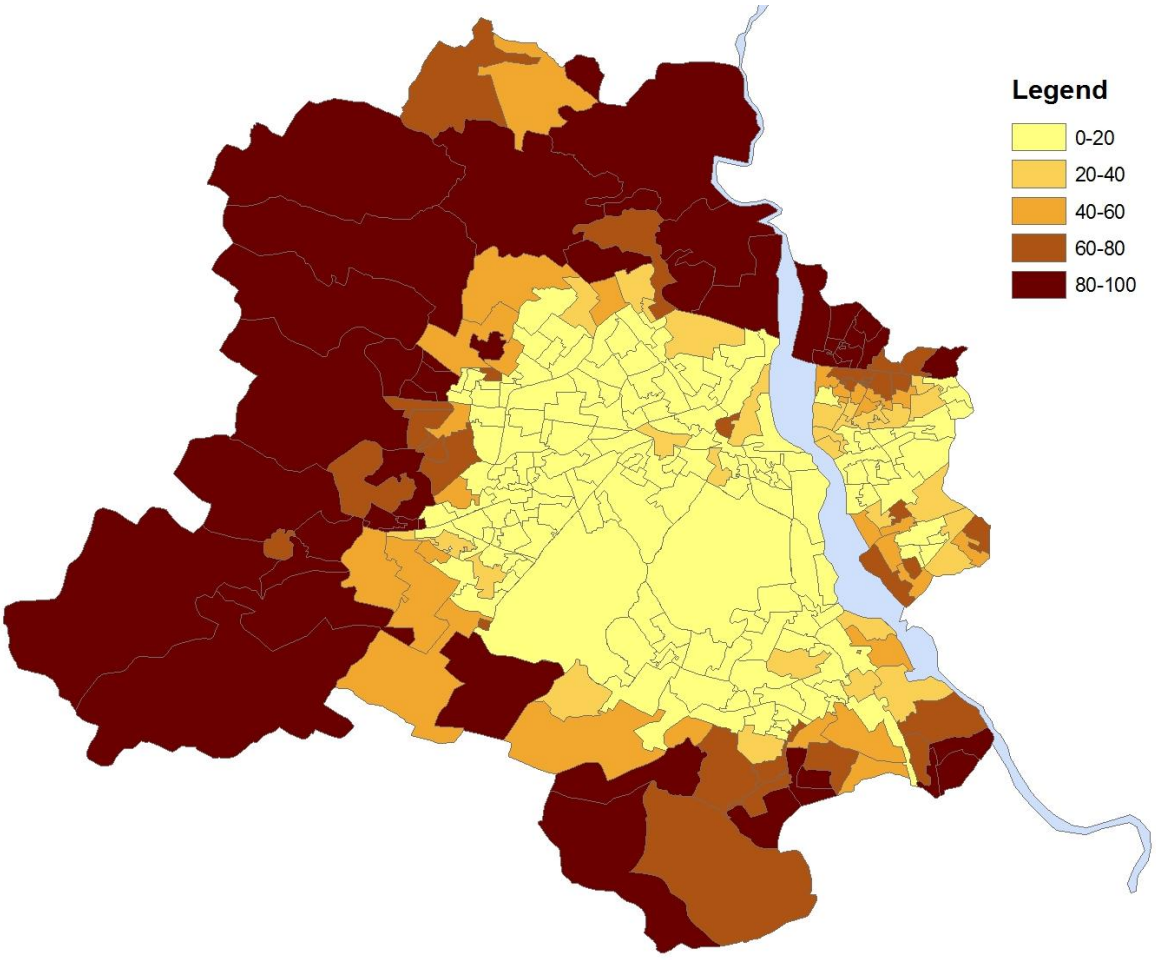

Figure 15: Map of OSS dependence area (Source: Based on Census, 2011)

4.3 Focus group discussions

The FGDs were conducted to complement, validate and challenge data collected during literature review and interviews. In total, 4 FGD sessions were conducted. FGDs were held with DJB officials and private emptiers. The questionnaires for FGDs were prepared in English, but the interviewer asked the questions, translating into the Hindi language. The findings from the FGD sessions revealed information that increased the understanding of the sanitation and septage management in Delhi. FGDs were useful in data triangulation. Primary survey helped in validating secondary data and data provided by different stakeholders. It resulted in actual and true SFD of the city.

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 Mr B.M. Dhaul, Member (Drainage), DJB, Mr R.S. Tyagi, Member (Water Supply), DJB, Mr S.K. Mahajan, Superintendent Engineer, DUSIB, Dr D. D Basu Former Scientist, CPCB for providing information for this assessment. Ms Shambhavi Shukla and Mr Pradip Mishra, Research interns at CSE helped in conducting in primary survey and FGDs on ground, without their help this report would not have been possible. A special thanks to Dr. Suresh Kumar Rohilla, Programme Director, CSE, for his supervision and guidance at every step of the assessment and report writing.

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7 Appendix

7.1 Appendix 1: Stakeholder identification

Table 16: Stakeholder identification

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

7.2 Appendix 2: Tracking of engagement

Table 17: Tracking of engagement

S.No.	Name of Organization	Designation	Date of engagement	Purpose of engagement
1	DJB	Member Drainage	22.9.2015	Introduction of SFD and FGD
2	DJB	Chief Engineer (Drainage)	22.9.2015	
3	DJB	Superintendent Engineer	22.9.2015	
4	DJB	Executive Engineer (SDW)	22.9.2015	
5	DUSIB	Superintendent Engineer	6.10.2015	KII
6	DUSIB	Superintendent Engineer	6.10.2015	KII
7	DUSIB	Assistant Engineer	6.10.2015	Data Collection
8	CPCB	Scientist D	30.10.2015	Introduction of SFD
9	CPCB	Scientist C	30.10.2015	Data collection, KII
10	CPCB	Former Scientist E	5.02.2015	Data collection, KII
11	CPCB	Scientist E	28.11.2015	KII
12	DJB ,VasantKunj, STP	Shift Engineer	21.08.2015	STP visit and KII
13	DJB, Coronation Pillar, STP	Junior Engineer	16.12.2015	
14	DJB , Rithala, STP	Chemist	15.12.2015	
15	DJB, Okhla, STP	Junior Engineer	14.12.2015	
16	DJB, Dwarka	Junior Engineer	10.09.2015	
17	DUSIB	Night shelter Delhi, Incharge	27.10.2015	KII
18	MCD	Public toilet in-charge, Govindpuri	16.09.2015	KII
19	MCD	Public toilet in-charge, VasantVihar	23.10.2015	KII
20	DUSIB	Public toilet in-charge, Bhumiheen Camp	16.09.2016	KII
21	DUSIB	Public toilet in-charge, sarvodya Camp	16.09.2017	KII
22	DUSIB	Public toilet in-charge, Okhla Phase 1	10.10.2015	KII
23	DUSIB	Night shelter Delhi, In-charge	27.10.2015	KII
24	MCD	Public toilet in-charge, Govindpuri	16.09.2015	KII
25	MCD	Public toilet in-charge, VasantVihar	23.10.2015	KII
26	New Delhi Railway Station	Health Inspector	02.11.2015	KII
27	SISSO	Deputy controller	21.08.2015	KII
28	SDMC Primary school,Jaitpur	Principle	12.10.2015	Survey
29	Sarvodayakanyavidyalaya, Nagloi	Principle	12.10.2015	Survey
30	Bandhu Camp Vasant	Community representative	16.09.2015	KII

31	Bawana	Community representative	23.09.2015	KII
32	KusumpurPahadi	Community representative	23.10.2015	KII
33	Khera Kalan	Community representative	28.10.2015	KII
34	Bandhu Camp VasantKunj	Community representative	16.09.2015	KII
35	Private	Mason, Kondli	21.09.2015	KII
36	Private	Plumber, KhajooriKhas	21.09.2015	KII
37	Private	Mason, Bhaktawarpur	21.09.2015	KII
38	Private	Mason, Jaitpur	10.12.2015	KII
39	Private	Mason, Pratap Nagar	28.10.2015	KII
40	Private	Mason, Najafgarh	28.10.2016	KII
41	Private	Mason, Karala	28.09.2015	KII
42	Private	Mason, Bawana	23.09.2015	KII
43	Hotel, karolBagh	Manager	27.10.2015	Commercial establishments survey
44	Market Association, HauzKhas	President	23.10.2015	
45	Market Association, Safdarjung Development Area (SDA) Market	President	23.10.2015	
46	Market Association, Khan Market	Association Head	27.10.2015	
47	DLF Prominade Mall, VasantKunj	SHE Engineer	23.10.2016	
48	Ambience Mall, VasantKunj	Deputy General Manager	23.10.2017	
49	DLF Emporio, VasantKunj	HSE Engineer	23.10.2018	
50	Mc Donald's	Supervisor	27.10.2015	
51	Private Desludger union, Prem Nagar	Union Member	28-09-15	FGD
52	Private Desludgerunion,Uttam Nagar	President	10/8/2015	FGD
53	Private Desludger union, Najafgarh	President	6/8/2015	FGD

7.3 Appendix 3: SFD matrix

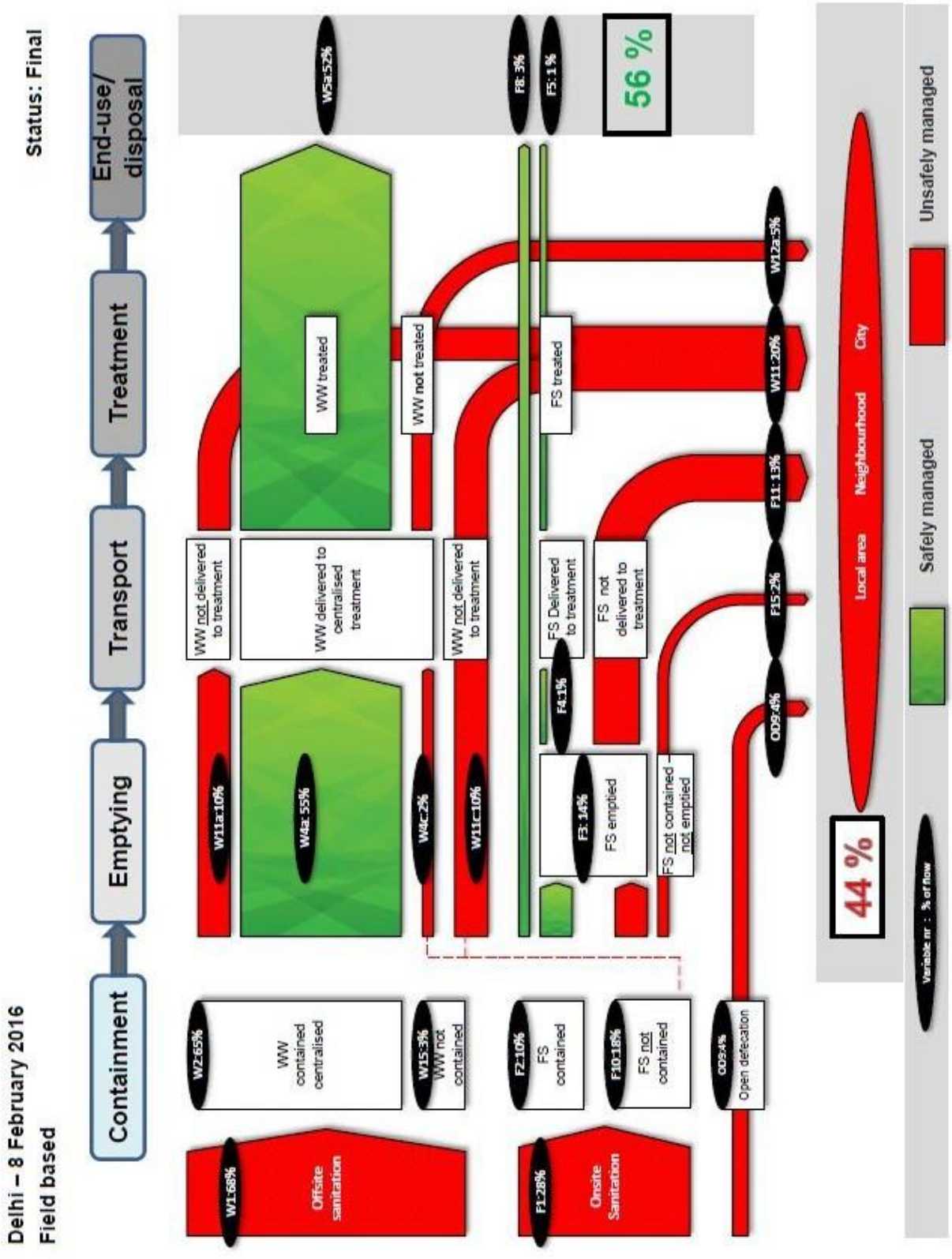


Figure 16: SFD matrix

7.4 Appendix 4: SFD calculation tool

Table 18: Sanitation containment system of Delhi as in the SFD calculation tool

Questions	Question A Where does the user interface discharge to? (i.e. what type of container, if any?).	Question B Where the user interface and /or container is abandoned, failed, damaged, collapsed, not working or open defecation is practiced, select which option applies	Question C What is the containment (or user interface if no containment) connected to? (i.e. where does the outlet or overflow discharge to?)	Question D What is the risk of pollution of groundwater ? Determine risk using ' Tab 3 – Question D'	Containment and emptying outcome	Tab 1 ref
Answers for system 1	No onsite container, user interface discharges directly to destination given in question C	Not applicable – question A applies	to centralised foul/separate sewer	Low risk	contained, emptying not applicable	**T1A1C2**
Answers for system 2	No onsite container user interface discharge directly bto destination given in question C	Not applicable – question A applies	to open drain or storm sewer	Low risk	Not contained, emptying not applicable	**T1A1C6**
Answers for system 3	No onsite container user interface discharge directly bto destination given in question C	Not applicable – question A applies	to open ground	Low risk	Not contained, emptying not applicable	**T1A1C8**
Answers for system 4	Septic tank	Not applicable – question A applies	to open drain or storm sewer	Low risk	Not Contained, emptying possible	**T1A2C6**
Answers for system 5	Fully lined tank (sealed)	Not applicable – question A applies	to open drain or storm sewer	Low risk	Not contained, emptying possible	**T1A3C6**
Answers for system 6	Fully lined tank (sealed)	Not applicable – question A applies	no outlet or overflow	Low risk	Contained, emptying possible	**T1A3C10**
Answers for system 7	Lined tank with impermeable walls and open bottom	Not applicable – question A applies	to open drain or storm sewer	Low risk	Not contained, emptying possible	**T1A4C6**
Answers for system 8	Septic tank	Not applicable – question A applies	to open ground	Low risk	Not contained, emptying possible	**T1A2C8**
Answers for system 9	Lined tank with impermeable walls and open bottom	Not applicable – question A applies	no outlet or overflow	Low risk	Contained, emptying possible	**T1A5C10**
Answers for system 10	Not applicable – question B applies	Open defecation	To open ground	Low risk	Not contained, emptying not applicable	**T1B11C7 to C9**

7.5 Appendix 5: Raw water sources and water production

Table 19: Raw water sources and water production

S.No.	Name of WTP	Production including Recycling from process waste (MLD)	Source of Raw Water Supply
1	CHANDRAWAL	423	Wazirabad pond
2	WAZIRABAD	607.5	Wazirabad pond
3	HAIDERPUR	1017	Delhi Branch (Existing Kacha Canal)
4	NANGLOI	180	
5	OKHLA	45	Raw water comes through Munak Canal. However, as interim arrangement reclaimed water from Chandrawal recycling plant is being pumped to Okhla WTP
6	DWARKA	-	
7	BAWANA	-	
8	BHAGIRATHI	481.5	Upper Ganga Canal
9	SONIA VIHAR	634.5	
A	Production from WTPs	3388.5	From surface water
B	Ranney Wells (15 Nos. and T/Wells (about 4400)	360	From sub-surface water
	Total (A+B)	3748.5 MLD	

7.6 Appendix 6: Organogram of Delhi Jal Board

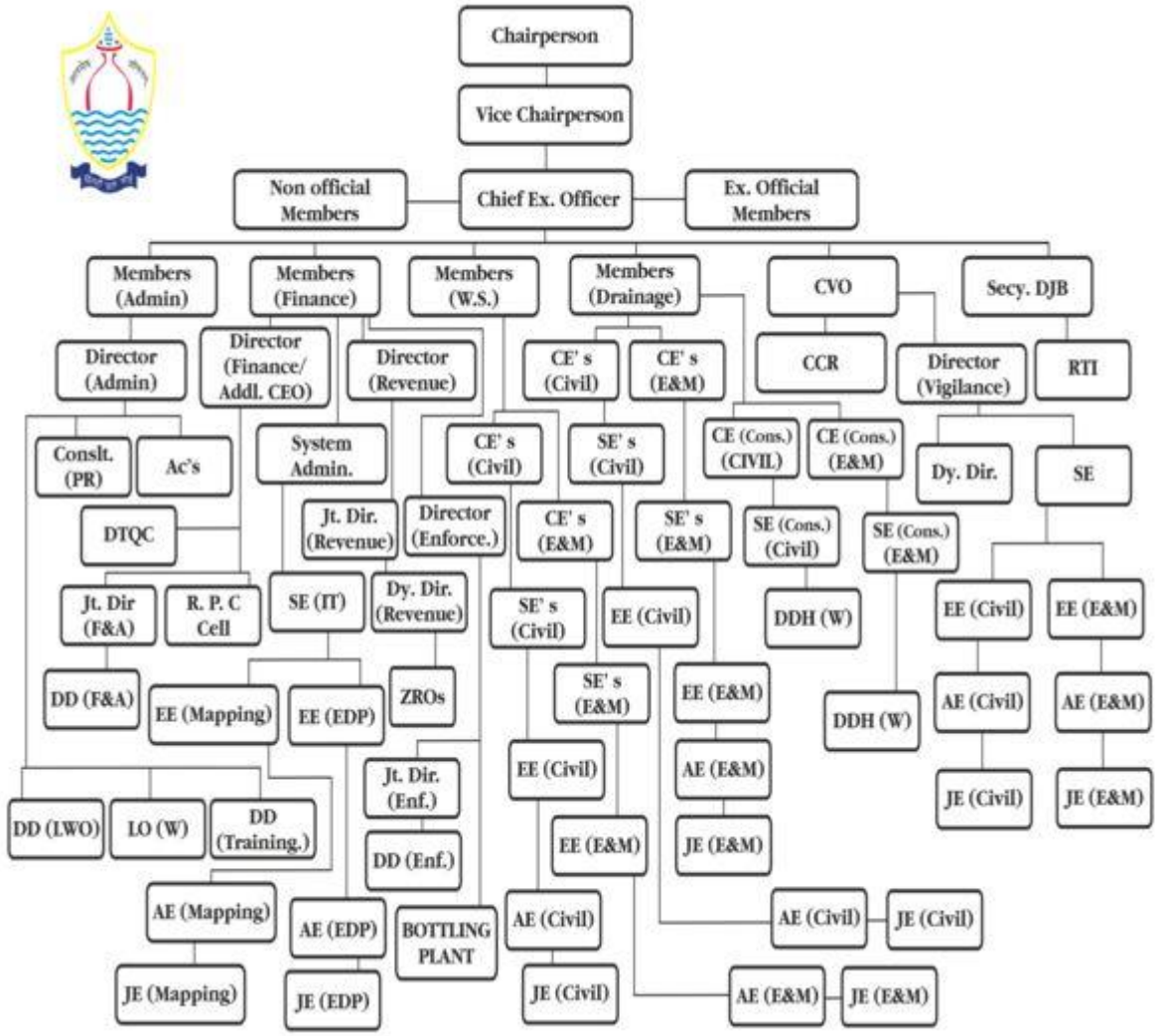
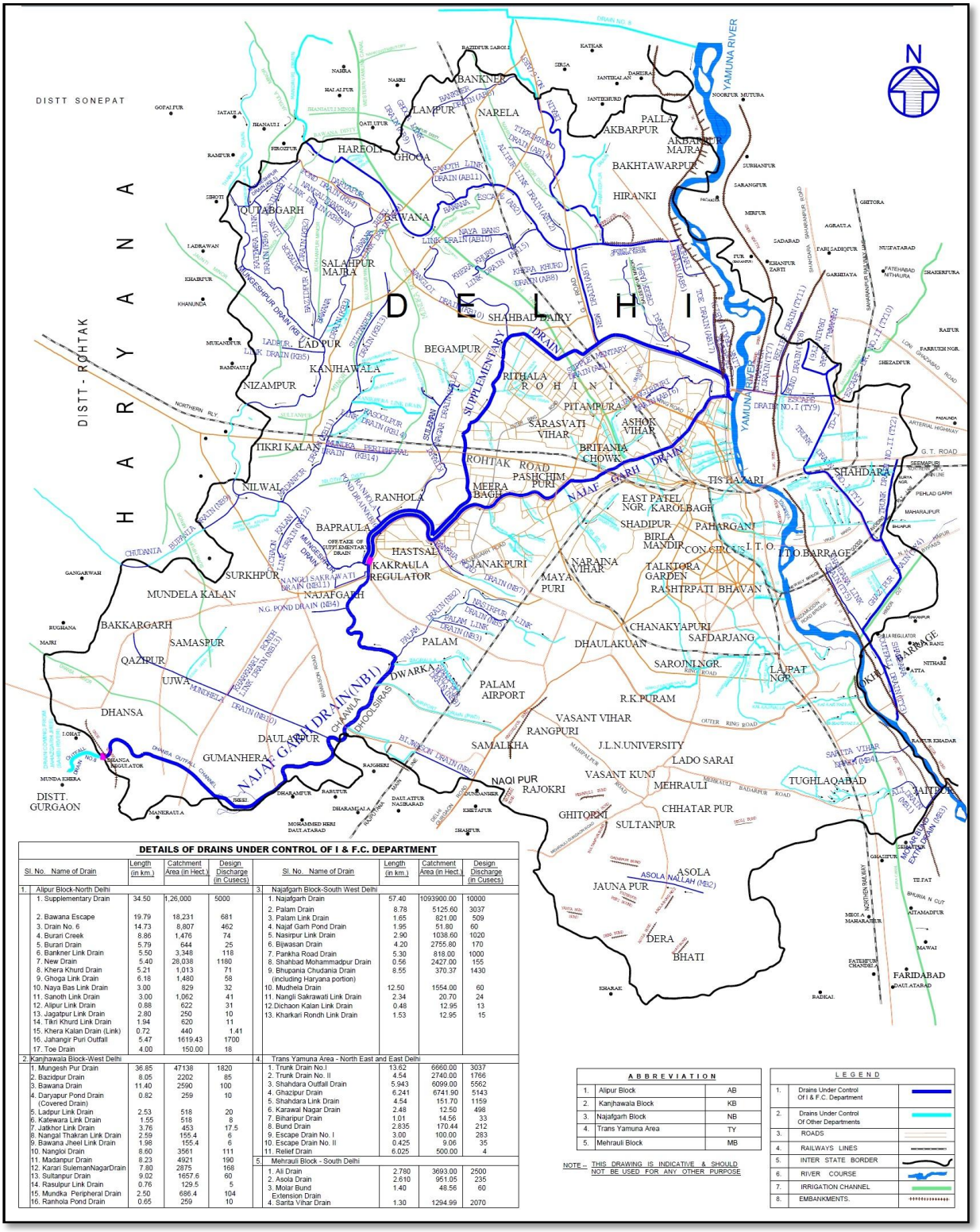


Figure 17: Organogram of Delhi Jal Board

7.7 Appendix 7: Maps of Delhi



DETAILS OF DRAINS UNDER CONTROL OF I & F.C. DEPARTMENT

Sl. No.	Name of Drain	Length (in km.)	Catchment Area (in Hect.)	Design Discharge (in Cusecs)
1.	Alipur Block-North Delhi			
1.	Supplementary Drain	34.50	1,26,000	5000
2.	Bawana Escape	19.79	18,231	681
3.	Drain No. 6	14.73	8,807	462
4.	Burari Creek	8.86	1,476	74
5.	Burari Drain	5.79	644	25
6.	Bankner Link Drain	5.50	3,348	118
7.	New Drain	5.40	28,038	1180
8.	Khera Khurd Drain	5.21	1,013	71
9.	Ghoga Link Drain	6.18	1,480	58
10.	Naya Bas Link Drain	3.00	829	32
11.	Sanoth Link Drain	3.00	1,062	41
12.	Alipur Link Drain	0.88	622	31
13.	Jagatpur Link Drain	2.80	250	10
14.	Tikri Khurd Link Drain	1.94	620	11
15.	Khera Kalan Drain (Link)	0.72	440	1.41
16.	Jahangir Puri Outfall	5.47	1619.43	1700
17.	Toe Drain	4.00	150.00	18
2.	Kanjhawala Block-West Delhi			
1.	Mungesh Pur Drain	36.85	47138	1820
2.	Bazidpur Drain	8.05	2202	85
3.	Bawana Drain	11.40	2590	100
4.	Daryapur Pond Drain (Covered Drain)	0.82	259	10
5.	Ladpur Link Drain	2.53	518	20
6.	Katewara Link Drain	1.55	518	8
7.	Jakhor Link Drain	3.76	453	17.5
8.	Nangal Thakran Link Drain	2.59	155.4	6
9.	Bawana Jheel Link Drain	1.98	155.4	6
10.	Nangloi Drain	8.60	3561	111
11.	Madanpur Drain	8.23	4921	190
12.	Karari SulemanNagarDrain	7.80	2875	168
13.	Sultanpur Drain	9.02	1657.6	60
14.	Rasulpur Link Drain	0.76	129.5	5
15.	Mundka Peripheral Drain	2.50	686.4	104
16.	Ranhola Pond Drain	0.65	259	10
3.	Najafgarh Block-South West Delhi			
1.	Najafgarh Drain	57.40	1093900.00	10000
2.	Palam Drain	8.78	5125.60	3037
3.	Palam Link Drain	1.65	821.00	509
4.	Najaf Garh Pond Drain	1.95	51.80	60
5.	Nasirpur Link Drain	2.90	1038.60	1020
6.	Bijwasan Drain	4.20	2755.80	170
7.	Pankha Road Drain	5.30	818.00	1000
8.	Shahbad Mohammadpur Drain	0.56	2427.00	155
9.	Bhupania Chudania Drain (including Haryana portion)	8.55	370.37	1430
10.	Mudhela Drain	12.50	1554.00	60
11.	Nangli Sakrawati Link Drain	2.34	20.70	24
12.	Dichaon Kalan Link Drain	0.48	12.95	13
13.	Kharkari Rondh Link Drain	1.53	12.95	15
4.	Trans Yamuna Area - North East and East Delhi			
1.	Trunk Drain No.I	13.62	6660.00	3037
2.	Trunk Drain No. II	4.54	2740.00	1766
3.	Shahdara Outfall Drain	5.943	6099.00	5562
4.	Ghazipur Drain	6.241	6741.90	5143
5.	Shahdara Link Drain	4.54	151.70	1159
6.	Karawal Nagar Drain	2.48	12.50	496
7.	Biharipur Drain	1.01	14.56	33
8.	Bund Drain	2.835	170.44	212
9.	Escape Drain No. I	3.00	100.00	283
10.	Escape Drain No. II	0.425	9.06	35
11.	Relief Drain	6.025	500.00	4
5.	Mehrauli Block - South Delhi			
1.	Ali Drain	2.780	3693.00	2500
2.	Asola Drain	2.610	951.05	235
3.	Molar Bund Extension Drain	1.40	48.56	60
4.	Sarita Vihar Drain	1.30	1294.99	2070

ABBREVIATION		
1.	Alipur Block	AB
2.	Kanjhawala Block	KB
3.	Najafgarh Block	NB
4.	Trans Yamuna Area	TY
5.	Mehrauli Block	MB

NOTE :- THIS DRAWING IS INDICATIVE & SHOULD NOT BE USED FOR ANY OTHER PURPOSE

LEGEND		
1.	Drains Under Control Of I & F.C. Department	
2.	Drains Under Control Of Other Departments	
3.	ROADS	
4.	RAILWAYS LINES	
5.	INTER STATE BORDER	
6.	RIVER COURSE	
7.	IRRIGATION CHANNEL	
8.	EMBANKMENTS.	

Figure 18: Drainage map of Delhi

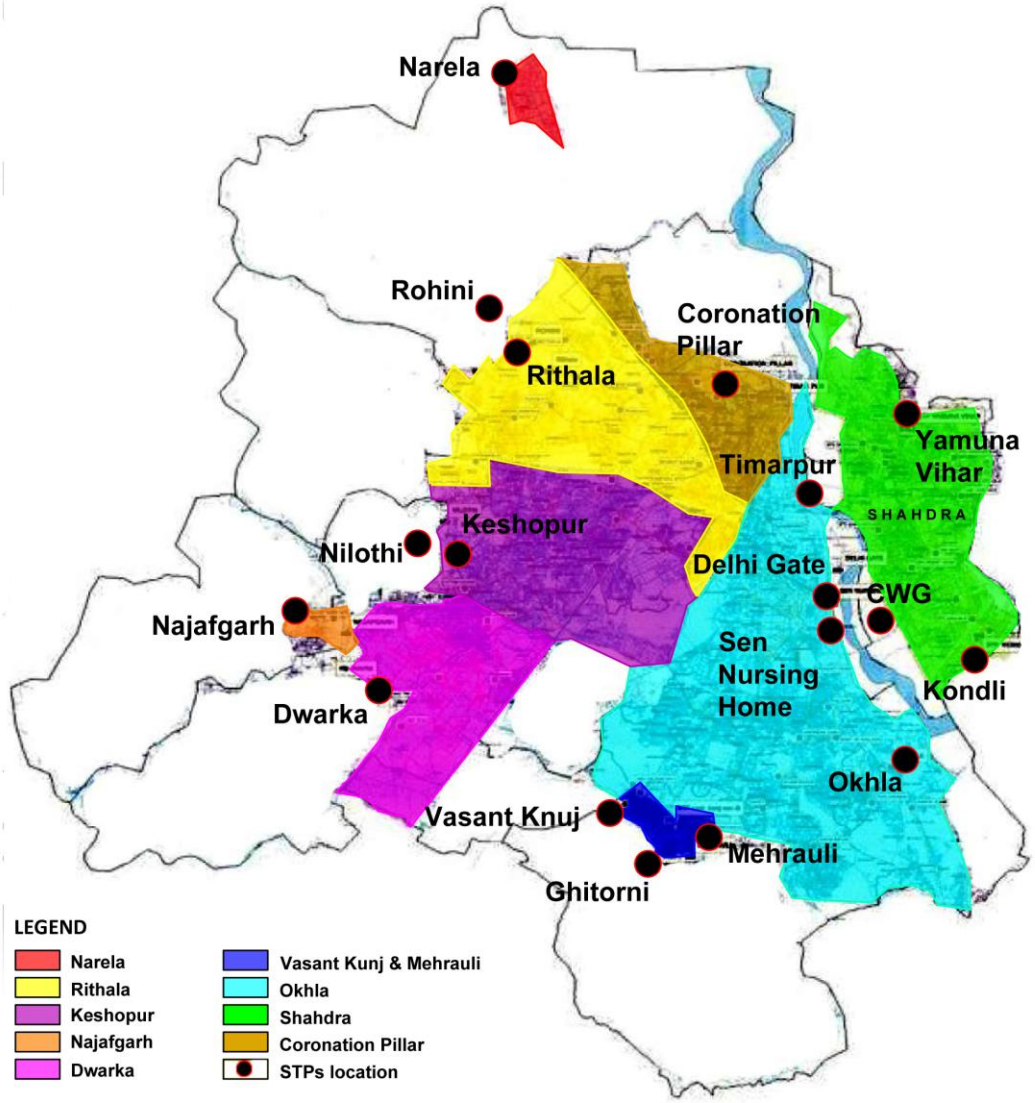


Figure 19: STPs command area

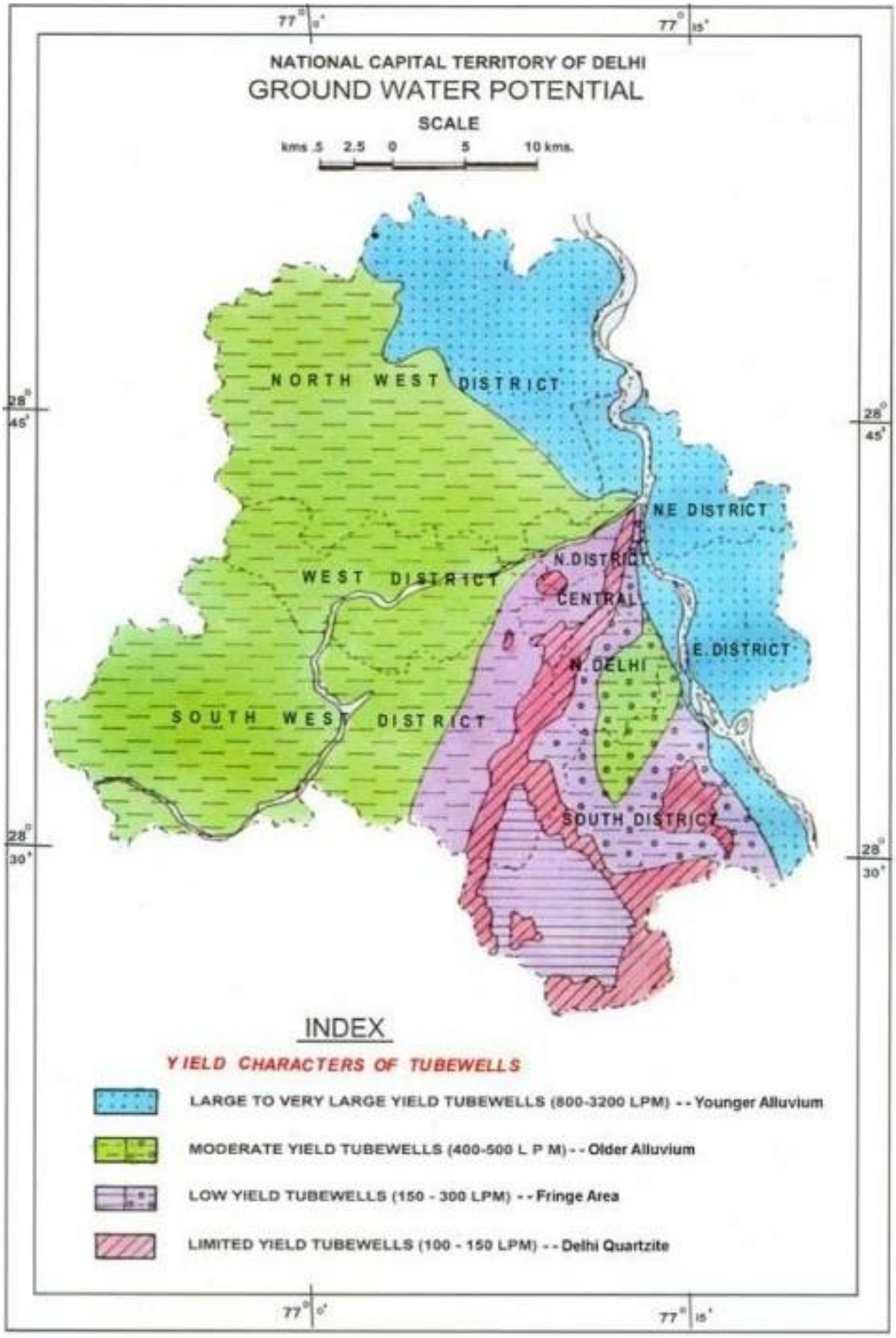


Figure 20: Groundwater potential

7.8 Appendix 8: Public toilet survey

Table 20: Public toilet survey

S.No.	Location	Organisation	Type	No.of Toilets		water Consumption	Effluent connected to	No of Users/ day
1	Guru Ravidasmarg, Govindpuri	SDMC	Public Toilet	Male	10	30,000 l/d approx	Sewerage Network	100-150
				Female	10			
2	Bhumiheen Camp, Govindpuri	DUSIB	Community toilet	Male	15		Sewerage Network	500-600
				Female	15			
3	Sarvodya Camp, Govindpuri	DUSIB	Community toilet	Male	14	20,000 l/d approx	Sewerage Network	200-300
				Female	7			
4	Chandanichowk	DUSIB	Public Toilet	Male	42		Sewerage Network	N/A
				Female	7			
	Indira KalyanVihar, Okhala phase-I	DUSIB	Public Toilet	24			Storm water Drain	
5	AzadpurMandi	SISSO	Public Toilet	44			Sewerage Network	100-200
6	Laxmi Nagar	SISSO	Public Toilet	Male	4		Sewerage Network	100-200
				Female	4			

7.9 Appendix 9: Sanitation facilities in commercial and educational establishments

Table 21: Sanitation facilities in NDLS and schools

Industries/institutions/commercial establishments	Type	Occupancy	No. of toilets	Type of containment	Emptying period
New Delhi Railway station (NDLS)	PSP	500,000	26	Sewer	NA
Sarvodayakanya Vidhyalaya, Nangloi	PSP	1732	32	Septic Tank	No emptying, entire FS discharged to Nullah using motor
Govt. Boys Sr. Sec. School, Khaira	PSP	635	11	Lined pit	One in 3 days
Jeet public school, Dellopura village	PSP	150	2	Direct discharge to open drain	NA
SDMC Primary school, Jaitpur	PSP			Direct discharge to open drain	NA

Table 22: Sanitation facilities in markets

S.No.	Market	No. of toilet complex/Toilet	Type of containment
1	Azadpur Mandi	7	Sewer
2	Laxmi Nagar	3	Sewer
3	Chandani chowk	5	Sewer
4	Hauzkhas Village		Sewer
5	Khan Market	4	Sewer
6	Vasant Vihar	1	Sewer
7	Govindpuri	1	Sewer
8	DLF Prominade Mall, Vasant Kunj	22	Private STP (Fluidized Aerobic Bio-Reactor)
9	DLF Emporio, Vasant Kunj	18	Private STP (Fluidized Aerobic Bio-Reactor)
10	Ambience Mall, Vasant Kunj	28	Private STP (Fluidized Aerobic Bio-Reactor)

7.10 Appendix 10: Details of STPs based on KII

Table 23: STPs survey

S.No.	Sewerage Treatment Plant	Capacity (MGD)	Treatment technology	Waste water reaching	Waste water treated	BOD (mg/l)		Reuse	Proposals
						Influent	Effluent		
1	Coronation pillar (Ph 1 and 2 combined)	20	Activated Sludge Process (ASP)	15-16	All Waste water treated	148	26	Agriculture use and PWD, DTC uses for construction work	70 MGD in next 3 years
	Coronation pillar Ph. 3	10		5-6		300	28		
2	Rithala Phase 1	40		20-25		155	22	Horticulture and Industrial use	Rehabilitation of the plant
	Rithala Phase 2	40		40		155	11	Horticulture and Industrial use	No
3	Okhla Phase 1	12		107-110					
	Okhla Phase 2	37							
	Okhla Phase 3	45						Edthment pump house and Horticulture	
	Okhla Phase 4	16						Edthment pump house and Horticulture	124 MGD
	Okhla Phase 5	30				175	7 to 8	Horticulture	
4	Dwarka	40		30-35				No reuse, disposed to nullah	No
5	Keshopur	72		60			30	Agriculture	No
6	Vasant Kunj	3		2.70 - 2.65			10 to 12		

7.11 Appendix 11: Photographs of community and public toilets in slums and markets

Figure 21: Public toilets (Source: Anil/CSE, 2015)

Night shelter, Bangla sahib, CP

Figure 22: Prefabricated bio-digester toilets in night shelters (Source: Anil/CSE, 2015)

7.12 Appendix 12: Photographs of household survey in slums

Figure 23: Household survey in slums (Source: Pradip/CSE, 2015)

7.13 Appendix 13: Survey with private emptiers

Figure 24: Survey with private emptiers (Source: Anil/CSE, 2015)

7.14 Appendix 14: Application for the license to run emptying business and dispose septage in pumping stations

PEFORMA OF APPLICATION FOR THE LICENCE FOR COLLECTION, TRANSPORTATION AND DISPOSAL OF SEPTAGE

PASTE PHOTO (SELF ATTESTED)

1. Name of the applicant: Shri/Ms_____
2. Nationality: Indian_____Other_____
3. Address: Regd. Office:_____
   Head office:_____
4. Telephone No.: (O)_____Mobile No._____Email ID_____
5. Registration No. of Vehicle :_____
6. Pollution certificate of the vehicle valid up to:_____
7. Insurance of the vehicle valid up to:_____
8. Fitness of the vehicle valid up to:_____
9. Vehicle, whether fitted with GPS:_____
10. Details of the vehicles indicating leak proof, odour and spill proof having proper vacuum/ suction and discharging arrangement (Document proof of any may be enclosed).
11. Processing fee for licence Rs. 1000/- (Non-refundable)
    D.D. No._____Date_____Bank_____

I/We certify that information given by me/us in column 1 to 11 are true to the best of my knowledge and belief. I also certify that I have read and understood the attached terms and conditions 1 to 13 and agree to abide by them. I agree that if any information given by me is found wrong the application for licence will be liable for cancellation at any time.

Signature(s) of applicant(s)

Date: _____

No. of document attached: _____