# SFD Promotion Initiative

## Bikaner
## India

### Final Report

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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

WEDC

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eawag aquatic research

Sandec Sanitation, Water and Solid Waste for Development

BILL & MELINDA GATES foundation

SFD Report Bikaner, India, 2016

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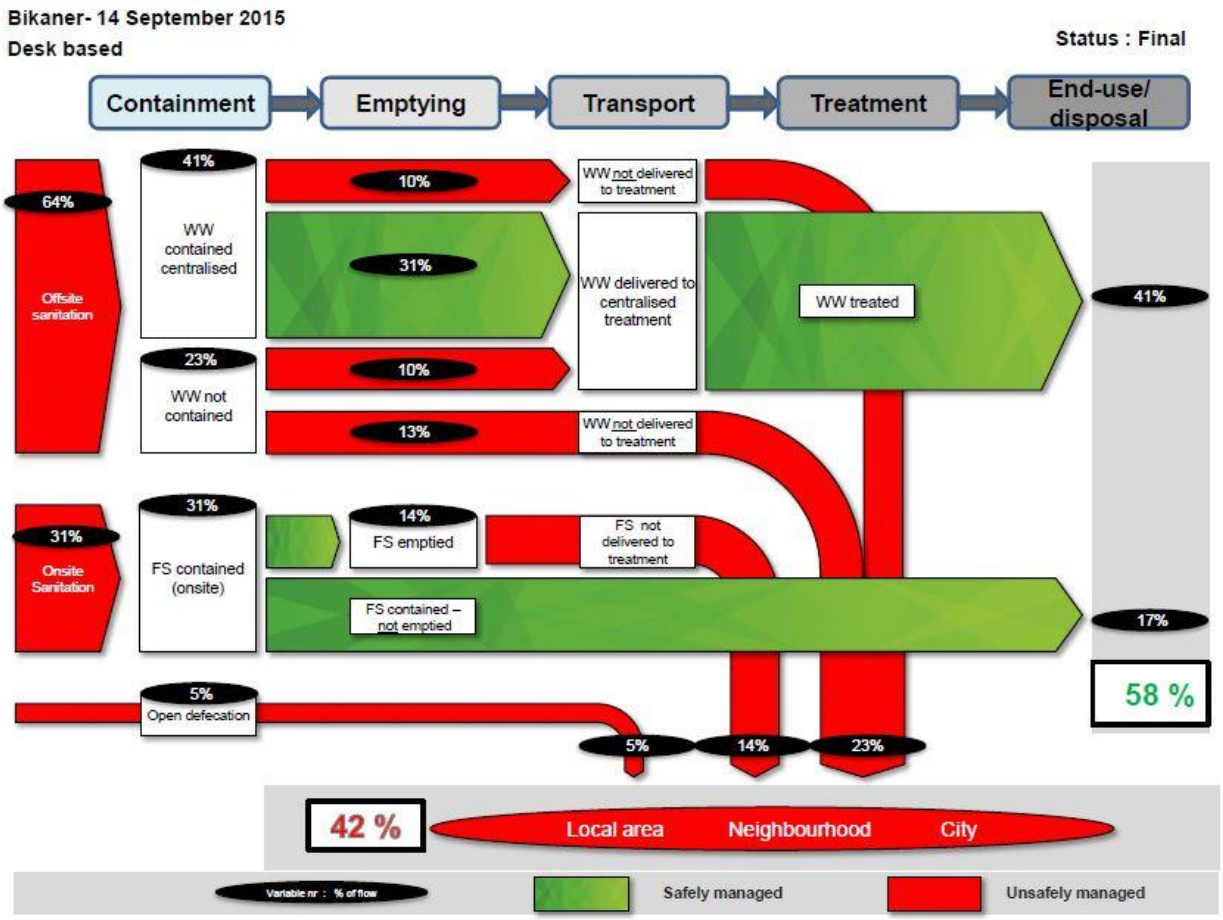
## 1. The Diagram




## 2. Diagram information

### Desk or field based:

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## 3. General city information

Bikaner city lies in the northwest region of Rajasthan state in northern India. The city is the administrative headquarters of Bikaner district. It was formerly the capital of the princely state of Bikaner. Situated in the middle of the Thar desert, it has hot desert climate with very little rainfall and extreme temperatures. In summers temperature can exceed 45 °C, and during the winters it may dip below freezing temperature (CII, 2015).

The population of city as per the Census 2011 is 644,406. The density of city is 4,157 persons per sq.km which is very high when compared to state average of 201 persons per sq.km. Total slum population is 121,855 representing 18.9% of the total population (Census of India, 2011).

Municipal boundary has been chosen for the current study. It comprises of an area of 155 sq.km (BMC, 2015).

## 4. Service delivery context

In 2008, the Ministry of Urban Development (MoUD) issued the National Urban Sanitation Policy (NUSP). The policy aims to: raise awareness, promote behaviour change; achieve open defecation free cities; develop citywide sanitation plans; and provide 100% safe confinement, transport, treatment and disposal of human excreta and liquid wastes. The NUSP mandates states to develop state urban sanitation strategies and work with cities to develop City Sanitation Plans (CSPs). Furthermore, it explicitly states that cities and states must issue policies and technical solutions that address onsite sanitation, including the safe confinement of faecal sludge (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). 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) Act. Municipal acts and regulations usually refer to management of solid and liquid wastes but may not provide detailed rules for septage management (MoUD, 2013).

## 5. Service outcomes

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

Containment: There is sewerage network in some part of the city. Significant number of households do not have onsite sanitation system; the user interface discharges directly to open drains. Peri-urban areas, within municipal boundary, are dependent on lined pits which are locally known as “Kuii”. The pits are constructed circular in shape with diameter of 1.5 to 1.8m, and a depth varying from 4.5 to 15m. These pits are properly covered at the top and are well maintained. These popular pits are referred as sepic tanks in Census 2011.

**Figure 1: WC to open drains (Source: Shantanu & Rahul/CSE, 2015)**

Emptying: Bikaner Municipal Corporation doesn’t provide septage emptying service. The city is dependent on one private emptier with one vacuum tanker of 5,500 litres capacity. The emptying fee is INR 1500/- (22 USD) per trip. Emptying frequency is 20 to 30 years. On an average a private vacuum tanker empties 30 pits per month which also includes services in rural areas, outside municipal boundary. There are no instances of manual emptying reported (S R Garu 2015, pers. comm., 12 March).

Transport: Private emptier transport septage by truck mounted vacuum tanker. Sewage is conveyed to Sewage Treatment Plants (STP) through three Sewage Pumping Stations (SPS) along with trapped open drains, generally open drains are lined.

Treatment: There are three STPs based on Waste Stabilization Pond (WSP) technology with total capacity of 38 MLD. There are no treatment facilities for septage.

End-use/Disposal: The emptied septage is discharged onto barren land at outskirts of the city (S R Garu 2015, pers. comm., 12 March). The treated sewage is used for cultivating vegetables at Vallabh garden. The treated sewage from 12 MLD STP is discharged onto land (BMC, 2015a).There are no separate treatment facilities for septage.

**Figure 2: Treated wastewater disposal point at Vallabh Garden (Source: Shantanu & Rahul/CSE, 2015)**

According to Census, 64% of city is dependent on offsite systems, population connected to sewer line is 41% and user interface directly discharging in open drain is 23%. 10% of waste water is lost in transmission via sewer lines and 13% is lost in transportation via open drains. Around 41% waste water is treated at STP which also includes 10% of waste water tapped from open drains.

Rest of the 31% of the city is dependent on onsite sanitation systems (OSS), out of which 23% is dependent on septic tanks and 8% on pits. The public latrines are connected to septic tanks and hence are incorporated in onsite systems. Lined pits with semi-permeable membrane and open bottom are quite common in Bikaner, but in Census these are referred as septic tanks. Since the ground water table is very low, these pits are considered contained.

There is no clear differentiation between volume of FS infiltrated and septage emptied from the pits, hence it's assumed to be 50% each. But since 90% people are getting their pits emptied, around 14% of FS is emptied and 17% of FS is left in the pits, which includes infiltration of water as well. 5% of population practices open defecation.

## 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 result in large gaps in implementation (USAID, 2010).

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

| Key Stakeholders | Institutions / Organizations |
|---|---|
| Public Institutions | Public Health Engineering Department (PHED), Bikaner Municipal Corporation(BMC), Urban Improvement Trust (UIT) Rajasthan Pollution Control Board (RPCB) |
| Private Sector | Private emptier |

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

PHED and UIT are responsible for planning, designing and construction of sewerage system. Operation and maintenance comes under Bikaner Municipal Corporation (BMC) but presently the functions have not been transferred to BMC and PHED is maintaining the STPs. The city corporation has no regulation on septage management in Bikaner.

One private emptier is responsible for septage management, providing services within the city and some rural areas nearby. PHED and RPCB are responsible for monitoring and evaluation of STPs.

## 7. Credibility of data

One key source of data is used; Census of India, 2011. The data is crosschecked and updated by key informant interviews. Five KIIs have been conducted with different stakeholders.

Data on containment is available in Census. Data on emptying and transport is collected by

KIIs and field visit. However most of the data is qualitative.

Some of the issues and challenges are listed below:

- Data insufficiency and non availability
- Accuracy: Discrepancy observed between Census data and actual ground situation- No proper septic tanks found, lined pit with open bottom prevalent all over the city
- Data available at different time lines
- Limited data available on reuse (formal / informal)

Assumptions followed for preparing SFDs:

- Data provided by Census, 2011 is correct
- Sewer connections on ground are as defined in Census, 2011
- Volume of waste water generated is 80 % of water supplied
- 90% of people dependent on OSS get their systems emptied, when full

## 8. Process of SFD development

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

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

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

Overall 58% of excreta is safely managed in the city and rest of the 42%, which also includes 5% of city defecating in open, is shown unsafe in SFD.

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

The data available is at different timelines, for example data on containment is from Census 2011, and data on emptying and transportation is collected through KIIs conducted in 2015. Whether excreta is safely managed or not is dependent on whether the system is contained or not, and not on whether waste is safely handled.

## 9. List of data sources

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

- Published reports and books:
  - Census of India 2011, House listing and Housing data, Government of India
  - Service levels in water and sanitation sector, MOUD, 2012.
  - Excreta Matters- volume 2, Centre for Science and Environment, 2012
- KIIs with representatives from
  - Government agencies: BMC, PHED
  - Service providers:
  - Private emptiers
- Websites/web links:
  http://bikanermc.org/

Bikaner, India, 2015

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## Abbreviations

| | |
|---|---|
| BIS | Bureau of Indian Standard |
| BMC | Bikaner Municipal Corporation |
| CAA | Constitutional Amendment Act |
| CII | Confederation of Indian Industry |
| CGWB | Central Ground Water Board |
| CPCB | Central Pollution Control Board |
| CPHEEO | Central Public Health and Environmental Engineering Organization |
| CSE | Centre for Science and Environment |
| CSP | City Sanitation Plan |
| FS | Faecal Sludge |
| GoR | Government of Rajasthan |
| KII | Key Informant Interview |
| LPCD | Litres Per Capita per Day |
| MoUD | Ministry of Urban Development |
| MSL | Mean Sea Level |
| NIUA | National Institute of Urban Affairs |
| PHED | Public Health and Engineering Department |
| RSPB | Rajasthan State Pollution Control Board |
| SFD | Shit Flow Diagram |
| SLB | Service Level Benchmarks |
| SMP | Septage Management Plan |
| SPS | Sewage Pumping Station |
| STP | Sewage Treatment Plant |
| SWM | Solid Waste Management |
| UIT | Urban Improvement Trust |
| USAID | United States Agency for International Department |
| WW | Waste Water |

# 1 City context

Bikaner lies in the northwest region of Rajasthan state. The city is the administrative headquarters of Bikaner district. It was formerly the capital of the princely state of Bikaner. The strategic location of Bikaner on the ancient caravan routes made Bikaner a major trade center; these routes linked central Asia and north Asia with Gujarat seaports (CII, 2015).

The population of city as per the Census 2011 is 644,406. The area of Municipal Corporation is about 155 sq.km. The density of city is 4157 persons per sq.km which is very high when compared to state average of 201 persons per sq.km. Total slum population is 121,855 representing 18.9% of the total population. The population growth rate of the city is given in the following table.

**Table 1: Population growth rate**

| Census year | Population | Growth rate (%) |
|---|---|---|
| 1971 | 2,08,900 | - |
| 1981 | 2,80,400 | 34.2 |
| 1991 | 4,16,300 | 48.5 |
| 2001 | 5,29,690 | 27.2 |
| 2011 | 6,44,406 | 21.7 |

The city is located at 28º1'N and 73º19' E. The magnificent forts and palaces, made of reddish-pink sandstone, bear testimony to its rich historical and architectural legacy. The city is Asia's biggest wool market and a leading carpet yarn manufacturing centre in the world. Bikaner is still calm and less crowded tourist destination (CII, 2015).

The city is well connected to some of major Indian cities via railways and roadways. It is 320 km and 445 km distance from Jaipur and New Delhi respectively. The city has direct rail connections to Delhi, Kolkata, Chennai, Mumbai, Kanpur, Guwahati and other cities (CII, 2015).

The city is situated in the middle of the Thar desert and has a hot desert climate. It has high temperatures during summer. The maximum temperature rises to around 48° C in summer and minimum dips to 4° C in winters. It receives very nominal rainfall throughout the year. The scarcity of water has affected the vegetation of the area. The soil type of the area is majorly alkaline (CII, 2015).

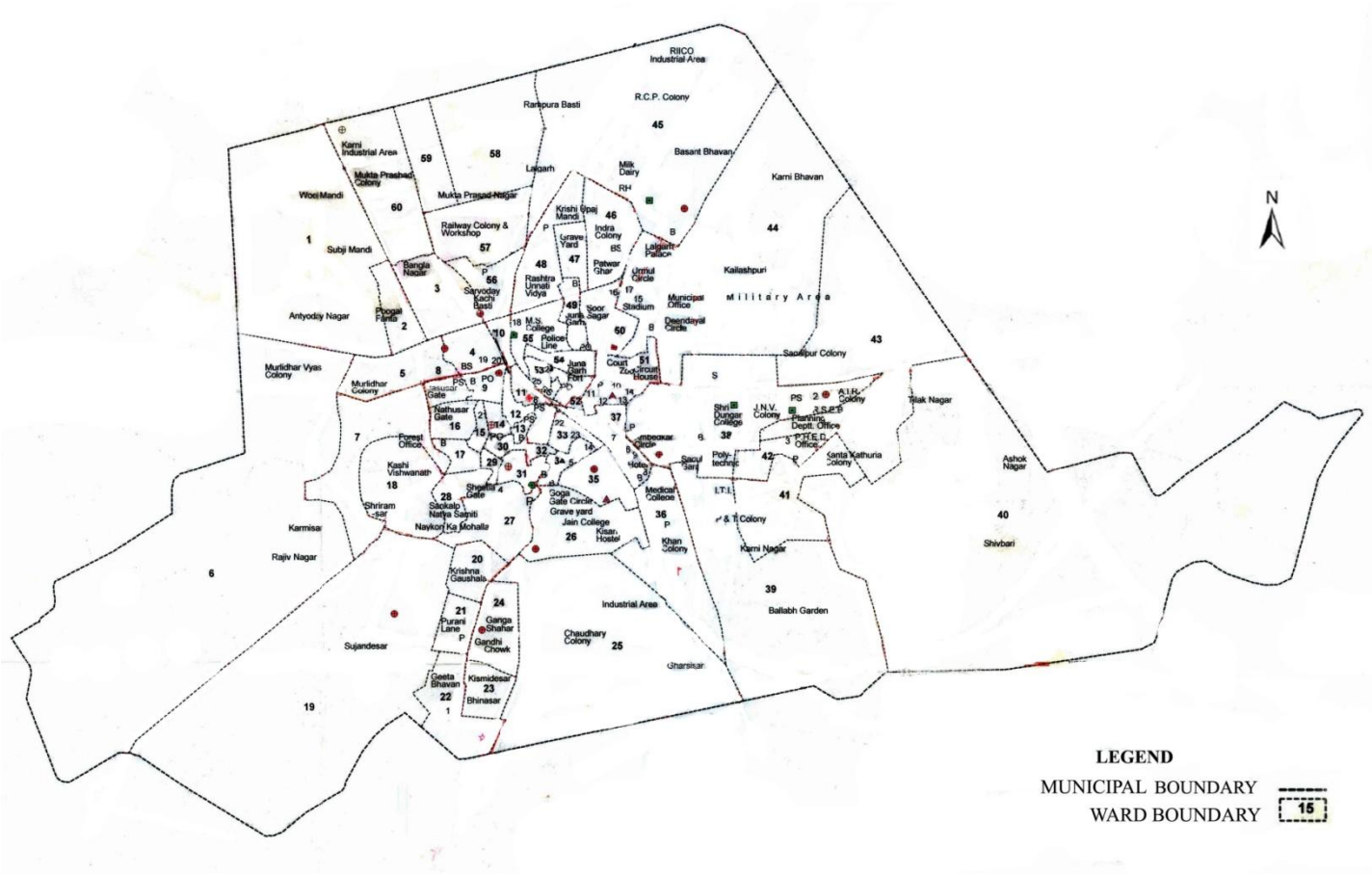


**Figure 1 Ward map of Bikaner**

# 2 Service delivery context description/analysis

## 2.1 Policy, legislation and regulation

### *2.1.1 Policies, legislations and regulations at national Level*

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

The advisory note on septage management in urban India, issued by MoUD in 2013, recommends supplementing CSPs with Septage Management Sub-Plan (SMP) as a part of the CSP, being prepared and implemented by cities. Septage here broadly refers to not only fecal sludge 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 to, while preparing their SMP (MoUD, 2013). It clearly discusses on techno- managerial and socio- economic aspects of septage management in India and provides guidelines for Urban Local Bodies (ULBs) to plan and implement SMP.

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

*The Prohibition of Employment as Manual Scavengers and their Rehabilitation Act* is enacted in 2013. This act prohibits employment of manual scavengers, installation of insanitary

latrines. It has laid strong emphasis on rehabilitation of manual scavengers. This act has become instrumental in eradicating manual scavenging from India.

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

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

The Rajasthan State Sewerage and Wastewater Policy, 2015 aims to improve public health through the creation of sustainable sanitation methods that serve all people living in the state of Rajasthan, especially poorer segments of the population. Priorities include the creation of City Sanitation Plans (CSPs) in each urban area and improving onsite and offsite sanitation, as well as wastewater reuse. Establishing an efficient, effective, affordable and accountable system for managing urban sewage and septage is one of the core principles of the policy. In addition, it provides details on septage collection, treatment and disposal.

*Rajasthan Municipalities Act, 2009* - This act has the provision to consolidate and amend the law relating to municipalities. As per this act, all the privies, cesspools within the municipality are under the control of the municipality. Removal of night soil is listed as one of the municipal functions.

### *2.1.3 Institutional roles*

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

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

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

**Table 2: Institutional roles and responsibilities**

| Institution | Roles and responsibilities |
|---|---|
| The Department of Local Self Government (DLSG) | This department controls all the municipalities. It also performs monitoring and co-ordination function at the state level for all the 188 municipal bodies of the state. |
| Public Health and Engineering Department (PHED) | Responsible for: water supply and treatment; setting water tariffs; construction of STPs and sewerage system operations and maintenance of sewer system and STPs. |
| Bikaner Municipal Corporation (BMC) | Responsible to establish By-Laws; for septage management, operation and maintenance of sewer system and STPs. |
| Rajasthan Pollution Control Board (RPCB) | Responsible for the monitoring and enforcement of environmental acts and rules enacted by the national and state governments. It plays an important regulatory role for environmental protection, which is closely tied to sanitation and wastewater management. |
| Urban Improvement Trust (UIT) | The main functions assigned to UITs include formulation of various schemes for development of the city, matters related to preparation of master plan, land acquisition and disposal, preparation of land layout, formation of open areas, provision of infrastructure facilities and sanitary arrangements, construction of buildings, streets and other public amenities such as water supply, street lighting, drainage, etc. |

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, PHED, UIT, BMC are responsible for actual implementation. Their roles are often overlapping. The Municipal Acts place most of the responsibilities in the area of sanitation to BMC.

### *2.1.4 Service provision*

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

### *2.1.5 Service standards*

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

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

3. Manual on Sewerage 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.

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

# 3 Service outcomes

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

## 3.1 Overview

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

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

| S. No. | Sanitation technologies and systems as defined by: | | SFD reference variable | Percentage of population |
|---|---|---|---|---|
| | Census of India | SFD promotion Initiative | | |
| 1 | Piped sewer system | User interface discharges directly to centralized separate sewer | T1A1C2 | 40.9% |
| 2 | Septic tank | Lined pit with semi-permeable walls and open bottom, no outlet or overflow, general situation | T1A5C10 | 26.6% |
| 3 | Other systems | User interface discharges directly to open ground | T1A1C8 | 6.4% |
| 4 | Pit latrine with slab | Lined pit with semi-permeable walls and open bottom, no outlet or overflow, general situation | T1A5C10 | 3.3% |
| 5 | Pit latrine without slab | Unlined pit no outlet or overflow, general situation | T1A6C10 | 0.4% |
| 6 | Night soil disposed into open drain | User interface discharges directly to open drain or storm drain | T1A1C6 | 16.5% |
| 7 | Service latrine | User interface discharges directly to ‘don’t know where’ | T1A1C9 | 0.3% |
| 8 | Public latrine | Lined pit with semi-permeable walls and open bottom, no outlet or overflow, general situation | T1A5C10 | 0.4% |
| 9 | Open defecation | Open defecation | T1B11C7 TO C9 | 5.1% |

### *3.1.1 Sanitation facilities*

This section presents existing sanitation facilities in slums, institutions and commercial establishments.

Public/ Community toilets: As per Census of India, 2011, 94 % of the city's population has individual toilets. The dependency on public toilets is very less. There are two community and five public toilets (BMC, 2015).

Institutional, Industrial and Commercial areas: There are 155 schools, 5 universities, 21 colleges, 15 hospitals in the city (BMC, 2015). Rani bazaar is an industrial area located in centre of the city. It holds around 190 production units. This is provided with water supply and sewerage by PHED. The markets in the city are covered by sewerage system (GoR, 2016).

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.

### *3.1.2 Containment*

The existing sewerage network covers less than half of the population. A significant population of the city doesn't have any type of containment, i.e. the night soil is disposed directly to open drains. 90% of the open drains are lined (BMC, 2015). The rest of the city is dependent on septic tanks which are generally not adhering to design prescribed by the Bureau of Indian Standards (BIS). In fact, the septic tank is commonly called as *Kuii* (BMC, 2015a). *Kuii* is a pit with diameter of 1.5m to 1.8m and depth of 4.5m to 15m. It is a lined pit with semi-permeable walls and open bottom with no outlet or overflow. It is covered with a slab. The pit gets filled in 20 to 30 years. This kind of containment is prevalent in peri-urban area (S R Garu 2015, pers. comm., 12 March).

### *3.1.3 Emptying*

BMC doesn't provide septage emptying service. The city is dependent on only one private emptier with one vacuum tanker of 5,500 litres capacity. The emptying fee is INR 1500/- (22 USD) per trip. Emptying frequency is 20 to 30 years. On an average, private vacuum tanker empties 30 pits per month which also include trips outside the city. Earlier the private emptier used plastic tanks of 1000 litres capacity mounted on a mini truck with a generator set for suction to empty the pits. The emptier doesn't use protective measures like use of gloves, boots or masks or any other safety gear (S R Garu 2015, pers. comm., 12 March).

### *3.1.4 Transportation*

The truck mounted vacuum tanker is fabricated by a metallurgy workshop in Haryana (S R Garu 2015, pers. comm., 12 March). After emptying septage from the *Kuii,* it is transported to outskirts of the city. The city is surrounded by desert. The sewage generated from the households is conveyed through two sewage pumping stations (SPS) located at public park

and Sudharsan Nagar. Households connected directly to open drains; the sewage is intercepted at SPS located in Gangasehar and conveyed to STP (BMC, 2015a).

### *3.1.5 Treatment and disposal*

There are three Sewage Treatment Plants (STPs) based on Waste Stabilization Pond (WSP) technology. The total capacity of the 3 STPs is 38 MLD. A 20 MLD sewage treatment plant is located at Vallabh garden, 12 MLD STP at Gangasehar and 6 MLD STP at Pugol road, which is not fully functional. The inlet BOD of 20 MLD STP is around 300 mg/l and the outlet BOD is 80 mg/l .The treated sewage is used for cultivating vegetables at vallabh garden. The treated sewage from 12 MLD STP is discharged onto land (BMC, 2015a).There are no separate treatment facilities for septage. Private emptier discharges septage onto barren land in the outskirts of the city (S R Garu 2015, pers. comm., 12 March).

## 3.2 SFD matrix

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

### *3.2.1 SFD matrix explanation*

According to Census of India 2011, 64% of the city is dependent on offsite systems, population connected to sewerage network is 41% and user interface directly discharging in open drain or open ground is 23%, it is estimated that 10% of waste water is lost in transmission via sewer lines and 13% is lost in transportation via open drains. Around 41% waste water is treated at STP which also includes 10% of waste water tapped from open drains. Around 31% of the city is dependent on onsite sanitation systems (OSS), out of which 27% is dependent on septic tanks and 4% on pits. Assuming public latrine is connected to septic tank, it is incorporated in onsite system. Lined pits with semi-permeable membrane and open bottom are quite common in Bikaner, but in Census these are referred as septic tanks. Since the ground water table is very low, these pits are considered contained.

There is no clear differentiation between the volume of infiltrate and septage generated from these pits, hence to reduce the maximum error; it's assumed to be 50% each. As 90% people get there pits emptied, when full, it is estimated that around 14% of FS is emptied. FS (including infiltrate) left in pits is estimated to be 17%. 5% of the population still practices open defecation. Definition and estimation of different variables (used to make SFD) are explained below.

**Table 4: Description of variables used in SFD**

| Variable | Description |
|---|---|
| W2 | WW contained centralized (offsite) |
| W15 | WW not contained (offsite) |
| W11 | WW not delivered to treatment |
| W11a | WW not delivered to centralized treatment plant |
| W11c | WW not contained not delivered to treatment plant |
| W4a | WW delivered to centralized treatment plant |
| W4c | WW not contained but delivered to treatment plant |
| W5a | WW treated at centralized treatment plant |
| F2 | FS contained (onsite) |
| F3 | FS emptied |
| F3a | FS contained- emptied |
| F8 | FS contained- not emptied |
| F11 | FS not delivered to treatment |
| OD9 | Open Defecation |

Assuming Census figures are correct; W2 was estimated to be around 41%. It is assumed that 31% of WW would reach STP through sewer line hence W4a is estimated to be 31% and W11a as 10%. W15 is rounded off as 23%, as it includes WW discharged into open drains i.e. 16.5%, WW discharged on open ground (defined as other systems in the Census) i.e. 6.4% and WW from service latrines i.e. 0.3%. 10% of WW from open drain is tapped and is reaching STP; hence W4c becomes 10% and W11c 13%. Since 100% WW reaching STP is treated, W5a becomes 41% (31%+10%). Total WW not delivered to the treatment plant, i.e. W11 comes out to be 23% (W11=W11a+W11c).

F2 is estimated to be around 31% and constitutes of 30.3% population dependent on lined pits with semi-permeable walls and open bottom (26.6% household septic tanks, 0.4% public toilet septic tanks and 3.3% pit latrine with slab) and 0.4% are dependent on unlined pits. Since there is no clear demarcation in the quantity of solid FS generated and infiltration generated from an onsite system, it is assumed to be 50% each. It is also assumed that 90% of the population (dependent on onsite systems) gets their system emptied when full. Therefore, out of 31% OSS dependent population, FS of 14% population is emptied; hence F3 is equal to 14%. Whereas FS contained but not emptied, i.e. F8 comes out to be 17%. F8 includes infiltrate as well. The emptied FS is discharged untreated in the environment; therefore F11 comes out to be 14%. 5% of population practice open defecation and hence OD9 is computed to be 5%.

It can be concluded that excreta of 58% population is managed safely in Bikaner city and 42% of excreta is discharged in environment untreated. Table 5 summarizes the percentage of the population using each sanitation technology and method along the service chain.

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

| System Type | Containment | Emptying | Transport | Treatment | End-use/ disposal |
|---|---|---|---|---|---|
| **Offsite** | T1A1C2 (Reference L1): 41% of the population is connected to centralised sewer, hence W2 is 41%.<br><br>T1A1C6 (Reference L4): 16.5 % of the population is discharging their excreta directly to open drain.<br><br>T1A1C8 & T1A1C9 (Reference L5): 6.4 % of the population is discharging their excreta directly to open ground and 0.3% discharging- don't know where.<br><br>Total WW not contained (offsite), i.e.W15, adds up to 23%. | Not applicable. | WW of 31%of the population served by centralised sewers, reaches treatment facilities, hence W4a is 31%. It is assumed that 10% would be lost due to leakage, hence W11a=10%<br><br>WW not contained, delivered to centralised treatment plant, i.e. W4c is 10%.<br><br>Therefore WW not contained not delivered to centralised treatment plants, i.e. W11c, is 13%<br><br>Total WW not delivered to treatment plant, i.e. W11, is 23%. | 41% of the population has their WW treated, and therefore W5a is 41%.<br><br>This also includes 10% of WW treated after tapping from open drains. | Treated WW is disposed into lake land and also used for irrigation sometimes.<br><br>Total WW disposed untreated in local area comes out to be 23% |
| **Onsite** | 31% of population is dependent on onsite sanitation systems, hence F2, FS contained is 31%<br><br>T1A5C10 (Reference L11):30.3% of population is dependent on lined pit with semi permeable walls and open bottom<br><br>T1A6C10 (Reference L11):0.4% of population is dependent on unlined pit | Since most of the population is getting their systems emptied, it is assumed 90% of population has their onsite technology emptied.<br><br>Since there is no clear differentiation between % of septage and infiltrate, it is assumed to be 50% each. FS contained- emptied, i.e. F3a/F3 is 14%. FS contained- not emptied, i.e. F8, becomes 17 % | No FS is transported to treatment plant therefore FS not delivered to treatment plant, i.e.F11, is 14%. | No treatment facility exists hence no FS is treated, therefore FS treated, i.e. F5, is 0%. | All the FS emptied ends up in local area without any treatment. |
| **Open Defecation** | 5% of population practice open defecation and hence OD9 is computed to be 5%. | | | | |

### *3.2.2 Risk of groundwater contamination*

According to 2011 data, the depth to water level of aquifers in Bikaner ranges from 8.54 to 111.70 mbgl during the pre monsoon season and 7.64 to 116.40 mbgl during the post monsoon season (CGWB, 2013). Data on faecal coliform contamination is not available.

# 4 Stakeholder engagement

## 4.1 Key informant interviews

The relevant departments were contacted through e-mail, letter, call and fax prior to a visit to the city. The purpose of the SFD study and depth of data required was conveyed through an introductory letter to respective departments. Overall, 5 KIIs were conducted with different stakeholders like government functionaries, private emptier, (see appendix 7.2). The Government of Rajasthan operates through its Department of local self Government.

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

# 5 Acknowledgement

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# 7 Appendix

## 7.1 Stakeholder identification

**Table 6: Stakeholder identification**

| No. | Stakeholder group | In Bikaner context |
|---|---|---|
| **1** | City council / Municipal authority / Utility | Bikaner Municipal Corporation |
| **2** | Ministry in charge of urban sanitation and sewerage | Department of Local Self Government, GoR |
| **3** | Ministry in charge of urban solid waste | Department of Local Self Government ,GoR |
| **4** | Ministries in charge of urban planning finance and economic development. | Department of Local Self Government, GoR |
| | Ministries in charge of environmental protection/ | Environment Department, GoR |
| | Ministries in charge of health | Department of Medical Health and Family Welfare Department, GoR |
| **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 | Bikaner Municipal Corporation |
| **8** | Market participants practising end-use of faecal sludge end products | Farmers |
| **9** | Service provider for disposal of faecal sludge (sanitary landfill management) | N/A |
| **10** | External agencies associated with FSM services: e.g. NGOs, academic institutions, donors, | Private emptiers |

## 7.2 Tracking of engagement

**Table 7: Tracking of engagement**

| Name of the organisation | Name of the contact person | Designation | Date of engagement | Purpose of engagement |
|---|---|---|---|---|
| Bikaner Municipal Corporation | Mr Virender Kumar Verma | Commissioner | 11/3/2015 | Permission to collect data and information from officials. |
| Bikaner Municipal Corporation | Mr Ramesh Meena | Executive Engineer | 11/3/2015 | KII |
| Bikaner Municipal Corporation | Mr Anil Acharya | Health Officer | 11/3/2015 | KII |
| Bikaner Municipal Corporation | Mr Deepak Kansal | STPs- In charge | 12/3/2015 | KII and data collection |
| Public Health and Engineering Department | Mr Arun Sethyia | Assistant Engineer | 12/3/2015 | KII and data collection |
| N.A | S. R. Garu | Private emptier | 12/3/2015 | KII |

## 7.3 SFD matrix

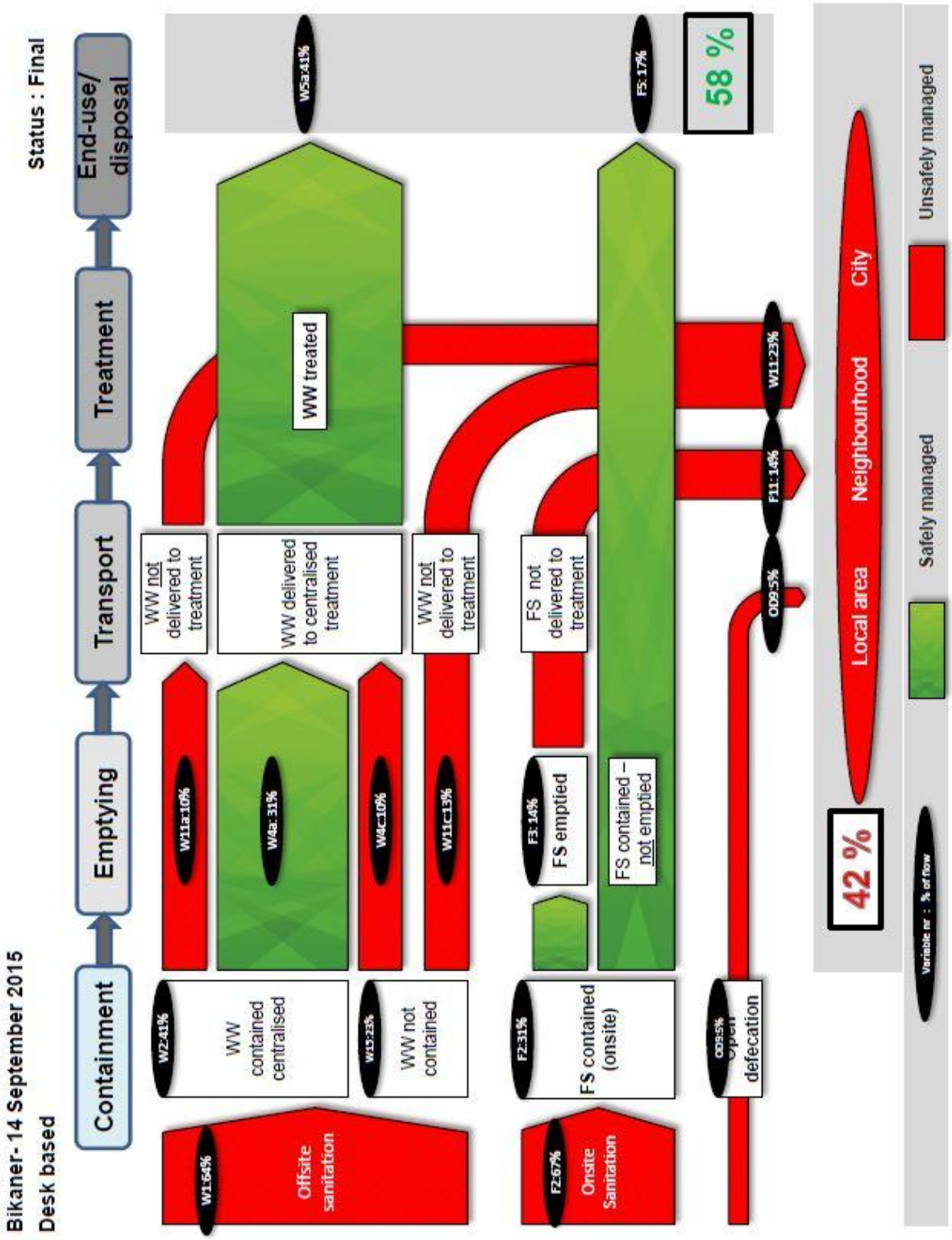


**Figure 2: SFD matrix**

## 7.4 Selected pictures taken during visit

**Figure 3: Night soil disposed into open drain (Source: Shantanu & Rahul/CSE, 2015)**

**Figure 4: Kuii (lined pit with open bottom) (Source: Rahul/CSE, 2015)**

**Figure 5: Open drain(Source: Rahul/CSE, 2015)**

**Figure 6: Open drain interception at Gangasehar (Source: Shantanu /CSE, 2015)**

**Figure 7: Generator based suction pump (Source: Rahul/CSE, 2015)**

**Figure 8: Waste Stabilization Pond in Vallabh garden (Source: Shantanu/CSE, 2015)**

**Figure 9: Land disposal of treated sewage at Vallabh garden area (Source: Shantanu/CSE, 2015)**

**Figure 10: Cultivation of vegetables at Vallabh garden (Source: Rahul/CSE, 2015)**