SFD Lite Report

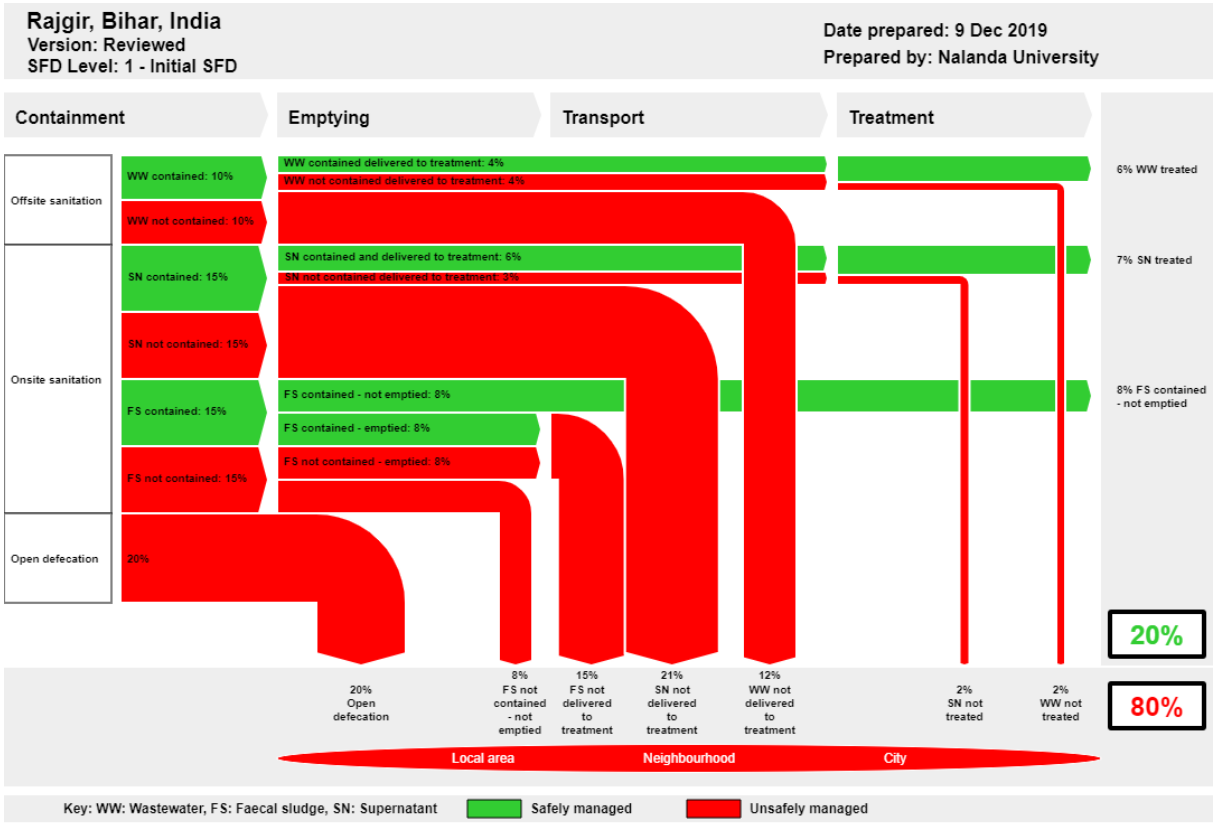
Rajgir

India

This SFD Lite Report was prepared by:
Nalanda University

Date of production: 09/12/2019

1. The SFD Graphic



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

2. SFD Lite information

Produced by:

- This SFD Report is prepared by the team from the Nalanda University, Rajgir, Bihar (Harsh Yadava, Somnath Bandyopadhyay, Gayatri Kumari). Annexure 2 was supported by Shivani (Urban Planner). Annexure 6 was supported by Amarpreet Kaur (student, Nalanda University). Ritika Rajput (student, Nalanda University) supported the field study to identify open defecation zones.
- Special thanks: Nagar Panchayat Rajgir (NPR) for support in data and Deutsche Gesellschaft für Internationale Zusammenarbei (GIZ-India) for financial support to the field visits.

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3. General city information

Rajgir is an ancient town within the district of Nalanda in the state of Bihar, covering an area of 50.2 square kilometres (sq.km). Seven hills – Vaibhara, Ratna, Saila, Sona, Udaya, Chhatha, and Vipula – surround Rajgir attracting tourists for their religious, cultural and historical importance. Rajgir is particularly famous among domestic and foreign tourists for its hot springs (Brahmkund, Suryakund, Makhdoom Kund, etc.), monasteries like Vishwa Shanti Stupa and serene beauty (BSTDC, 2018).

The average temperature of Rajgir fluctuates between 44°C to 20°C during the summer (April to June), and between 28°C to 6°C during the winter (October to March). The town receives 1,860 mm of rainfall on an average during the monsoon season (from mid-June to mid-September). The average wind velocity is 8–16 km/ hour. The topography of Rajgir is generally flat with local undulations and gentle slopes of 10 m/km. The geological features of Rajgir are defined by low to high compacted sediments of silt and clay which is deposited over underlying bedrock (Census, 2011).

According to Census (2011), Rajgir has a total population of 41,587 living in 7,030 households distributed over 19 wards (Annexure 1) with an average household size of 6 and population density of 829 people/km. Nagar Panchayat Rajgir (NPR) is the elected Urban Local Body (ULB) responsible for providing services such as sanitation, water supply and roads within the town area. Table 1 shows the population growth of Rajgir over the past five decades.

Table 1: Population and growth rate of Rajgir over the past decades.

Year	Population	Growth rate
1971	13,098	45.1
1981	18,034	37.7
1991	23,730	31.6
2001	33,738	42.2
2011	41,587	23.3

Source: Census (2011)

4. Service outcomes

Table 2 shows the SFD matrix for Rajgir and data used to prepare the SFD graphic. Overall, the graphic depicts that 20% of the excreta is safely managed while 80% is discharged unsafely to the environment.

The 20% of safely managed excreta comes from: the contained (and part of the not contained) wastewater (WW) delivered to the treatment facility and treated (6%); supernatant (SN) contained (and part of the not contained) which is delivered to the treatment and treated (7%); and faecal sludge (FS) contained but not emptied from the On-site Sanitation Systems (OSS) (8%). The 80% of unsafely managed excreta is distributed as: WW not contained delivered to treatment but not treated (2%), WW not delivered to treatment and reaching water bodies or local area (12%), SN from OSS which is delivered to treatment but not treated (2%) and SN which is not delivered to treatment (21%), FS which is not delivered to treatment (15%) and FS not contained and not emptied (8%), and open defecation (20%).

Table 2: SFD matrix of Rajgir.

Rajgir, Bihar, India, 9 Dec 2019. SFD Level: 1 - Initial SFD
Population: 41587
Proportion of tanks: septic tanks: 50%, fully lined tanks: 50%, lined, open bottom tanks: 50%

System label	Pop	W4a	W5a	W4c	W5c	F3	F4	F5	S4d	S5d	S4e	S5e
System description	Proportion of population using this type of system	Proportion of wastewater in sewer system, which is delivered to centralised treatment plants	Proportion of wastewater delivered to centralised treatment plants, which is treated	Proportion of wastewater in open sewer or storm drain system, which is delivered to treatment plants	Proportion of wastewater delivered to treatment plants, which is treated	Proportion of this type of system from which faecal sludge is emptied	Proportion of faecal sludge emptied, which is delivered to treatment plants	Proportion of faecal sludge delivered to treatment plants, which is treated	Proportion of supernatant in sewer system, which is delivered to treatment plants	Proportion of supernatant in sewer system that is delivered to treatment plants, which is treated	Proportion of supernatant in open drain or storm sewer system, which is delivered to treatment plants	Proportion of supernatant in open drain or storm sewer system that is delivered to treatment plants, which is treated
T1A1C1 Toilet discharges directly to a centralised combined sewer	10.0	40.0	75.0									
T1A1C6 Toilet discharges directly to open drain or storm sewer	10.0			40.0	75.0							
T1A2C1 Septic tank connected to a centralised combined sewer	30.0					50.0	0.0	0.0	40.0	75.0		
T1A2C6 Septic tank connected to open drain or storm sewer	30.0					50.0	0.0	0.0			20.0	75.0
T1B11 C7 TO C9 Open defecation	20.0											

4.1. Sewered areas

Approximately, 10% of the population is covered under a centralized underground sewerage network (KII-1, 2019, field observations). Though the sewerage network was designed to carry black water (wastewater from toilets), it was observed that both black water and grey water (wastewater from bathrooms and kitchens) was being discharged into the sewer systems (KII-1, 2019; field observations). During the monsoon season, it has been observed that in some areas local communities open the manholes to divert stormwater into the sewer system in order to reduce water logging locals (Figure 1) (FGD-2, 2019; field observations).

Figure 1: Sewer network manhole in water logged area (Harsh/NU/2019).

Households (HHs) in sewered areas of Rajgir do not pay any fees to the NPR for their sewer connections. On the contrary, there is a scheme to provide financial incentives to households who connect (KII-2, 2019). Yet, there are few HHs who are directly connected to the sewer system (KII-1, 2019).

A sewerage system was introduced in some parts of the town about 35 years ago which is now defunct (DPR-Sewerage Rajgir, 2014; KII-2, 2019). It was observed that in some areas (notably wards 11, 12 and 17) the old sewer line was not fully defunct, hindering the function of the new sewer network (Figure 2).

Figure 2: Old and new sewer in ward 11 (Harsh/NU/2019).

Figure 3: Toilet outlet pipe directly opening into open drain in ward 19 (Harsh/NU/2019).

In Figure 2, the red and blue arrows indicate the old and new sewer lines respectively. Some HHs reportedly connected to the old sewer network directly, which further discharged into the open drains (FGD-2, 2019; field observations). In ward numbers 19, 6, 11 and 17, some HHs had connected their toilets directly (Figure 3) to open drains (field observations). Combining HHs that are connected to the old defunct sewer and HHs disposing of night soil into open drains directly, it is estimated that approximately 10% of the population of Rajgir contributes to the system T1A1C6 in the SFD graphic (KII-1, 2019; FGD-1, 2019).

Currently, Rajgir has one Sewage Treatment Plant (STP), Ramharipind STP, which was built by Bihar Urban Infrastructure Development Corporation Ltd (BUIDCO Ltd). Table 3 provides the details of the STP.

Table 3: Details of Ramharipind STP at Rajgir.

S. No	Location	Capacity (MLD)	Current sewage inflow (MLD)	Treatment Technology	Current Status & year of Commissioning	Discharge of treated sewage
1	Rajgir	10	1-2	ASP* / With extended aeration system of capacity 8 MLD consisting of Screening, Grit Chamber, Primary Clarifier, Aeration Tank, Secondary Clarifier, Chlorination System, Sludge Drying Bed	Operational / 2014	Farm land through the *Pyne***

Source: DPR-Sewerage Rajgir (2014)

*ASP is Activated Sludge Process.

***Pyne* is traditional water harvesting system in Bihar.

There are around 3,000 manholes, each separated by a distance of 30 m, on a gradient of 2-3 mm per metre sloping towards the STP or the Sewage Pumping Stations (SPS). Krushi, a Hyderabad-based firm, has been contracted to run the STP until 2020. Three actors are involved in managing the STP – BUIDCO, Krushi and Nagar Panchayat Rajgir (KII-1, 2019; KII-3, 2019). Staff include two operators at main STP, one lab technician to check the quality of treated water, and one fitter-cum-electrician to check overall management (KII-3, 2019).

The sewer network in Rajgir is only partially functional at the moment due to technical issues in the line (KII-3, 2019; FGD-1, 2019). As understood from discussions with the local communities and the STP staff, the sewer network is partially open and hence the water reaching the STP through the SPS and other intercepted sources is assumed to be 40% (variable W4a) (KII-3, 2019; KII-1, 2019). The average flow of influent at the STP is 1-2 MLD per day of which 75% (variable W5a) is actually treated (KII-3, 2019).

4.2. On-site Sanitation Systems (OSS)

Containment

Despite the presence of sewer network in most of the NPR area, 60% of the population in NPR area is dependent on OSS (KII-1, 2019; FGD-1, 2019; KII-4, 2019). The OSS comprises of septic tanks connected to open drains (T1A2C1) and septic tanks connected to sewers (T1A2C6) (field observations; KII-4, 2019). T1A2C1 and T1A2C6 types of system are divided equally at 30% each (assumed); as observed, some households have connected to the sewer line (KII-1, 2019; FGD-1, 2019).

Figure 4: Septic Tank connected to open drain built in between a Lane (Harsh/NU/2019).

The septic tanks are not contained as they are connected to open drains. Since no standardization is being followed in the construction of containment systems (Figure 4), a few households have constructed very large capacity tanks, inconsistent with the household size, with a general perception of emptying the septic tanks only after 8-12 years (FGD-1, 2019; KII-4, 2019). As observed, usually HHs septic tanks have two to three chambers almost equal in dimensions and generally 8 to 10 feet deep (field observations). Annexure 3 gives the details of typical OSS observed in the NPR area.

Emptying

NPR provides services for emptying (KII-4, 2019; KII-2, 2019) and charges INR 2,000 (USD 21.98) to INR 3,000 (USD 41.67) depending on the size of the containment and provides a receipt for the service (Figure 5). NPR owns a vacuum tanker (5,000 litres capacity) to provide emptying services (KII-4, 2019). It was observed that the NPR vacuum tanker was not in operation since 2017 due to lack of maintenance (field observations). A vacuum tanker from Silao Nagar Panchayat (10 km from NPR) is generally called for any urgent emptying applications (KII-4, 2019).There is also a private desludging operator who provides emptying services in both Silao and Rajgir (FGD-

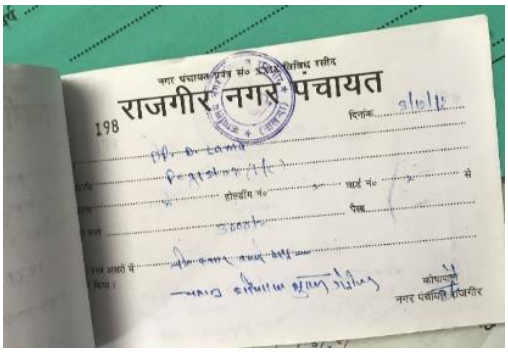


Figure 5: Receipt given by NPR for emptying service (Harsh/NU/2019).

1, 2019) and uses electric poles and walls in the city for advertisement (Figure 6). HHs generally empty their septic tanks when they are full and do not follow any scheduled emptying system (field observations).

Figure 6: Advertisement done by private emptying operator in ward 2 (Harsh/NU/2019).

Manual Emptying

A community popularly known as 'Dom community' provides manual emptying services in Rajgir (KII-4, 2019). These people, comprising about 300 HHs, live in pockets in NPR area – in Dhobi Tola (22 HHs), near Dharamshala Road (40 HHs), near Rajgir thana (10 HHs), near Giriyak Road (10 HHs), near Ajathsatru (12 HHs), and Makdum Kund area (30 HHs) (FGD-1,2019). Some of them work as sweepers for the NPR, either on short-term contract or on permanent employment basis, depending on the demand (KII-2, 2019; KII-4, 2019). It was observed that no Personal Protective Equipment (PPE) is being used by manual emptiers to carry out the emptying operations (Figure 7) (field observations). Manual emptiers have high demand in wards with narrow and congested roads where usually a vacuum tanker cannot operate (like ward no.11, 12, 13, 14, and 17). Manual emptiers usually work in groups of three to four to empty a septic tank and charges INR 600 (USD 8.43) to INR 900 (USD 12.64) per feet depth of the containment (FGD-1, 2019). However, it was interesting to notice that some manual emptiers had cleaned tanks alone to earn extra income and some of them were employed by NPR on contract basis in a tourist season to clean the Public Toilets (PT) (KII-4, 2019).

Figure 7: Manual emptiers cleaning the faecal sludge without any PPE (Harsh/NU/2019).

The frequency of emptying of containment types T1A2C1 and T1A2C6 varied from 7 to 12 years throughout the city (field observations; KII-4, 2019). Therefore, for the purpose of the SFD graphic, it was assumed that 50% of the population is emptying their containment (KII-1, 2019; KII-4, 2019).

Transport

Figure 8: NPR desludging vacuum tank standing in the NPR store area (Gayatri/Nu/2019).

Figure 9: Cart used to transport faecal sludge emptied by manual scavengers (Harsh/NU/2019).

The NPR owns a vacuum tank which is mounted on a tractor to transport the faecal sludge emptied from HHs and other government buildings (KII-4, 2019) (Figure 8). The manual emptiers usually have a hand cart to carry the faecal sludge emptied with the help of buckets and bamboo sticks (Figure 9) (field observations). The sewer network present in the city is considered to be efficient by 40% i.e. only 40% of the wastewater from systems Wa4, W4c and S4d is reaching the treatment plant (KII-3, 2019; KII-1, 2019). This assumption is based on the discrepancies observed in sewer network as it is not completely operational due to blockage (FGD-2, 2019; KII-4, 2019). However for system S4e the efficiency is assumed 20%, considering more blockages and lack of maintenance of open drains (field observations).

Treatment and disposal

There is no provision for co-treatment at STP (Figure 10) or mandate for disposal of faecal sludge followed by NPR (KII-1, 2019). The emptied FS is disposed into farmland or *pynes* or sometimes into low lying areas in the NPR region. Usually, manual emptiers ask for a disposal site from the owner and the additional cost is added into the final bill if the disposal site is more than 2 kilometres away. The manual emptiers avoid emptying in daylight if they are not provided with any place for disposal by the owner, as in that case they dispose FS into open drains, considering the social issues (FGD-1, 2019; KII-4, 2019). The wastewater from sewers and tapped drains reaches the 10 MLD STP.

The treatment efficiency of the plant is assumed to be 75% (variables W5a, W5c, S5d and S5e all set to 75%) i.e. 75% of the influent reaching the plant is treated as per the standards set by Central Pollution Control Board (CPCB). The remaining is assumed to be released untreated due to inefficiencies in the system posed by power failures (KII-3, 2019).

Figure 10: Sewage Treatment Plant in Rajgir (Harsh/NU/2019).

Figure 11: Treated effluent from STP and storm water drain opening to a *Pyne* (Harsh/NU/2019).

The treated effluent is released to the *pyne* where it also mixes with the untreated water coming from an open drain (Figure 11). It was interesting to observe that both the treated water and untreated water drained into the same *pyne* (field observations). As discussed with the STP operator, the treatment of water is hardly a concern, and the STP is running just to maintain the flow of the system (KII-3, 2019).

4.3. SFD with floating population (SFD-2)

Rajgir is a busy tourist place, which attracts tourists from all over the country and the world, especially from Buddhist countries. As discussed with the NPR officials, Rajgir has the maximum domestic and international footfalls between October and March (KII-2, 2019; BSTD 2018).

Domestic population usually come in groups with their own vehicles with the purpose of having a holy bath in the hot water springs (KII-2, 2019). They usually do not stay for more than a day and prefer to stay in community halls or try to manage on roadside footpaths (Figure 12) (field observations). To understand the role of floating population in Rajgir, a new SFD graphic i.e. SFD-2 is made which is explained below.

During the peak season of tourists, i.e. around six months of the year, on an average 11,320 persons visited the city per day (BSTD, 2018) (Table 4). Hence, for this study the floating population is assumed to be 11,320 per day as shown in Table 4[1].

[1] Note: Data collected from BSTD was available for the year of 2018 i.e. previous year of the study year.

Figure 12: Domestic tourists who manage their nights on footpaths seen near Brahama Kund (Somnath/NU/2019).

Table 4: Floating population.

Floating population in the Year 2018		
Floating population	3,921,941	
International tourist	159,976	
Peak tourism months with floating population		
Months	*Domestic tourist*	*International Tourists*
January	211,168	23,388
February	108,024	25,615
March	108,226	23,605
October	144,279	12,564
November	106,159	17,073
December	210,532	28,230
Total	888,388	130,475
Gross	1,018,863	
Average daily floating population	11,320	

Source: Ministry of Tourism (2018)

The containments assumed for floating population are clubbed in Table 5 to obtain the final percentages of populations to prepare the SFD-2 of Rajgir including floating population.

Table 5: Types of systems assumed for floating population.

Floating Population	Description of assumptions made	Systems assumed	Relative Population
Out of total floating population, 15% is International	This population is considered as staying in hotels, monasteries and guest houses that have toilets connected to septic tanks connected to open drains.*	Septic tank	15%
Remaining 85% of the population is domestic	50% of the domestic floating population i.e. 42% of the total floating population is assumed to be staying in hotels and guest houses that have toilets connected to septic tanks connected to open drains.	Septic tank	21%
		Fully lined tanks	21%
	It is assumed that the rest, i.e. 43% of the total floating population is a one-day visitor who is either dependent on public/community toilets or practising open defecation. It is further assumed that 30% of 43% of population i.e. 13% is catered by public and community toilets.**	Septic tank	13%
	It is estimated that about 30% of the floating population practice open defecation on *Vaitarini River* and in proximity of bus stand area.	Open Defecation	30%

Source: Compiled by Nalanda University (2019)

*As discussed with NPR officials, none of the hotel or guest houses or public or community toilet is connected to sewer network (KII-1, 2019; KII-4, 2019).

**The 30% usage of public or community toilets was agreed upon discussion with NPR officials owing to the behavioural inclination towards open defecation by domestic tourists.

The final percentages obtained from Table 6 are used for preparation of SFD-2 graphic with floating population shown population shown in SFD-2 graphic (Figure 13).

Table 6: Final percentages of population dependent of different types of sanitation systems.

Containment Systems	Fixed Population (41,578)		Floating Population (11,320)		Final Population (52,898)	
	%	*Population*	*%*	*Population*	*%*	*Population*
Sewered and no containment	20	8,316	0		16	8,316
Fully lined tanks connected to open drains	0		21	2,377	3	2,377
Septic tank connected to a centralised combined sewer	30	12,473	0		24	12,473
Septic tank connected to an open drain	30	12,473	0		24	12,473
Septic tanks connected to open drains for PT, CT, Hotels or Guests house, etc..	0	0	49	5,547	10	5,547
Open defecation	20	8,316	30	3,396	23	11,712

Source: Compiled by Nalanda University (2019)

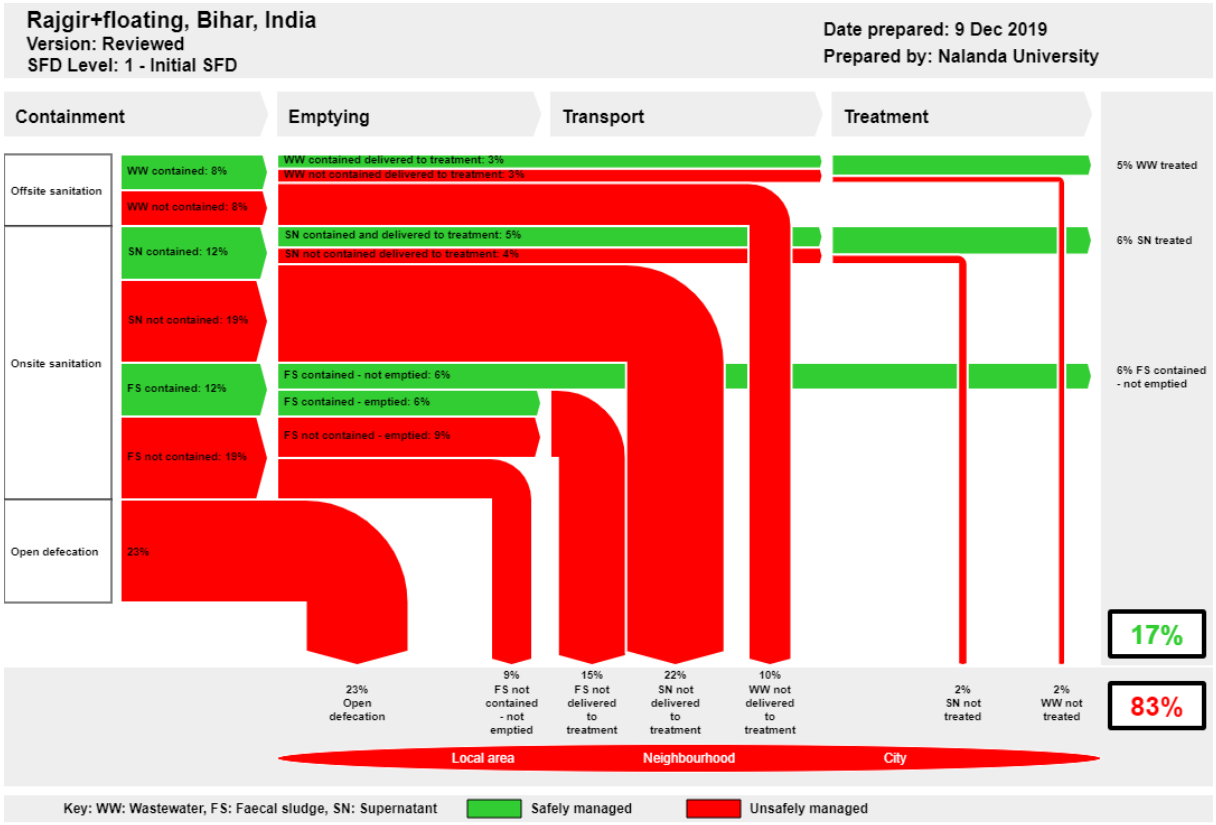


Figure 13: SFD-2 Graphic with floating population.

Table 7: SFD Matrix using percentages from Table 6 (source: compiled by Nalanda University, 2019).

Rajgir+floating, Bihar, India, 9 Dec 2019. SFD Level: 1 - Initial SFD
Population: 52898
Proportion of tanks: septic tanks: 50%, fully lined tanks: 50%, lined, open bottom tanks: 50%

System label	Pop	W4a	W5a	W4c	W5c	F3	F4	F5	S4d	S5d	S4e	S5e
System description	Proportion of population using this type of system	Proportion of wastewater in sewer system, which is delivered to centralised treatment plants	Proportion of wastewater delivered to centralised treatment plants, which is treated	Proportion of wastewater in open sewer or storm drain system, which is delivered to treatment plants	Proportion of wastewater delivered to treatment plants, which is treated	Proportion of this type of system from which faecal sludge is emptied	Proportion of faecal sludge emptied, which is delivered to treatment plants	Proportion of faecal sludge delivered to treatment plants, which is treated	Proportion of supernatant in sewer system, which is delivered to treatment plants	Proportion of supernatant in sewer system that is delivered to treatment plants, which is treated	Proportion of supernatant in open drain or storm sewer system, which is delivered to treatment plants	Proportion of supernatant in open drain or storm sewer system that is delivered to treatment plants, which is treated
T1A1C1 Toilet discharges directly to a centralised combined sewer	8.0	40.0	75.0									
T1A1C6 Toilet discharges directly to open drain or storm sewer	8.0			40.0	75.0							
T1A2C1 Septic tank connected to a centralised combined sewer	24.0					50.0	0.0	0.0	40.0	75.0		
T1A2C6 Septic tank connected to open drain or storm sewer	34.0					50.0	0.0	0.0			20.0	75.0
T1A3C6 Fully lined tank (sealed) connected to an open drain or storm sewer	3.0					50.0	0.0	0.0			20.0	75.0
T1B11 C7 TO C9 Open defecation	23.0											

SFD-2 percentages of flow:

The 17% of safely managed excreta comes from: wastewater (WW) contained (and part of the not contained) delivered to the treatment and treated (5%), supernatant (SN) contained (and part of the not contained) and delivered to the treatment and treated (6%) and faecal sludge (FS) contained not emptied (6%) from the On-site Sanitation Systems (OSS). The 83% of unsafely managed excreta is distributed as: WW not contained delivered to treatment but not treated 2%, WW not delivered to treatment and reaching water bodies or local area 9%, SN from OSS which is delivered to treatment but not treated (2%) and SN which is not delivered to treatment (21%), FS which is not delivered to treatment (15%) and FS not contained and not emptied (10%) and open defecation (23%).

It was observed that ward number 19 caters to all major tourists buildings, public toilets and religious spots and hence have the maximum footfalls of floating population (field observations). Annexure 2 shows the status and locations of different public or community toilets (PT and CT) in Rajgir whereas Annexure 4 describes the condition of PT and CT at the time of the visit. The emptying process in the public toilets, institutional buildings and hotels is done by mechanical processes (field observations). Usually, septic tanks were observed to be connected to open drains, and are emptied only when the tanks overflow. However, in a few cases, septic tanks were also connected to soak-pits (like toilets in Virayatan) which is not accounted for in making the SFD graphic. Figure 14 shows a peter machine[2] set used to empty a tank connected to a series of toilets installed in an institutional building famous for Jain tourists - Virayatan (field observations). Some hotel calls for the private emptiers with vacuum tanks connected to tractors. For the purpose of SFD graphic, percentages for emptying is assumed to be 50% for different systems (variable F3 set to 50% in all cases).

Figure 14: Toilet in Veerayatan premises which gets emptied through *Perter Machine (*pump set*)* (source: Gayatri, NU 2019).

NPR also has a set of portable toilet systems mounted over a trolley, which is used during high domestic tourist influx (Figure 15). The set has 3 toilets each for men and women. The collection tank is present at the bottom which is emptied on daily basis during the season (field observations). However, the collected faecal wastes are disposed to nearby water body (Vaitarini River, see annexure 5) without any pre-treatment (KII-4, 2019). Due to lack of sufficient data, effect of this toilet is not incorporated in the SFD graphic.

Figure 15: Portable toilet system used during high floating season (source: Gayatri, NU 2019)).

[2] A Peter Diesel Engine connected to a pump that sucks out the septage from the tanks.

Figure 16 illustrates the state of poor maintenance of PT where overflowing containment system was observed. The conditions of the public toilets puts a question mark on the sustainability of sanitation in NPR.

Figure 16: Overflowing Septic Tank of Public Toilet in Ward no. 5 at Bus Stand (source: Harsh NU, 2019).

People are generally unwilling to use public or community toilets as open defecation appears to be a better alternative (KII-4, 2019). People also complained about the irregularity in the timing of the opening of PT or CT as most of the times they are found closed[3] (FGD-4, 2019) (Figure 17).

Figure 17: Public toilets in ward 19 near Braham Kund and Surya Kund found to be closed at 11 am (Harsh/NU/2019).

For the purpose of the SFD graphic, usage of toilets by domestic tourists was taken as 30% after discussion with city officials. Though open defecation is a concern in Rajgir, a better management and maintenance of PT and CT could urge people to use them efficiently.

4.4.Open Defecation

Open defecation (OD) in Rajgir Nagar Panchayat area is a bigger challenge to attain any commendable level of sanitation in the city. The SFD graphic in section 1 shows the open defecation practised by 20% population inside NPR, whereas SFD-2 shows 23% of open defecation when floating population is added to the total population. The additional 3% comes from the domestic floating population which according to NPR officials is a behavioural issue. Annexure 5 puts light on major OD zones under NPR boundary visited during the study for the preparation of the SFD graphic.

[3] All the community toilets visited were found closed. Public Toilets were also closed in most cases.

The 20% open defecation in the SFD graphic in section-1 is a reflection of conditioned behaviour, absence of household toilets or limited access to clean public toilets. The issue of closed CT and maintenance of CT and PT was discussed at length (FGD-2, 2019; FGD-4, 2019). Annexure 5 describes two zones, viz. 1 and 2, for open defecation. Zone-1 is at Vaitarini River which originates from the Brahma Kund and later becomes a *pyne* and ends up in farms (KII-4, 2019). The major part of the river goes from ward 19, where there is high tourist influx as well as high visibility of open human faeces (field observations). During the field visit people were observed going for OD (Figure 18), even when PT was present in the vicinity.

Figure 18: Person going for Open defecation in ward 19 near *Vaitarini River* - OD Zone 1 (Harsh/NU/2019).

4.5.Risk of groundwater contamination

The SFD assessment includes the risk of groundwater pollution as an important factor in determining whether excreta are contained or not contained. If the risk of contamination to groundwater is low, then FS is considered “contained”. The type of OSS in use also has an influence on the infiltration of liquid into the groundwater and therefore on the potential risk of groundwater pollution. Risk of groundwater contamination is estimated through the graphic generator tool and overall risk estimated is ‘Significant Risk’.

The groundwater in the phreatic aquifers in Rajgir district is slightly alkaline in nature. Based on the survey with households and KIIs in Rajgir, it was decided to characterize all existing sanitation containment systems as having “significant risk" of groundwater pollution as the pre-monsoon groundwater table depth in Rajgir ranges from 5-10 metres below ground level (mbgl) and the post-monsoon groundwater table depth ranges from 2-5 mbgl (CGWB, 2013). Also a major part of the population in Rajgir was dependent on groundwater sources (Annexure 6), which increases the risk further (FGD-3, 2019).

According to the Census (2011), 36.7% and 38.7% of the population were dependent on hand pumps and uncovered wells respectively for water supply, 5.9% of the population was dependent on tap water from a treated source and 14.1% on a private well, tube well or bore well, covered well, spring or other sources. According to the random sample survey and FGD with the Public Health Engineering Department (PHED) conducted, it was reported that around 1,061 HHs in NPR have a piped water supply in the premises, the source of which is groundwater from deep tube wells while the remaining HHs rely on hand pumps, bore wells and Water ATMs (FGD-3, 2019). List of distribution of hand pumps, stand-posts and water tankers across different wards in Rajgir is given in Annexure 6.

4.1.Septage management related policies and regulations

National Urban Sanitation Policy (NUSP) was issued in 2008, by the Ministry of Housing and Urban Affairs (MoHUA), formerly known as Ministry of Urban Development (MoUD). 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 state to develop state urban sanitation strategies and work with cities to develop City Sanitation Plans (CSPs).

NUSP identifies the constitution of the multi- stakeholder task force, known as City Sanitation Taskforce (CSTF) as one of the principal activities to be taken up to start the city sanitation planning process. CSTF has now been renamed as Swachh Bharat City Level Task Force (SBCLTF) (MoUD, 2014).

The Environment (Protection) Act, 1986 and the Water (Prevention and Control of Pollution) Act, 1974 have provisions relating to sanitation services and environmental regulations. It applies to households and cities with regard to disposing waste into the environment. ULBs/utilities also have to comply with discharge norms for effluent released from sewage treatment plants and to pay water cess under the Water Cess Act, 1977 (MoUD, 2013).

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

The Employment of Manual Scavengers and Construction of Dry Latrines (Prohibition) Act, 1993, promulgated by the Ministry of Urban Affairs, prohibited construction of dry latrines that were quite common in India, including the countryside, and provided the need for scavenging. The 1993 law has punitive clauses for the employment of manual scavengers as well, but no prosecution has happened till date under this law. The Prohibition of Employment as Manual Scavengers and their Rehabilitation Act 2013 seeks to regulate hazardous manual cleaning of sewer and septic tanks, and rehabilitate manual scavengers (MoSJE, 2014). However scenario in Rajgir, questions the state of implementation of the act after field observations.

4.2.Ongoing and proposed sanitation projects

There are various schemes launched by the central government and state government to provide basic amenities including improvement of urban sanitation. These include Swachh Bharat Mission (SBM) and Chief Minister's Saat Nischay Yojana (7 resolves), to meet the same objective and 1985 toilets have been constructed.

The Ganga Water Lift Project is an ambitious programme for piped supply of Ganga waters to Rajgir, Bodh Gaya and Nawada by June 2021 at an estimated cost of INR 2,836 crores (USD 398,219.21) (FGD-3, 2019). Augmenting tap waters will improve the efficiency of the sewerage system of Rajgir, particularly when a majority of households are connected. Rajgir is thus poised for dramatic transformation of its sewage management within the next two years (KII-2, 2019; FGD-3, 2019).

5. Data and assumptions

Population data are based on the Census 2011 http://censusindia.gov.in/DigitalLibrary/Archive_home.aspx.

The proportion of On-site Sanitation Systems mentioned in the report is based on the rapid field visit by authors to the town and various rounds of discussions with different stakeholders.

In addition, and to prepare the SFD graphic, the following key assumptions were made:

- The proportion of the contents of each type of onsite container is considered as 50% faecal sludge (step two of the Graphic Generator). In SFD-2 graphic the proportion of contents in the system T1A3C6 is considered 50% faecal sludge.
- For finding floating population the data of 2018 was taken for month wise tourists' inflow (domestic and international). It was assumed there is no change in footfalls in 2019.
- The proportion of FS emptied from septic tanks was assumed to be 50% (variable F3).
- STP treatment efficiency was assumed to be 75% (variables W5a, W5c, S5d and S5e all set to 75%).

6. List of data sources

Reports and literature

- DPR- Sewerage Rajgir, 2014; Detailed Project Report for Sewerage Network in Rajgir, BUIDCO
- CGWB, 2013. Ground Water Information Booklet, Nalanda District, Bihar. Central Ground Water Board
- Census of India. 2011. District Census handbook - Nalanda. Directorate of Census operations, Bihar
- MoUD. 2013. Septage Management in Urban India. Ministry of Urban Development, Government of India.
- MoUD. 2014. Guidelines for Swachh Bharat Mission. Ministry of Urban Development, Government of India.
- MoUD. 2017. National Policy on Faecal Sludge and Septage Management. Ministry of Urban Development
- BSTD. 2018. Data collected from Bihar State Tourism Development Corporation Limited.
- MoSJE. 2014. The Prohibition of Employment as Manual Scavengers and their Rehabilitation Act, 2013 [18th September, 2013]. Ministry of Social Justice and Empowerment, GoI.

Key Informant Interviews (KIIs)

- KII-1, 2019; Interview with Mr. Kumar Anand, Junior Engineer, Nagar Panchayat Rajgir.
- KII-2, 2019; Interview with Mr. Rajmani Kumar Gupta, City Manager, Nagar Panchayat Rajgir.
- KII-3, 2019; Interview with Mr. Pintu Kumar Yadav, Operator- Sewage Treatment Plant, Krushi Services.
- KII-4, 2019; Interview with Mr. Shankar Kumar Yadav, Sanitation Supervisor, Nagar Panchayat Rajgir.

Focus Group Discussions (FGDs)

- FGD-1, 2019; Focus Group Discussion with Manual Emptiers NOS-6.
- FGD-2, 2019; Focus Group Discussion with locals in old sewer area.
- FGD-3, 2019; Focus Group Discussion with Mr Manoj Kumar, Junior Engineer and Mr Rakesh Ranjan, Sub-Divisional Officer (SDO) Public Health Engineering Department office, Rajgir
- FGD-4, 2019; Public and Community toilets care takers and people who frequently use PT CT in ward 19.

Field Observations

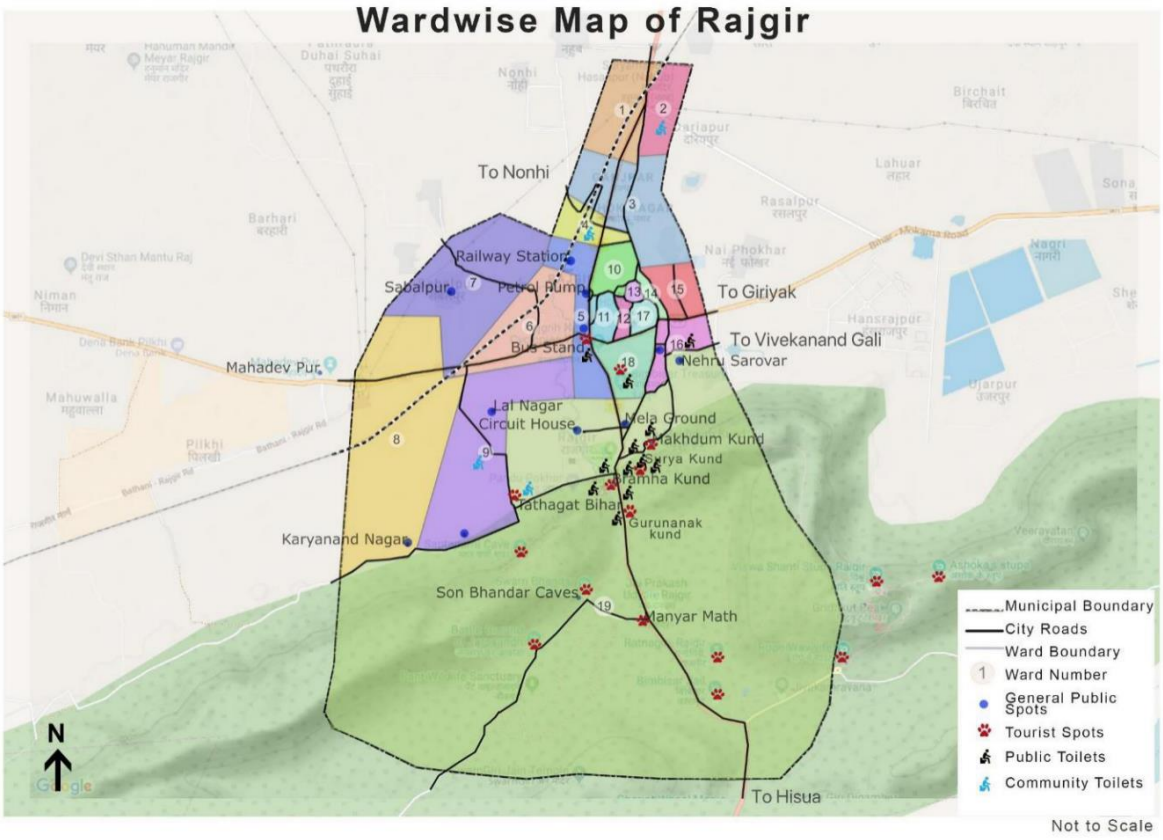
- Sewage Treatment Plant, Rajgir; Public Toilets in ward-19 and 5; Sewage Pumping Station at Ledua Bridge; Old Sewer wards (11,12 &17), Manual Emptiers houses;
- Visit to approximate 100 households spread throughout the city.
- Open defecation Zones near Vaitarini River, Ajathshatru Ground and Fort and Mela Ground
- Public toilets at Bus Stand, Makdum Kund, Brahamma Kund and Surya Kund.

Annexure 1

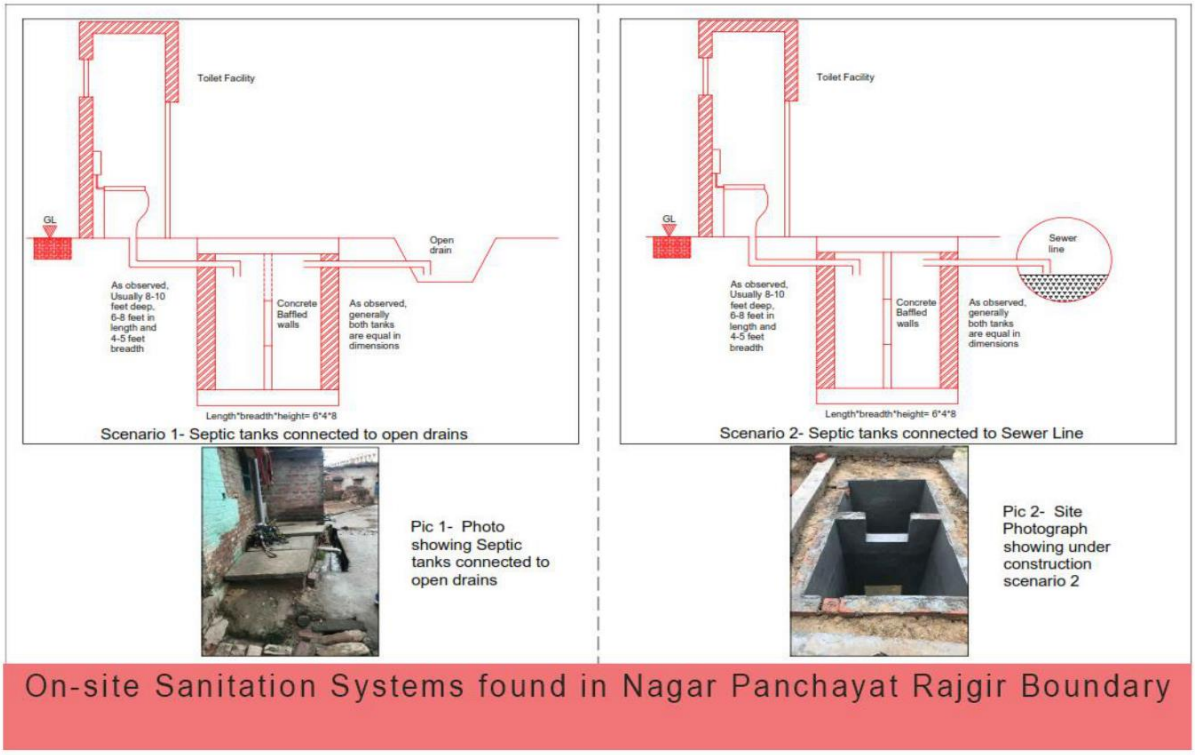
Serial Number	Ward Number	Ward Population
1	1	1,248
2	2	1,308
3	3	1,335
4	4	3,084
5	5	1,391
6	6	2,607
7	7	2,514
8	8	1,960
9	9	1,951
10	10	3,909
11	11	3,012
12	12	1,721
13	13	1,518
14	14	1,919
15	15	2,268
16	16	2,710
17	17	1,863
18	18	1,733
19	19	3,536
Total		41,587

Source: Census 2011

Annexure 2


Wardwise Map of Rajgir
To Nonhi
Railway Station
Sabalpur
Petrol Pump
Bus Stand
To Giriyak
To Vivekanand Gali
Nehru Sarovar
Mahadev Pur
Lat Nagar
Circuit House
Mela Ground
Makhdum Kund
Surya Kund
Ramha Kund
Tathagat Bihar
Gurunanak kund
Karyanand Nagar
Son Bhandar Caves
Jarasandha Akhara
Jarasandha Math
To Hisua
Municipal Boundary
City Roads
Ward Boundary
Ward Number
General Public Spots
Tourist Spots
Public Toilets
Community Toilets
N
Not to Scale

Annexure 3


Toilet Facility
GL
Open drain
As observed, Usually 8-10 feet deep, 6-8 feet in length and 4-5 feet breadth
Concrete Baffled walls
As observed, generally both tanks are equal in dimensions
Length*breadth*height= 6*4*8
Scenario 1- Septic tanks connected to open drains
Toilet Facility
GL
Sewer line
As observed, Usually 8-10 feet deep, 6-8 feet in length and 4-5 feet breadth
Concrete Baffled walls
As observed, generally both tanks are equal in dimensions
Length*breadth*height= 6*4*8
Scenario 2- Septic tanks connected to Sewer Line
Pic 1- Photo showing Septic tanks connected to open drains
Pic 2- Site Photograph showing under construction scenario 2
On-site Sanitation Systems found in Nagar Panchayat Rajgir Boundary

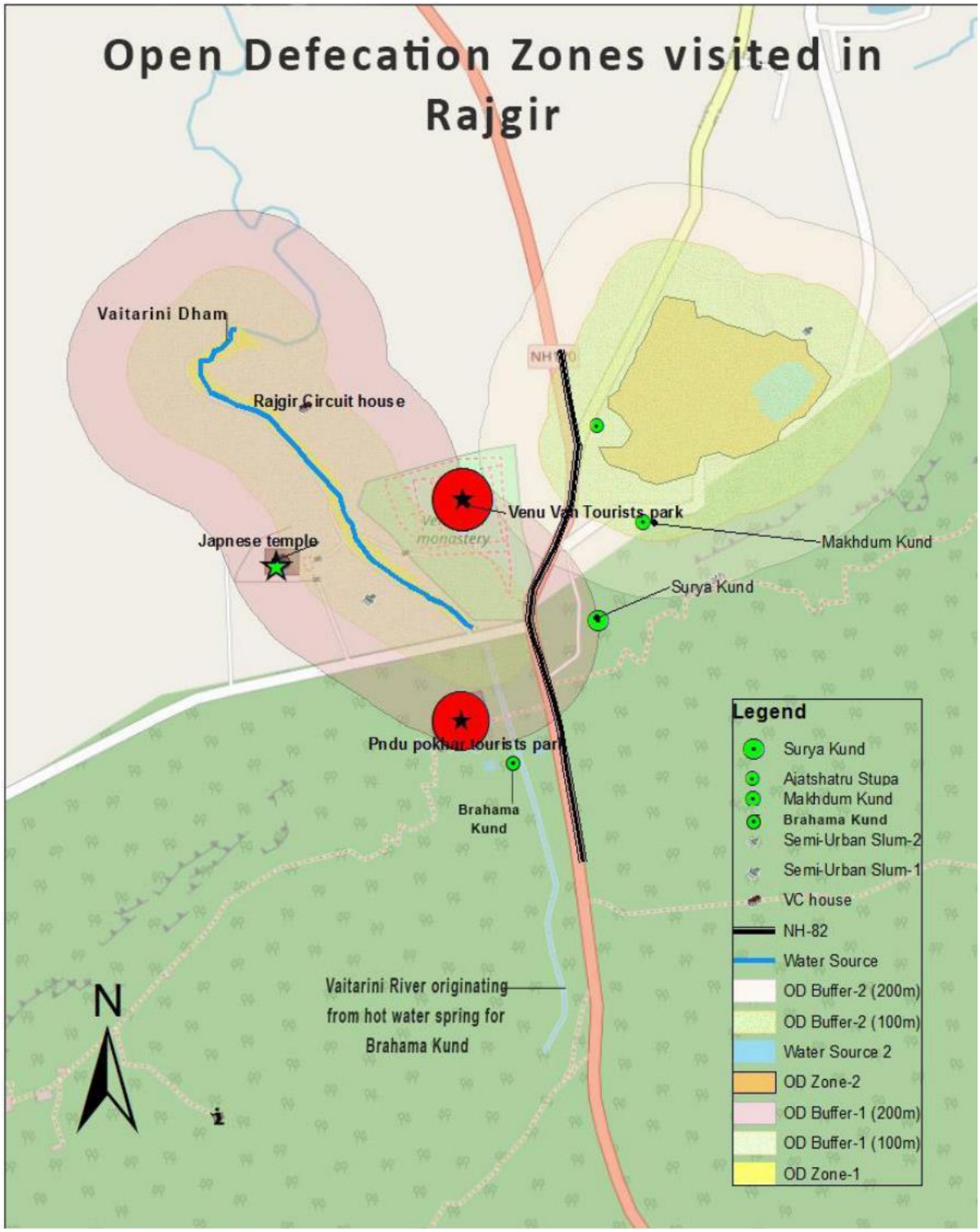
Annexure 4

Status of Public and Community Toilets in Rajgir (NPR; Field Observation).

Public Toilets			
S. No.	*Ward No.*	*Location Name*	*Present Condition Remark**
1	19	Makhdum Kund main exit	working
2	19	Surya Kund main exit	Working but found closed
3	19	Surya Kund	working
4	19	Brahma Kund	Working but found closed
5	19	Brahma Kund	Working
6	19	Brahma Kund	Working but found closed
7	19	Brahma Kund	Not Working
8	19	Brahma Kund	Given to priests of temple
9	19	Gurunanak Kund	Working but found closed
10	16	Bazar	working
11	18	Dharmshala Road	working
12	5	Bus Stand	Working but filthy condition
Community Toilets			
1	2		Closed
2	4		Closed
3	9		Closed
4	19	Virayatan Road	Closed

*the remarks are given on basis of field observations.

Annexure 5


Open Defecation Zones visited in Rajgir
Vaitarini Dham
Rajgir Circuit house
Japnese temple
Venu Van Tourists park
Makhdum Kund
Surya Kund
Pndu pokhar tourists park
Brahama Kund
Vaitarini River originating from hot water spring for Brahama Kund
N
Legend
Surya Kund
Ajatshatru Stupa
Makhdum Kund
Brahama Kund
Semi-Urban Slum-2
Semi-Urban Slum-1
VC house
NH-82
Water Source
OD Buffer-2 (200m)
OD Buffer-2 (100m)
Water Source 2
OD Zone-2
OD Buffer-1 (200m)
OD Buffer-1 (100m)
OD Zone-1

Annexure 6

List of distribution of hand pumps, stand posts and water tankers across different wards in Rajgir.

S. No.	Ward No.	Hand Pump		Stand Post	Water tanker supply
		Total	Functional		
1	1	5	5	0	Daily
2	2	2	2	0	Daily
3	3	3	3	0	Daily
4	4	2	2	0	Daily
5	5	6	5	Water A.T.M	As per need
6	6	2	1	0	As per need
7	7	2	2	0	Daily
8	8	1	1	0	Daily
9	9	3	3	0	Daily
10	10	2	2	7 (Dysfunctional)	Daily
11	11	2	2	1	As per need
12	12	2	2	2	Daily
13	13	0	0	0	Daily
14	14	1	1	0	Daily
15	15	2	2	0	Daily
16	16	1	1	0	Daily
17	17	1	1	8	Daily
18	18	2	2	6	Daily
19	19	3	3	10	Daily
	Total	**42**	**40**	**34 + 1 A.T.M**	