Beur STP, Patna
Co-treatment Case Study

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A. City Profile

Patna, the capital of Bihar, is situated on the southern banks of River Ganga. The city extends linearly along River Ganga for approximately 25 kilometres and is bounded by River Sone in the West and River Punpun, which eventually joins River Ganga, in the South. (**Error! Reference source not found.** city map refer Annex 1) Apart from being an administrative centre, Patna is also a major educational and medical centre.

The Patna Municipal Corporation (PMC) which covers an area of 109.21 km^2 had a population of 1.68 million in 2011 and its present population is estimated to be around 1.8 million[1]. The PMC is a part of the Patna Urban Agglomeration[2] (PUA) which covers an area of 146.16 km^2 and had a population of approximately 2 million[3] in 2011. Given that Patna is an administrative, educational, health and trade hub its floating population is quite high, ranging between 0.4 million to 0.5 million daily[4].

Access to toilets: As per Census 2011, 92 percent of households in Patna (including the area under PMC and its Out Growths) have Individual Household Latrines (IHHLs). Further, while 3 percent of households were using public toilets (maintained by PMC[5]) the remaining 5 percent were defecating in the open. While PMC is committed to making the city Open Defecation Free (ODF) it hasn't been able to make much progress as availability of space for constructing IHHLs is a major constraint for households that currently lack access to toilet facilities[6].

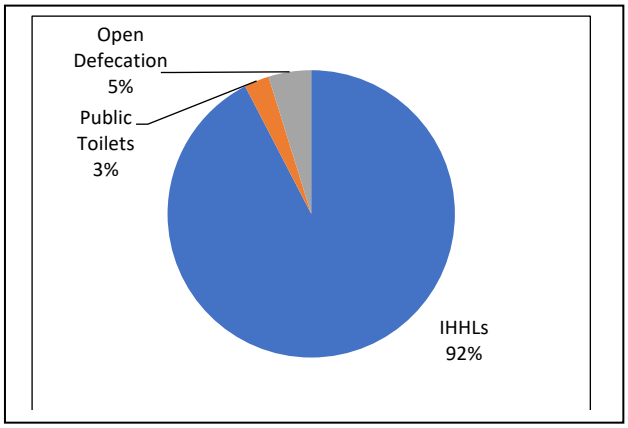


Figure 1: Access to toilets in Patna (Census, 2011)

Sewage collection and conveyance systems: Although a large majority of households have IHHLs, only 23.4 percent of these were connected to piped sewer system in 2011[7]. As per a study undertaken by Population Services International (PSI) in 2017 of the households with IHHLs, only 15 percent were directly connected to piped sewer system while the remaining discharged into open drains and thus the waste water from these households was not safely treated.

Majority (71 percent) of the households with IHHLs in Patna were based on septic tanks in 2011[8]. The PSI research (2017) brought to light that approximately 65 percent of households with IHHLs were based on septic tanks[9]. Most of the septic tanks have 2 or 3 chambers with an outlet for flow of

[1] Source: Patna Municipal Corporation
[2] Patna Urban Agglomeration (PUA) comprises of the area under the jurisdiction of the PMC, and its outgrowths namely, Patlipura Housing Colony, Digha-Mainpur, Sabazpura, Khalilpura and Badalpura. Danapur Cantonment Area, Danapur Nagar Palika Parishad area, Khagaul Nagar Palika Parishad area, and its outgrowth of Saidpura, Phulwarisharif Nagar Palika Parishad area. Apart from these it also consists of Fatwah Nagar Panchayat area, Maner Nagar Panchayat area and 104 villages. The area under the jurisdiction of Patna Regional Development Authority (PRDA) covers an area of 234.70 km^2 comprising of a large portion of Patna district, and some portions of the Saran and Vaishali districts.
[3] Source: Social Assessment and Management Plan (SMP) for Sewerage Schemes in Patna City – Beur Zone", July 2015. Available at http://nmcg.nic.in/writereaddata/fileupload/55_SMPBeur%20Sewerage%20Schemes.pdf
[4] Source: SFD Report Patna 2018, A Report prepared by Population Services International. Available at http://www.susana.org/_resources/documents/default/3-2990-7-1519733214.pdf
[5] There are 21 public toilets in Patna; Source: Patna City Development Plan
[6] Source: Discussions with Population Services International and PMC
[7] Source: Census 2011
[8] Ibid.
[9] Another 3 percent of households are dependent on leach pits.

effluent.[10] The research revealed that the effluent / supernatant from septic tanks either flows into storm water drains (50 percent) or into open lands (50 percent)[11].

In Patna, open drains act both as drains and sewers. As mentioned above at many places, households discharge sewage through open drains into *nallas*. Encroachment, along with dumping of solid waste, not only obstructs the flow of waste water but the presence of putrescible organic matter also causes septic conditions resulting in foul odour and proliferation of disease causing vectors.

Sewage treatment facilities: Patna is divided into six sewerage zones, namely, Digha, Beur, Saidpur, Kankarbagh, Pahari and Karmali Chak[12]. There are four STPs with a total installed capacity of 109 MLD. However, only some portion of the installed capacity is currently being utilised in all STPs. At present, only 71 MLD of treatment capacity is being used, which is 65 percent of the installed treatment capacity. (Table 1) All STPs are based on Activated Sludge Process (ASP) technology. The treated wastewater is discharged into River Pun-Pun and River Ganga.

Table 1: Details of STPs in Patna

STP – Location	*Installed Capacity*	*Current Capacity in use for treatment*	*Technology*
Saidpur	45 MLD	33 MLD	ASP
Beur	35 MLD[13]	20 MLD	ASP
Karmali Chak (under construction)	4 MLD	2 MLD	*ASP*
Pahari (under construction)	25 MLD	16 MLD	ASP
Total (at present)	**109 MLD**	**71 MLD**	

Septage Management: As mentioned above, majority of households with IHHLs are based on septic tanks. PMC has eight vacuum tankers with jetting and suction machine assembled with a truck/tractor. Between two or three tanks are emptied on demand per day for a charge of INR 1,000 per septic tank[14]. However, PMC's service is unable to meet the overall demand for desludging; thus many private operators are engaged in this service. As per a study undertaken by PSI there are about 20 operators with 55 vehicles in the city. The private operators desludge septic tanks on demand and charge a fee of around INR 1,500 - 1800 per trip. The vehicles used are tractors mounted with suction pumps and tanker with capacities ranging from 1 m^3 – 5 m^3. Emptied septage is discharged into nearby open areas, open drains (connected to River Pun-Pun and River Ganga) or sewer manholes. Recently, Bihar Rajya Jal Parishad (BRJP) has collaborated with PSI to initiate decanting of septage collected by private desludging operators and its co-treatment at Beur and Saidpur STPs.

Institutional Arrangements: Multiple institutions are involved in management of sewerage services in Patna including Urban Development and Housing Department[15] (UD&HD), Government of Bihar; Bihar Urban Infrastructure Development Corporation[16] (BUIDCo); BRJP; PMC and Bihar Pollution Control Board (BPCB). Table 2 presents the institutional responsibilities related to sewerage services in Patna.

[10] Source: SFD Report Patna 2018, A Report prepared by Population Services International. Available at http://www.susana.org/_resources/documents/default/3-2990-7-1519733214.pdf
[11] Ibid.
[12] Earlier there were only four zones, two new zones have been created namely, Digha and Kankarbagh
[13] Two treatment trains of 20 MLD and 15 MLD
[14] Source: SFD Report Patna 2018, A Report prepared by Population Services International. Available at http://www.susana.org/_resources/documents/default/3-2990-7-1519733214.pdf
[15] The Urban Development and Housing Department (UD&HD) is the nodal department for policy formulation and guidance for the urban Water Supply and the Sewerage (WSS) sector. It also allocates resources to ULBs through various centrally-sponsored schemes, providing finance support through national financial institutions.
[16] BUIDCo is a Flagship company to implement urban infrastructure projects related to Solid Waste Management, Water Supply, Drainage Network and Sewerage & Sewage Treatment in BIhar.

Table 2: Institutional Responsibilities Related to Sewerage Services in Patna

Institution	Planning	Implementation	Operation and Maintenance	Regulation
UD&HD				
BUIDCO				
BRJP			O&M of STPs	
PMC		SBM	O&M of sewerage network	
BPCB				

City's Vision for Sanitation: Projects worth INR 32,376.9 million have been sanctioned aimed at creating 350 MLD sewage treatment capacity and laying of 1140.26 km of piped sewer lines. It is envisaged that these projects will ensure that all households are connected to the piped sewer network, all collected waste water is treated and no untreated waste water reaches River Ganga from Patna.

- Work is underway in Beur and Saidpur sewerage zones which is aimed at creating sewage treatment capacity of 140 MLD and laying of 422.88 km of piped sewer network at a cost of INR 7380.4 million[17].
- Under the *Namami Gange,* a project costing INR 11,115 million has been sanctioned to upgrade the sewerage infrastructure in Patna which involves laying of 376 km[18] of piped sewer network, installation of 2 Sewage Pumping Stations (SPS) and installation of one STP of 25 MLD capacity at Pahari.
- Three more projects are scheduled to start soon in Karmalichak, Digha and Kankarbagh sewerage zones which will create treatment capacity of 150 MLD and lay 534.54 km of piped sewer network.

B. Co-treatment – Genesis

At present, co-treatment of septage is being undertaken at two STPs, namely Beur and Saidpur. In this paper we present the case of Beur STP. The STP is located in Beur sewerage zone which covers the west-southern part of the city. (Refer Annex 3 for map of the sewerage zones) Spanning an area of 11.50 km^2, Beur zone had a population of 0.28 million in 2017 and is expected to reach 0.39 million by 2032[19].

The Beur STP has two treatment trains with a combined installed capacity of 35 MLD (20 MLD and 15 MLD). The 15 MLD train is currently defunct (Table 1) and work is underway to set up a new STP, with a capacity of 33 MLD, at the same site. The STP is based on an Activated Sludge Process (ASP) technology. The STP receives waste water flow of ~18 MLD[20] and there is spare treatment capacity of ~2 MLD which is being used for co-treatment of septage.

A key stakeholder in this initiative has been a Civil Society Organization (CSO), PSI, which under a grant[21] from the Bill and Melinda Gates Foundation (BMGF) undertook research and advocacy with key institutions, namely, UD&HD and BRJP, and brought them on board for initiating co-treatment as a mechanism to ensure that septage collected by private desludging operators from on-site

[17] Source: http://pib.nic.in/newsite/PrintRelease.aspx?relid=178535
[18] 172.50 km of sewerage network in Saidpur zone, 87.696 km of sewerage network in Pahari sewerage zone and 115.93 km of sewerage network in Pahari sewerage zone. Source: http://pib.nic.in/newsite/PrintRelease.aspx?relid=178535
[19] Source: Social Assessment and Management Plan (SMP) for Sewerage Schemes in Patna City – Beur Zone", July 2015. Available at http://nmcg.nic.in/writereaddata/fileupload/55_SMPBeur%20Sewerage%20Schemes.pdf
[20] Source: Beur STP's Technician / Chemist
[21] The project was initiated in 2014 and was aimed at creating business models for pit emptying, disposal and treatment and to create an enabling environment that fosters public private partnership for Faecal Sludge and Septage Management (FSSM)

sanitation systems is not dumped in the open and/or in drains and that most of the waste water generated is treated.

The co-treatment initiative has been a process of starts and stops. The first pilot was implemented in February 2017 at Beur and stopped due to complaints about foul smell from neighbouring residential areas. A second pilot was implemented across July and August 2017. In March 2018 a full scale implementation of co-treatment has been initiated at Beur and Saidpur STPs.

Partnership between Service Provider, CSO and Association of Tanker Operators

The co-treatment initiative is a partnership between BRJP (the service provider), PSI (a CSO) and Bihar Rajya Tanker Association (BRTA) (an Association of tanker operators). BRJP is responsible for the Operation and Maintenance (O&M) of Beur STP. As mentioned above PSI was implementing a project aimed at creating enabling conditions for Public Private Partnerships in Faecal Sludge and Septage Management (FSSM) in Bihar. Under the aegis of this project, PSI undertook research and advocacy with key stakeholders including UD&HD, BRJP, PMC and private desludging operators. BRTA, an association of private desludging operators working in Patna, was provided hand holding support, during its formation and development, by PSI. Table 3 outlines the key activities undertaken towards initiating co-treatment.

Table 3: Details and sequence of activities undertaken towards co-treatment (2015-2018)

Year	Activity
2015	• Research: Mapping of private desludging operators and sewage treatment facilities in Patna (STPs, Lifting stations and Pumping stations) undertaken by PSI • Advocacy initiatives: Meetings with Principal Secretary (PS), UD&HD Outcome: Letter issued by PS, UD&HD to PMC and BRJP to initiate co-treatment
2016	• BRJP issues letter to initiate co-treatment with a tipping fee of INR 300 per trip per truck plus INR 1000 for registration • PSI initiates registration of private desludging operators
2017	• Research: Assessment study conducted for co-treatment at STPs by PSI • First pilot initiated at Beur STP in February 2017 • Second pilot at Beur (July and August 2017) • Formation of an association of tanker operators – BRTA with 14 private tanker operators as its member.
2018	• Full scale co-treatment initiated at Beur and Saidpur STPs (four decanting points identified two at the STPs and two manholes) • Registration of private desludging operators with BRJP (10)

Formation of an Association of Tanker Operators

With support from PSI the tanker operators operating from the Digha Chana Road[22] have formed an association, namely BRTA. There are 15 members who operate 22 tankers. The association has a membership fee of INR 500 per month. BRTA has regular monthly meetings and has developed bye-laws for proper functioning. BRTA has office bearers who are selected through a process which is clearly outlined in the bye laws. The association has a registered office[23] in Patna and has a dedicated bank account. Following its formation BRTA won a bid for pit cleaning services required by PMC during the closing ceremony of *Prakashotsava* (a local festival). Four tankers were deployed by BRTA and 1.08 million litres of faecal sludge were discharged at the STP over 8 days. The association was paid INR 0.216 million for this work.

C. Co-Treatment at Beur STP

Plant Details

The Beur STP has an installed capacity of 35 MLD and is based on an Activated Sludge Process (ASP) technology. At present, only one treatment train of 20 MLD is functional. Discussions with officials of the BRJP (responsible for O&M of the plant) revealed that the STP receives waste water flow of around ~18 MLD. The plant has a spare treatment capacity of ~2 MLD which is being used for co-treatment of septage.

The outfall point for the treated waste water is *Badshahi Pien*, from where it is discharged into River Punpun, a tributary of River Ganga.

Planning and Implementation of Septage Co-treatment – Pilots and Scale up

Co-treatment of septage at Beur STP was initiated as a pilot in February 2017. In the first pilot, nine private desludging tankers were registered with BRJP for decanting septage at Beur. In the second pilot which was implemented across July and August 2017, 14 tankers were registered. Since March 2018, 15 operators have been registered and they operate a total of 22 tankers. The tanker operators have to pay an annual registration charge (INR 1,000 per tanker) and a tipping fee of INR 100 per tanker per trip.

Two decanting points have been identified, one within the STP (at the screening chamber prior to the sump) and the other is a manhole located approximately 300 meters away from the STP.

Private desludging Tanker

Decanting point outside the STP

[22] This is one location from where private tanker operators operate. They usually can be seen parked there during the working hours.

[23] Plot No – F1/18, S. No. – 2238, Jai Prakash Nagar, Digha – Ashiana Road, Near May Flower School, Patna – 800011

Volume and Quality of Septage

In the first pilot 23 truckloads i.e., approximately 115m^3 of septage was decanted at Beur STP[24]. In the second phase (July – August 2017) 123 truckloads / 615m^3 of septage was decanted at Beur and Saidpur STPs[25]. Discussions with the laboratory in-charge revealed that in the scale up phase since March 2018 2-4 tankers (with capacity varying from 1m^3 – 5m^3) decant at the Beur STP daily. (Table 4)

Table 4: Pilots and Full scale implementation – Details of operators and septage decanted

Project	Operators (Numbers)	Details of decanting
Pilot I (February 2017) Beur STP	9	23 truckloads; 115m^3 decanted at Beur
Pilot 2 (July August 2017) Beur and Saidpur STPs	14	123 truckloads; 615m^3 decanted at Beur and Saidpur
Full scale implementation	15 operators 22 tankers	Daily 2-4 tankers / trucks of capacity 1m^3 – 5m^3 at Beur; 14m^3 litres per day

The facility is receiving very small amounts of septage, each day 2-4 trucks with a capacity of 1m^3 – 5m^3 decant at Beur STP amounting to approximately 14m^3 per day. Septage addition and co-treatment has not resulted in any operational challenges at the STP.

Infrastructure Investments and Operational Changes for Co-treatment

Decanting Points: There are two decanting points, one within the STP at the screening chamber prior to the sump and another is a manhole located approximately 300 – 400 meters away from the STP. The infrastructure was already in place and thus no additional capital investment has been made.

The septage mixes with the waste water at the manhole and flows through the pipe connecting the septage receiving manhole to the inlet chamber of the STP, prior to the preliminary treatment process and the combined waste stream subsequently undergoes the entire treatment cycle.

No retrofits or additions to the treatment train or changes in O&M protocols have been made at Beur STP following initiation of co-treatment.

Septage sampling protocols: At present, there is no sampling of septage being decanted either at the manhole or the STP. According to the chemist of the in-house laboratory the sample of the combined waste water (sewage + septage) is taken from the inlet point for testing.

Record keeping protocols: At present, there are no mechanisms for recording the number of trucks and amounts of septage being decanted at the STP. No dedicated staff for recording the entry and exit of tankers at the decanting point.

Safety protocols: There are no safety protocols that have been put in place to ensure the safety of the people involved in decanting.

Financial Details

Discussions with staff of BRJP revealed that no additional capital costs have been incurred for constructing a receiving station or for making any changes or additions to the plant post initiation of co-treatment. They also shared that since the amounts of septage received are so miniscule there have been no changes in the overall O&M costs.

[24] Source: PSI
[25] Source: PSI

The tanker operators have to pay an annual registration charge (INR 1000 per tanker) and a tipping fee of INR 100 per tanker per trip. The registration charge and tipping fee have emerged as revenue sources. Since March 2018 total collection of tipping fee has been approximately INR 0.16 million.

Table 5: Co-treatment – Capital Costs and Revenue generated (approximations)

Category	***Details***	***Amounts (in INR)***
Capital Cost	Receiving area for decanting	**None**
O&M Cost	None made so far	None
Revenue Generated	Registration Charge (@ INR 1,000 per tanker /year)	22,000
	Tipping Fee (@ INR 100 per truck / trip)	1,58,400[26] (March 2018)
	Total (INR)	**1,80,400**

Performance Details

The data available for March 2017 and March 2018 for BOD, COD and TSS at both inlet and outlet points shows that there has been an increase in all values post co-treatment of septage at Beur STP.

Table 6: Performance Indicators: BOD, COD and TSS at inlet and outlet points (March 2017 and March 2018)[27]

Parameter	**Point**	**Mar-17**	**Mar-18**	**Increase**	**Increase in %**
BOD (mg/L)	Inlet	189	193	4	2.12
	Effluent	25.5	38	12.5	49.02
COD (mg/L)	Inlet	343	364.5	21.5	6.27
	Effluent	73.5	109	35.5	48.30
TSS (mg/L)	Inlet	293	313	20	6.83
	Effluent	36.5	40	3.5	9.59

D. Impact of co-treatment

- **Regularisation of private desludging operators:** The activities of the 15 private operators who are registered for decanting septage at Beur STP have been regularised. Their details are now available with the BRJP and PMC and the agencies have much better control on them.
- **Environmental Impact:** The initiative has ensured that illegal dumping of septage by private operators has reduced substantially in Beur (and Saidpur) zones.
- **Recognition and dignity for private desludging operators:** The initiative has ensured that the work of the private desludging operators is recognised and acknowledged by the city and the state authorities. Given that they have a designated decanting place they don't need to wait for the dark to sneak out and discharge the septage into open areas / drains, etc.
- **City population being served by co-treatment**: Given that 22 trucks are registered with BRJP there can be anywhere between 44 – 66[28] trips per day. Based on this it is estimated that the co-treatment of septage at Beur is likely to provide septage treatment solution for approximately 26,000 to 110,000 households with septic tanks[29].
- **Potential Source of Revenue:** The annual registration charge and the tipping fee charged to the private desludging operators have emerged as a revenue source. In March 2018

[26] There are 22 trucks and assuming that each truck makes 3 trips per day and they work for 24 days in a month
[27] Source: Data received from the Chemist, STP Beur
[28] Given that there are 22 tankers registered and assuming two to three trips per day
[29] Estimate based on number of households that can be serviced when septic tank sizes varies from 4 to 10 m^3, desludging truck size of 3.5m^3 and when desludging is done once every 3-5 years.

approximately INR 0.16 million were collected as tipping fee from the 22 tankers decanting at Beur.

E. Key lessons and practices

- The partnership between government agencies, a CSO and an association of private desludging operators has enabled initiation of co-treatment despite the initial resistance due to concerns around smell from surrounding residential neighbourhoods.
- The PMC and the BPCB need to undertake rigorous enforcement of environmental protection and pollution control provisions along with co-treatment in order to ensure that private operators move to a regulated system.
- The STP receives a very small amount of septage. Data on treated water available for March 2017 (pre co-treatment) and March 2018 (with co-treatment) shows that there has been some increase in values of BOD, COD and TSS in both the waste water at inlet and the final effluent. However, the data available isn't enough to make a clear deduction. There is thus a need for more stringent quality testing of septage, sewage at inlet and treated effluent at outlet point.
- Tipping Fee charged for decanting at an STP should be minimal. The fact that the tipping fee has been kept at INR 100 per tanker per trip has enabled private operators to use the facility.
- Record keeping mechanisms need to be put in place to control and record the movement of tankers at the decanting points.
- Safety protocol should be put in place to identify and eliminate industrial waste from being disposed of at co-treatment facilities; this must include random testing of the septage arriving at the STP. Also protocols to ensure safety of the staff involved in decanting needs to be put in place.

Annex 1: Patna City Map

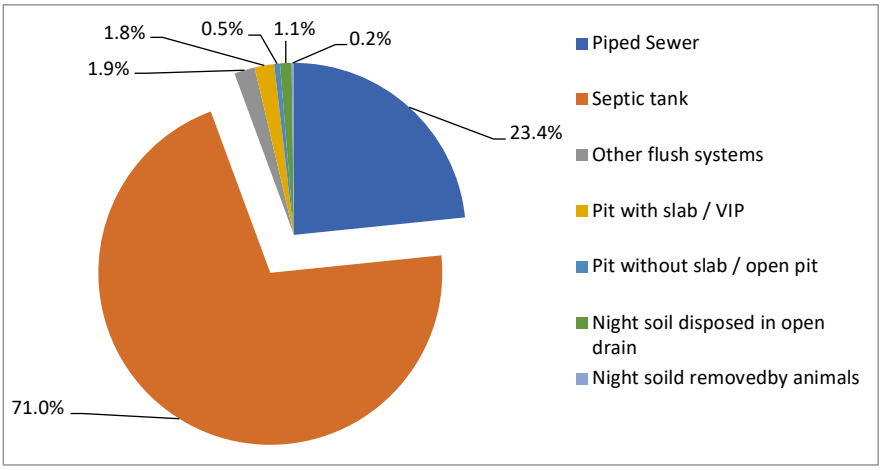
Annex 2: Status of access and collection and conveyance systems in Patna

Table 1: Access to toilet facilities (Census 2011)

Access to Sanitation Facilities	Number of households	%
Individual Toilets	271,944	92.39
Public Toilets	8,249	2.80
Open defecation	14,142	4.80
Total households	**294,335**	**100.00**

Table 2: Collection and Conveyance systems (Census 2011)

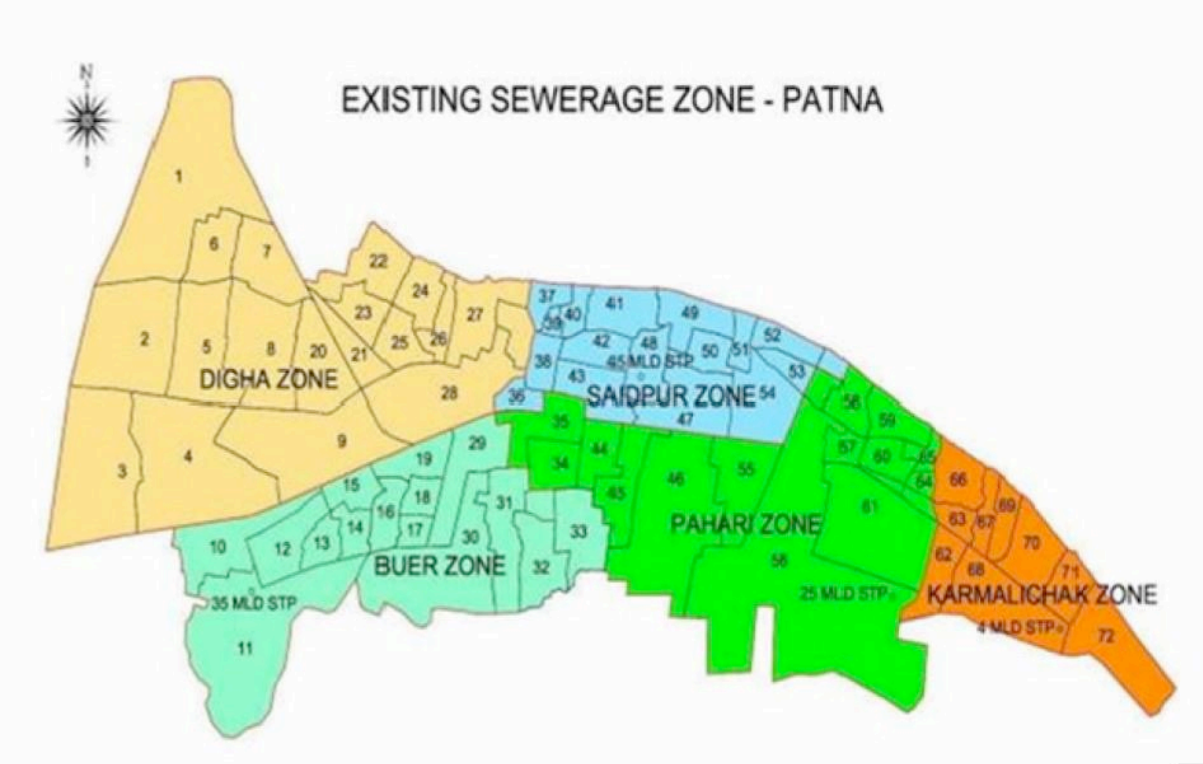
	Number of households	%
Piped sewer	63,640	23.38
Septic Tank	193,277	71.00
Other Flush System	5,303	1.95
Pit with slab / VIP	5,008	1.84
Without slab/ open pit	1,473	0.54
Night soil disposed into open drain	2,946	1.08
Night soil serviced by animal	589	0.22
Total	**272,236**	**100.00**



Containment and conveyance Mechanisms for Waste water in Patna (Census 2011)

Annex 3: Sewage Treatment Zones in Patna

The sewerage system in Patna was established in 1936 and has been upgraded subsequently. The city has four sewage treatment plants located at Saidpur (45 MLD), Beur (35 MLD), Pahari (25 MLD) and Karmali Chak (16 MLD) although the quantum of sewage reaching the plants is lower than installed capacity. There are 33 lifting stations.



Annex 5: STP Details for Beur STP

Installed in 1929, the STP is based on the Activated Sludge Process (ASP) technology. The STP consists of a screen (machine and manual), primary settling tank, Sludge Pump House[30], Sludge Digestor and Gas burner. The primary treatment is through biological treatment (Mixed Liquor Suspended Solids) which is followed by aeration and secondary settlement.

[30] Pumps - 75 HPx3, 30 HPx1 and 20 HPx1

Annex 6: List of officials met at Patna

S. No.	Name, Designation, Organisation
1	Mr. Rajesh Meena, Managing Director, BRJP
1.	Mr. Anil Kumar, Chief Engineer, BRJP
2.	Mr. Vishal Kumar Mandal, Deputy Municipal Commissioner-Sanitation, Patna Municipal Corporation
3.	Mr. Hareram, Chemist/Lab Technician, BRJP, STP- Beur
4.	Mr. Amar Anand PMU
5.	Mr. Sanjay Singh, PSI
6	Mr. Surojeet Chandan, PSI
5	BRTA Members