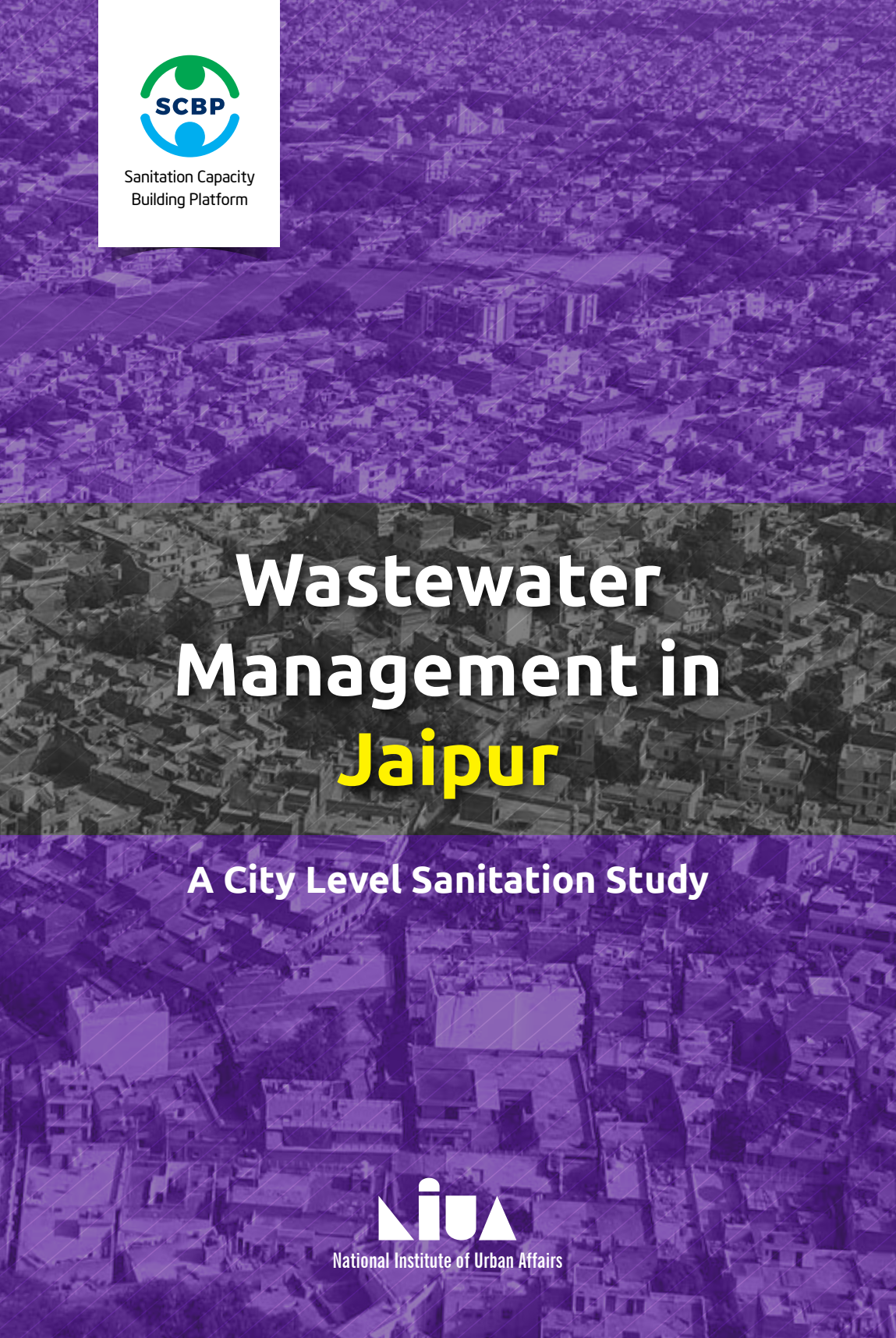
SCBP
Sanitation Capacity
Building Platform
Wastewater
Management in
Jaipur
A City Level Sanitation Study
National Institute of Urban Affairs

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Foreword

About Sanitation Capacity Building Platform (SCBP)

Sanitation Capacity Building Platform is a platform of credible national organizations forged by NIUA. The platform advocates for a paradigm shift in favor of non sewered systems based urban sanitation solutions. Non sewered sanitation systems are relevant for India, given the predominantly septic tank based sanitation systems of urban India and the emerging priorities of water conservation, managing water demand and reducing the waste water footprint of urban India. The program core is Capacity Building for non sewered sanitation and integrated waste water management.

The program supports technical assistance, developing and delivering training content and modules, research studies and policy advise to urban local bodies, nodal national training institutes, academia and private sector. The program is supported by a grant from Gates Foundation and has in the last 4 years produced a portfolio of training modules, research reports and academia and institutional partnerships to deliver capacity building for faecal sludge management at scale. This will be sustained for the second phase of the program starting 2020.

The program has provided the state of Uttar Pradesh, Bihar and Uttarakhand, with technical assistance for a DPR preparation for their first Faecal Sludge Treatment Plants. SCBP provides on demand support to cities and has supported the city of Port Blair to review its centralized Sewage Treatment Plant DPR and suggest alternative decentralized solutions.

The program has partnered with 10 national nodal training institutes, 30 Alliance partners of the NFSSM (a coalition of agencies) and 10 Universities/ Colleges: to train more than 2000 government officials through 30 trainings across more than 500 cities of India, more than 250 students and 30 Academia Faculty, developed a set of 13 training modules, brought out 24 research and publications.

The program has created a Knowledge Hub/Portal: scbp.niua.org. Where all the SCBP work is available for dissemination. The portal received more than

140,000 individual visitors, has more than 650 users and over 9500 downloads over the past 2 years. It has the most comprehensive repository of knowledge resources on decentralized and non sewered sanitation in India.

SCBP has contributed to the MoHUA Urban Learning portal with 3 sets of capacity building documents on Urban Water and Waste Water Management: 1. Policy Framework, Policy Workbook, 3. Evaluation Metrices. Three sets of standardized and update Training Modules on Non Sewered Sanitation systems, were recently released by Secretary MoHUA.

SCBP has also contributed to the draft of the National Urban Sanitation Policy 2.0 that was submitted to MoHUA in 2018. The program has contributed to the recognition of NIUA as a lead national knowledge/CB organization. MoUs have been forged with Uttarakhand state, as a partner of choice in Rajasthan and UP. Also recognised internationally in South Asia and Africa.

SCBP support for Rajasthan

NIUA supported the government of Rajasthan during 2017-19, for adopting non sewered sanitation systems for urban local bodies, as a viable solution for managing and treating septage waste.

NIUA supported the state for Policy guidelines, Technical support (preparation of Detailed Project Reports for setting up Faecal Sludge Treatment Plants), conducting state wide FSSM and ODF Training programs and exposure visits for engineers and Executive Officers of ULBs, with support of SCBP partner organisations.

Several research studies were done. These included a Legal and Institutional study of 100 towns assessment exploring the potential for septage treatment, 3 Detailed Project Reports for setting up Faecal Sludge Treatment Plants and this study of Urban Wastewater Management of Jaipur.

Executive Summary

The capital city of Rajasthan, Jaipur, has an extensively developed centralised sanitation system that covers 60 percent of the area and 80 percent of the population. The present report is a desk study of the sanitation situation in Jaipur based on a perusal and analysis of Government documents and secondary literature combined with observations from a brief field visit to the city to examine the operation of the centralised sanitation system. The objectives of the study are –

- Review of the Overall Status of Centralised Sanitation in Rajasthan.
- Review of the State policies with regard to sanitation and faecal sludge management.
- Review of the planning and functioning of the centralised sanitation systems in the city of Jaipur inclincluding an analysis of the expenditures of existing sanitation infrastructure.
- Review of the possibilities of co-treatment of faecal sludge in sewage treatment plants
- Review of the possibilities of implementing decentralised sanitation systems in order to ensure economic viability, equity and environmental sustainability.

The Rajasthan Government has over the past decade or so considerably enhanced its investments in building centralised sanitation infrastructure in the state with its own resources augmented by funding from the central government under various schemes and also with loans from the Asian Development Bank. It has also notified a policy on Sewerage and Wastewater and another on Faecal Sludge and Septage Management.

The centralised sanitation systems are mostly there in towns of population greater than 5 lakhs though projects are under implementation in smaller towns also. The major constraints to the successful operation of centralised sanitation systems are as follows –

- Lack of adequate water supply is the first major obstacle. Sewerage systems ideally require 135 litres per capita per day water supply to maintain adequate flow but apart from Jaipur and Udaipur, this is absent and on an average the water supply is only 66 lpcd.
- Even where sewerage systems have been installed and are operational there are not enough house connections. Even if there are house

connections these are to the septic tanks and the kitchen and bathroom wastewater.

- There are inadequate resources with the urban local bodies for the operation and maintenance of the sewerage system and STPs. The sanitation charges that are levied from the users do not cover the costs.
- The cleaning of sewers which get clogged due to inadequate flow and the flushing of plastics is largely done by contractors. The work is mostly done manually in violation of the law against manual scavenging.

The few STPs that are operating are not following standard procedures and are releasing inadequately treated water into the environment. Apart from two privately constructed and run STPs in Udaipur and Bhilwara reuse of treated wastewater for non-potable use is not being done.

The Jaipur Development Authority has divided the city into four main drainage zones with the northern and central zones draining into the Dravyavati River while the western zone drains into the Chandlai lake and the eastern and southern areas combined drain into the Dhundh River. Sewerage systems and STPs have been constructed accordingly with the installed capacity being 730 kms of sewer lines and 442 MLD of sewage treatment. However, due to inadequate water supply which currently is about 90 litres per capita per day there is inadequate flow in the sewers and so they get choked frequently. The STPs are not operating at full capacity and neither are they treating the waste water according to prescribed standards. Apart from the STPs at Delawas, generation of electricity from the digestion of sludge and the use of manure and reuse of treated wastewater is not being done. The STPs constructed as part of the Dravyavati Riverfront Development Project too are not functioning properly.

Onsite sanitation systems still serve 20 percent of the population of Jaipur and the faecal sludge and septage from these are not being disposed of properly. Therefore, the possibilities of co-treatment of faecal sludge in sewage treatment plants, which are running at less than their installed capacity, need to be explored as has been done in some other cities in India.

The primary reason for the under performance of the centralised sanitation systems in Jaipur are inadequate finances. The shortfall in the actual expenditures for the Public Health Department of the Jaipur Municipal

Corporation from budget estimates for 2014-15 is 27 percent. These actual expenditures in the case of sewerage and STPs fall short of prescribed standards by 41.5 percent. The recovery of this expenditure in the form of sanitation taxes and sewerage and sewage treatment charges is only a dismal 1.6 percent. The overall finances of the Jaipur Municipal Corporation show similar shortfall in revenue expenditure of 27 percent and a high 75 percent shortfall in capital expenditures. The per capita revenue expenditure is only Rs 1779 as opposed to the average for Tier I cities of Rs 8500 and the per capita capital expenditure is Rs 1361 as compared Rs 7000 for Tier I cities. The revenue garnered from property taxes is only 7 percent of the total revenue receipts as against the norm of 25 percent and this is a major reason for poor revenue mobilisation leading to a revenue deficit.

An affordability analysis shows that if the actual expenditures of the public health department on sewerage and sewage treatment were to be recovered from user charges to be levied from the section of the populace that is above the poverty line then 35 percent or more of the population would be paying 4.5 percent or more of their average household consumption expenditure as sanitation charges which is a very high proportion. Thus, there is a considerable financial barrier to running centralised sanitation systems as the revenue for them cannot be raised either through taxes or through user charges.

The water supply scenario too is equally problematic with the actual supply being only 90 lpcd combining all sources. As much as 200 million litres per day of potable water is supplied from the Bisalpur dam on the River Banas at a very high cost of Rs 18 per kilolitre. The domestic consumption of this water is 90 percent and it is under charged. Even these low charges are not properly collected and currently there is an overdue of Rs 50 crores.

Thus, given the operational, environmental and financial unsustainability of the centralised sanitation and water supply systems in Jaipur the provisions of the State Waste Water Policies for reuse of treated waste water, generation of energy and manure from digested sludge in sewage treatment plants, decentralised waste water treatment and reuse and co-treatment of faecal sludge should be explored. Decentralised waste water treatment by private parties capable of doing so will be a progressive measure that will considerably reduce the financial and operational burden of the Jaipur Municipal Corporation and lead to a much better sanitation scenario in the city.

WASTEWATER MANAGEMENT IN JAIPUR CITY: CURRENT SITUATION AND FUTURE PROSPECTS

A major area of concern currently for the country is the proper disposal of wastewater, both grey and black, in urban areas. The huge increase in supply of potable water to cater to the needs of modern urban households has correspondingly increased the quantum of waste water. The implementation of the Swacch Bharat Mission has also led to a substantial increase in the number of toilets and this has increased the faecal sludge and the wastewater load considerably. The state of Rajasthan too like the rest of the country faces this challenge of proper disposal of waste water and faecal sludge. The Rajasthan Government, with the aim of tackling this problem of wastewater disposal has implemented centralised sanitation systems extensively over the past decade or so in a number of towns and cities in the State with loan funding from the Asian Development Bank (ADB) and grant funding from the Central Government, supplemented by its own funds. The Rajasthan Government has also formulated and notified a detailed State Sewerage and Waste Water Policy (SSWWP) in 2016 so as to ensure proper collection, treatment, reuse and disposal of waste water (GoR, 2016a). Additionally, there is also a State Policy on Faecal Sludge and Septage Management (SPFSSM) notified in 2017 to properly dispose of faecal sludge and septage from onsite sanitation systems in areas which have not been covered by centralised systems (GoR, 2017).

The planning, installation and running of centralised sanitation systems involve considerable capital and operational expenditures, the latter on a recurring basis. Therefore, the performance of the various systems put in place needs to be reviewed to assess whether the investments are being made judiciously and whether the outcomes are beneficial in terms of proper wastewater disposal. This is the report of a study of the centralised sanitation systems of Jaipur, the capital city of Rajasthan. This report first sets out the objectives, methodology and limitations of this study. This is followed by an overview of the overall centralised sanitation situation in the state of Rajasthan. Next comes a detailed review of the status of the existing and proposed centralised sanitation systems in the capital city of Jaipur and compares them to the standards set in the SSWWP. Finally, it explores the possibility of implementing decentralised alternatives for achieving the objectives outlined in the SSWWP.

Objectives, Methodology and Limitations of Study

The objectives of the study are as follows –

- Review of the Overall Status of Centralised Sanitation in Rajasthan.
- Review of the State policies with regard to sanitation and faecal sludge management.
- Review of the planning and functioning of the centralised sanitation systems in the city of Jaipur in relation to the standards set in the SSWWP. This includes an analysis of the expenditures of existing sanitation infrastructure.
- Review of the possibilities of co-treatment of faecal sludge in sewage treatment plants
- Review of the possibilities of implementing decentralised sanitation systems in order to fulfill the objectives of the SSWWP.

The methodology of the study is primarily a perusal and analysis of various documents, both government and non-government, as follows –

- Documents on centralised sanitation and water supply in Jaipur of various Government agencies such as the Jaipur Municipal Corportation, Jaipur Development Authority, Department of Urban Development etc.
- Existing literature on sanitation, co-treatment of faecal sludge and alternative decentralised sanitation systems.
- News reports on the operation of centralised sanitation systems in Rajasthan in general and Jaipur in particular.

A field visit to Jaipur and some other towns of Rajasthan was also undertaken to meet officials and to examine the operation of the sewerage systems and sewage treatment plants.

Based as it is on secondary sources, the main limitation of the study is its dependence on dated and limited data and so it provides only an indicative analysis of the situation of centralised sanitation in Jaipur inferred from this limited data and standard parameters and costs available in the literature.

Overview of Centralised Sanitation in Rajasthan

The sanitation situation in Rajasthan got a massive boost with the launch of the Swachch Bharat Mission (SBM) in 2015. The proportion of centralised sanitation, consisting of sewerage sytems and sewage treatment plants (STP), was only 23 per cent prior to the SBM and less than half of this or about 10 per cent of the overall wastewater being generated was being effectively treated and only 0.1 per cent was being reused after treatment (CDD & NIUA, 2017). The expenditures on centralised sanitation increased considerably from 2016 onwards under the Atal Mission for Rejuvenation and Urban Transformation (AMRUT) and Smart City Mission and various other schemes. The funding for water and sanitation infrastructure went up from 2 per cent of the budget of the Ministry of Urban Development and Housing earlier to 16 per cent thereafter (CDD & NIUA op cit). The situation as of 2016 with regard to centralised sanitation in Rajasthan is as given in Table 1 below (GoR, 2016a).

Table 1: Status of Centralised Sanitation in Rajasthan 2016

Sl.	Population Category of Towns (Lakhs)	No. of Towns	Total Population 2016*	Average Existing Sewerage Coverage (%)	Proposed Sewerage Coverage (%)	Required STP Capacity ** (MLD)	Existing Operational STP Capacity	
							(MLD)	%age of Required
1.	> 10	3	55,84,693	61.8	100.0	603	355	58.9
2.	5 – 10	2	13,04,213	34.6	100.0	141	59	41.8
3.	2 – 5	7	22,75,418	4.5	100.0	182	40	16.3
4.	1 – 2	21	27,16,751	2.4	100.0	217	-	0.0
5.	0.5 – 1	24	16,17,417	5.5	100.0	129	-	0.0
6.	< 0.5	47	15,40,262	0.8	68.2	84	-	0.0
7.	**Total of Towns with Centralised Sanitation**	**104**	**1,50,38,754**	**27.7**	**96.7**	**1356**	**27.7**	**96.7**
8.	Other Urban Areas ***	192	37,14,140	-	-	-	-	-

**As estimated in the Rajasthan State Sewerage and Wastewater Policy 2016.*

*** Estimated assuming that towns with population greater than 5 lakhs will be supplied with 135 litres per capita per day (lpcd) of water and other towns with 100 lpcd of water and 80 % of this will be converted to wastewater.*

**** Includes 111 Census Towns with population density greater than 400 per square km& population greater than 5000.*

Clearly, centralised sanitation systems are installed and in operation mostly in the larger towns with population greater than 5 lakhs while the smaller towns are bereft of them. A number of sewerage schemes and sewage treatment plants have been installed in the other towns with loans from ADB and grants under the Jawaharlal Nehru National Urban Renewal Mission (JNNURM) and AMRUT schemes but these are mostly not operational yet. The major constraints to the successful operation of centralised sanitation systems are as follows –

- Lack of adequate water supply is the first major obstacle. Sewerage systems ideally require 135 lpcd water supply to maintain adequate flow and in no circumstances can this be less than 100 lpcd. Apart from Jaipur and Udaipur, no other town in Rajasthan is able to provide 135 lpcd water supply and on an average the water supply is only 66 lpcd (GoR, 2016b).
- Even where sewerage systems have been installed and are operational there are not enough house connections. Even if there are house connections these are to the septic tanks and the kitchen and bathroom wastewater which not only fail to provide adequate flow but also do not have enough faecal matter (NIUA, 2018a).
- There are inadequate resources with the urban local bodies (ULB) for the operation and maintenance (O&M) of the sewerage system and STPs. The sanitation charges that are levied from the users do not cover the cost of O&M of the sewerage systems and STPs (NIUA, 2018).
- The cleaning of sewers which get clogged due to inadequate flow and the flushing of plastics is largely done by contractors. There is an inadequate supply of machines capable of cleaning the sewers and so this work is mostly done manually in violation of the law against manual scavenging. This frequently results in deaths of the staff employed for the purpose.

The few STPs that are operating are not following standard procedures and are releasing water that is inadequately treated as per the norms set by the Central Pollution Control Board (CPCB) (these have been discussed in detail later) into the environment as stated in a report of an evaluation conducted by the Central Pollution Control Board (CPCB, 2015a). This evaluation report broadly mentions the following deficiencies in the operation of STPs in Rajasthan –

- There is a big gap between the wastewater generation and treatment. The inadequately treated and untreated wastewater is being released into water bodies causing ground and surface watercontamination.
- Cities do not have proper sewerage networks to collect the entire sewage

and amajor part of the untreated sewage is discharged in opendrains which lead to surface water bodies or percolate into the subsoil.

- Majority of STPs are operating without obtaining consent to operate from the State Pollution Control Boards under the provisions of the Water (Prevention & Control of Pollution) Act, 1974.
- The agencies or departments engaged in the O&M of STPs are suffering from financial crisis and lack of skilled manpower.
- The treatment and disposal of sludge from the STPs is a problem leading to a reduction of cleaning of the STPs, resulting in a drastic reduction in treating capacity.
- Industrial effluents are also being mixed into the sewage coming to the STPs instead of being treated in Effluent Treatment Plants separately.
- Majority of the STPs have no arrangements to measure inlet and outlet flow. A few plants have flow meters at the inlet to measure flow but none of them are working.
- All the STPs have a by-pass arrangement. The STPs treat only a portion of the sewage received and the rest of the sewage is discharged untreated through by-pass arrangements. During monsoons when it rains heavily, the whole flow is bypassed.
- The oxidation ponds & waste stabilization ponds do not have proper paths and approachroads and the surroundings are covered with grass and bushes. More importantly some STPs donot have even lighting arrangements and boundary wall. The overall maintenance of these oxidation ponds and waste stabilization ponds is very poor.
- The treated sewage of most of the STPs is not being monitored and analysed on a regular basis for the assessment of the degree of treatment as there are no dedicated laboratories in the STP campus for this purpose.
- Proper records are not being maintained for the operation of the STPs like inlet flow, outletflow, sludge generation etc. by the operators.
- There is no planned reuse or recycling of treated wastewater which is an important means of cost recovery.
- The treated sewage is being discharged in the nearest wastewater drain. Chlorination is not beingdone at the outlet of any of the STPs for control of Total and Faecal Coliforms thus contributing to contamination of surface water bodies.
- Diesel generator sets are not provided in the STPs for backup power for operation of the biological system without any interruption duringpower failure.

Proper treatment and reuse of wastewater which takes care of both sanitation and non-potable water supply is generally not being done. There are a few exceptions in the city of Jaipur and in the towns of Bhilwara and Udaipur. Hindustan Zinc has installed and is running two STPs in Udaipur of total capacity of 60 MLD and reusing the treated wastewater for its industrial processes and also supplying it to the municipality (ISC, 2016). Similarly, Jindal Saw is running an STP of 10 MLD capacity in Bhilwara and transporting the treated water by pipeline over 23 kms to its plant for use in its processes and gardens (CPCB, 2015b). The sludge from the sewage is a potent source of biogas and manure but apart from the STP at Delawas in Jaipur this potential has not been tapped.

State Policies related to Sanitation

The policies notified by the Government of Rajasthan with regard to sanitation have been discussed in this section. First the State Sewerage and Waste Water Policy 2016 and then the Policy on Faecal Sludge and Septage Management 2017.

A. State Sewerage and Waste Water Policy 2016

The Rajasthan Government has formulated a detailed State Sewerage and Wastewater Policy (SSWWP) to address the problems of centralised sanitation mentioned above (GoR, 2016a).The important provisions of this policy are as follows –

- All ULBs will prepare City Sanitation Plans (CSP) in accordance with the Central Public Health and Environmental Engineering Organisation (CPHEEO) revised Manual on Sewerage and Sewage Treatment published in 2013. These plans have to be in accordance with the overall town plans so as to avoid mismatches in development and ensure the proper treatment and reuse of wastewater. Technologies such as Geographical Information Systems (GIS), Ground Penetrating Radar (GPR) and Total Station Surveyors (TSS) should be used to prepare detailed maps of the sewer network. These maps should be updated every ten years and linked to an MIS detailing the assets and their parameters.
- Highrise buildings, Hotels and the like with high discharge of waste water should mandatorily have on site STPs and reuse of waste water preferably with energy generation from digestion of sludge.
- Wastewater shall be treated as per prescribed standards and reused as it is a valuable resource. Priority should be for reuse in agriculture. Industrial reuse should be next in line. Gardening and coarse washing needs can also be met. Appropriate infrastructure will be built to facilitate reuse.
- The sludge should be properly digested and reused as manure and if possible energy should be generated during digestion of sludge.
- Charges, fees and taxes should be levied to recover the O&M costs and in the long run also the capital investment in centralised sanitation systems. The “polluter pays” principle will be applied to determine the charges to be levied.
- Treated waste water, manure and energy will be priced and sold to recover costs.

- Private participation will be encouraged to reduce the burden on government finances and they will be offered contracts to build and operate the sanitation systems and recover as much of the costs as possiblewith the Government providing viability gap funding.
- Public awareness campaigns will be conducted to involve the citizens in the process.

The SSWWP, thus, provides for comprehensive planning and implementation of centralised waste water treatment and reuse by ULBs with the involvement of private parties to ensure, resource mobilisation, cost recovery and quality of service in Rajasthan.

B. State Policy on Faecal Sludge and Septage Management 2017

The SSWWP states that 192 towns in Rajasthan with a population of 37,14,140 in 2016 will be completely dependent on onsite sanitation systems and even in cities and towns with centralised sanitation systems there are likely to be some areas that will continue to be served by onsite systems. Therefore, faecal sludge and septage management (FSSM) assumes importance especially since the state will see the construction of around 5 lakh new toilets under the Swachh Bharat Mission. Consequently the Rajasthan Government has notified a State Policy on Faecal Sludge and Septage Management with the following prescriptions (GoR, 2017) –

- **Ensuring timely and safe collection and transport of faecal sludge and septage:** Encouraging a shift towards scheduled desludging of septic tanks, pit latrines, etc. (periodically within 2 – 3 years) in all ULBs, while generating awareness and incentivising households for the same. The process would ensure complete containment of waste with no direct human contact with the waste under any circumstance.
- **Complete treatment of all collected waste:** All collected Faecal sludge should reach the treatment facility (without arbitrary and illegal disposal) and treated as per standards for safe disposal/reuse. System of incentives and appropriate imposition of penalties will be the tool to monitor desludging operators and to ensure disposal at designated locations. There will be greater use of technologies that consume very less power and use biological processes.
- **Ensuring resource recovery:** The treatment facility would maximize reuse of treated wastewater and sludge for various public and commercial

purposes. This will contribute in part towards cost recovery and even profit generation.

- **Create enabling institutional environment and strengthening regulatory framework:** The mandate, roles and responsibilities of all government departments and other stakeholders would be clearly defined and necessary steps taken for augmenting their capacities. Appropriate institutions, management & monitoring systems and standard procedures would be in place at state and city level that incrementally strengthen FSSM operations in urban areas. Necessary steps would be taken to augment capacities at state, city and community level for government officials, service providers, residents, etc. The institutional framework would also enable an environment conducive for greater participation of private sector.
- **Standardized Infrastructure and Professionalized Operations:** Standards and norms documented and adequately disseminated for design, construction and O&M of FSSM infrastructure such as On-Site Sanitation Facilities (Septic Tanks, Soak pits/Soak fields, Lined Pit Latrines, Digestion Tanks, etc.), Suction Emptier trucks and equipment, treatment technologies (Sludge Drying Beds, DEWATS, Faecal Sludge Treatment Plants (FSTPs), Co-Treatment with STPs, etc.) and criteria for end-product disposal and reuse. Moreover, the services provided by various public and private players should be professionalized with standard operating procedures, operating and monitoring guidelines, etc. This is to be ensured through appropriate training and capacity building of relevant service providers and regulators.
- **Innovation in service delivery and management:** Improving service delivery, management and monitoring by introducing technological interventions such as information technology enabled single window system, GIS/GPS aided planning and operations, custom MIS modules, etc. and greater emphasis on private participation in service delivery.
- **Setting up an Urban Sanitation Fund:** This will be a dedicated fund for sanitation and FSSM, which would consolidate resources and funds from multiple sources – various central schemes and programs, state government grants, ULB funds, Corporate Social Responsibility, Urban Infrastructure Fund (URIF), Donor fund, Bilateral and multilateral grants and loans; and through innovative instruments such as Social & Development Impact Bonds, Alternative Investment Funds, etc. which would be managed by the state government (through a designated nodal agency) and provided to

ULBs/ service providers/ other relevant stakeholders based on transparent and flexible criteria, linked to performance and need. Similarly, ULBs with sufficient capacities can set-up city sanitation funds (linked to the state sanitation fund) for implementation of city-level FSSM strategy, plan and projects.

- **Greater Awareness and Participation:** The residents would become active participants in the planning, implementation and monitoring process, while all stakeholders would be sensitized and sufficiently made aware of the processes, procedures, components, etc. of FSSM. Multiple channels (digital, broadcast, print, physical, etc.) for communication, learning and stakeholder engagement would be used. Promoting mechanisms to bring about and sustain behavioural changes aimed at adoption of healthy sanitation designs and practices, including the responsibility to ensure safe containment and management of faecal sludge and septage by urban households including liquid effluent.
- **A strong partnership network:** Multi-sector partnership of government agencies/ULBs with other public/private organisations, groups and institutions for collaborating on knowledge improvement, funding, improved services, business opportunities, research & innovation, stakeholder engagement, peer learning, etc. Formal and Informal platforms would be established for networking among various ULBs, service providers, associations, etc. for learning, knowledge sharing and partnership building.

The SPFSSM is quite comrehensive and takes into account the administrative, financial and public participation aspects in detail for ensuring proper containment and disposal of faecal sludge and septage through FSSM. In what follows, the centralised sanitation situation in Jaipur, the capital city of the state, is reviewed in the context of these state policies and the various standards prescribed by the CPHEEO

General Information About Jaipur

The city of Jaipur, Rajasthan has the following general characteristics -

1. **Location:** Jaipur is situated in the Eastern Arid Plain agro-climatic region of Rajasthan which consists of the districts of Ajmer, Jaipur and Tonk. It is located at 26071'N latitude and 75048'E longitude at a height of 430m above mean sea level and is situated 272 kms away from Delhi and is connected to it by air, road and rail. It is the capital city of Rajasthan. It is situated in the Banas River basin as shown in Fig. 1 below.

Fig. 1: River Basin Map of Rajasthan showing Location of Jaipur

(Source: https://www.rajras.in/index.php/rajasthan-river-basins-features-stretch/)

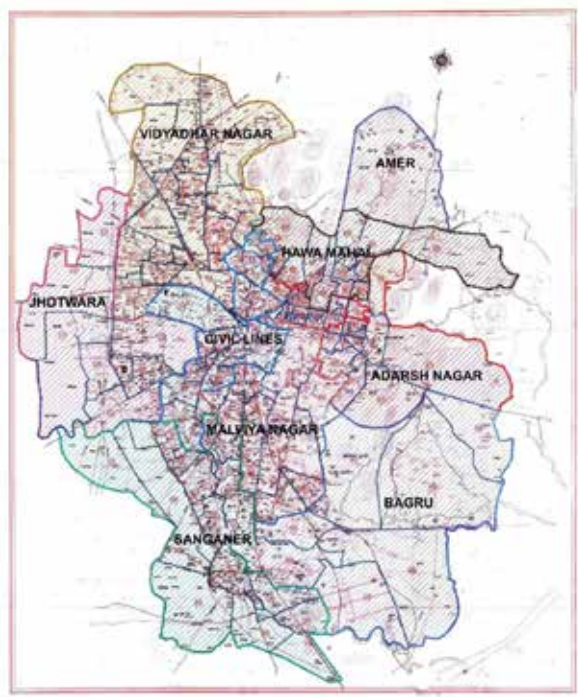
2. **Terrain, Geology and Climate:** The city is surrounded by the Nahargarh hills in the north and Jhalana hills in the east, which are a part of Aravalli the hill range and it stretches towards the south which is plain. The municipal area is 485 square kilometers. The slope of Jaipur city and its surroundings is from north to south and then to south-east. The ephemeral streams flow in this direction with the Dravyavati River being the main drainage. The flat topped hills of Nahargarh at a height of 587 meters are the highest point. The major water bearing formations are gneiss and granites with a poor yield of 30 - 90 m3 per day. Ground water occurs under unconfined to semi-confined conditions in weathered and

fractured parts of the consolidated formations. The pre-monsoon depth of the water table is between 10 and 20 meters below ground level whereas the post monsoon depth is between 5 and 10 meters below ground level (CGWB, 2017).

The mean temperature of Jaipur is 36 C varying from 18 C in January to 45 C in June. The normal annual rainfall of Jaipur is 600 mm nearly 90 percent of which takes place in the summer monsoon period from June to September and the rest comes from the winter cyclones.

3. **Demography:** JaipurMunicipal Corporation has 91 wards currently which is more than in 2001 when the population was 23.22 lakhs while it increased to 30.46 lakh in 2011 (GoI, 2014). Assuming a 10 per cent increase in population over the five years up to 2016 the population would be 33.51 lakhs. The ward map of JMC is shown in Fig. 2 below.

Fig. 2: Map of Jaipur Municipal Corporation Area



(Source:http://jaipurmc.org/Presentation/AboutMcjaipur/MstImageViewer.aspx ?ImgName=JNN_Ward_Map.jpg&ImgHead=NNJ%20Ward%20Map)

There was an average annual growth rate of 2.38 percent as compared to the national urban growth rate of approximately 2 percent over the period 2001 to 2011. The current sex ratio of Jaipur city stands at 909 females per 1000 males. The walled city has 14 per cent of the population while the rest of the city has 86 per cent. The population living within the JMC has increased due to expansion in area but the population in the walled city has declined in 2011. This is a positive phenomenon as the walled city is very densely populated.The walled city has a spatial extent of only 6.7 sq. km housing nearly four lakh people. The reason for this decline in population is out movement of inhabitants from the area to new residential colonies being developed in the suburbs of the city.

Jaipur city's population density is 6523 persons per sq. Km.The population density of the walled city area is 42008 persons sq. Km. There is also migration into Jaipur city from all parts of the state. Trends suggest that Jaipur is gaining importance as a favored destination not only within the state but also at the national level. The main causes of migration into the city have been employment, marriage and dependents moving along with the households. Employment accounts for nearly one-fourth of the total migrants to Jaipur. The second important reason for migration is marriage.

4. **Drainage and Sanitation:** Jaipur city has many small nalas which drain into the Dravyavati River running through the western part of the city from north to south. The Jaipur Development Authority (JDA) has taken up the construction of concrete stormwater drains along the sides of roads since 2003 to tackle the problem of flooding caused by rains. The firm, Engineering Projects India Limited, was contracted to draw a drainage plan. Even though the plan was never notified, the JDA went ahead with implementing the drainage works and most areas have been covered especially the main thoroughfares like JhotwaraRoad, Station Road, Prithviraj Road, M.I. road, Ashok Marg, TonkRoad, BhagwandasRoad, Mahaveermarg, SaraswatiMarg, GovindMarg, Vijay Path, BhabhaMarg, Moti Doongri Road, Katputli Nagar, Sahakar Marg, Nakul Path, Singh Highway and Kabir Marg .

   The JDA, Rajasthan Urban Infrastructure Development Project (RUIDP) and later the Rajasthan Urban Drinking Water, Sewerage and Infrastructure

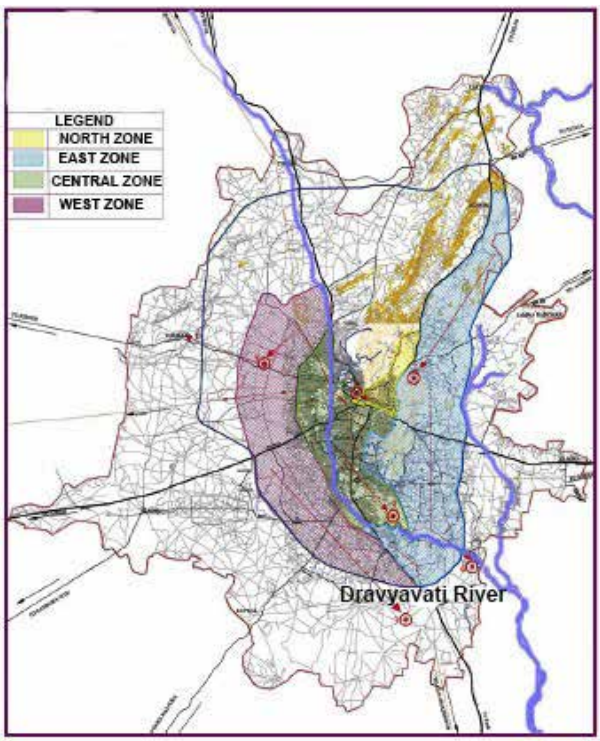
Corporation (RUDSICO) have together implemented a sewerage system over the same period to augment what was there from earlier implementation. The coverage of the sewerage system is less than that of the drainage system as it covers only 60 per cent of the JMC area and caters to about 80 per cent of the population. However, not all households have taken house connections to the sewers and some have connected their septic tank outflows only. This results in the flows in the sewers being less and their clogging up sooner. The JMC has a few sewer cleaning machines but still the work of sewer cleaning is contracted out and done manually in violation of The Prohibition of Employment as Manual Scavengers and Their Rehabilitation Act 2013. Off and on there are deaths of sanitation workers who are employed as contract labour for cleaning the sewers by the JMC (Jain, 2018).

The incomplete sewerage coverage has meant that some of the waste water is released into the nalas which in turn flow into the Dravyavati River which consequently had polluted flow in it. A Dravyavati Riverfront development project has been implemented from 2016 onwards involving diversion of the flow of the nalas into five new STPs of capacity 170 MLD to augment the existing 265 MLD (Tata Projects, 2019).The treated water is to be used to develop gardens and woods along the riverfront.

Sanitation Planning

The Jaipur City Development Master Plan 2025 was adopted and notified in 2011 (JDA, 2011). The plan estimated the wastewater generation in 2025 to be 783 MLD. The plan divided the city into four zones and proposed the treatment of the waste water in a series of STPs located in these separate zones for a total interim treatment capacity of 317 MLD. The treated water from the eastern part was to be released towards the Bandi River. The treated water from the western and south western parts was to be released towards the Chandlai dam. The treated water from the northern and north eastern part was to be pumped and released into the Dhund River. The treated water from the central part was to be channelled through the Dravyavati River towards the Dhund River. These arrangements are shown in Fig. 3 below.

Fig.3: Proposed Sewerage Map of Jaipur City



(Source: Jaipur Development Authority, Jaipur City Development Master Plan 2025)

The Dravyavati Riverfront Development Project consists of the construction of 5 STPs at intervals of 9 kms along the 47 kms of the length of the river within the city area as follows –

- Bassi Sitarampura : 20 MLD
- Devri : 15 MLD
- Sanganer : 100 MLD
- Bambala : 25 MLD
- Goner : 10 MLD

Along with this 81 kilometers of sewers are to be laid to carry all the sewage that was being earlier released untreated into the river to the STPs. The project has been undertaken by a private consortium which is to recover the capital and O&M expenditure of the project by developing commercial and residential real estate on the land overlooking the river front.

A process was also started to ring fence the water supply and sewerage functions of the city under a separate Jaipur Water Supply and Sewerage Board in 2017 as per the recommendations of the JNNURM . Currently, the water supply is being done mainly by the Public Health Engineering Department (PHED) with some amount being done by JMC and JDA. The construction of sewers and STPs is done by the JDA mainly and also the JMC to some extent and in the last few years by the RUIDP and the RUDSICO. The sewers are maintained by the JMC while the STPs are maintained by the JMC mostly and some by the JDA. This multiple institutional governance of the water supply and sewerage services results in inefficiencies in both operational and financial terms and that is why it was provided under JNNURM that these services should be ring fenced under a separate institution which will undertake the construction and O&M of all facilities, arrange the funds for these and also collect user charges. However, even though a draft Jaipur Water Supply and Sewerage Board Bill (GoR, 2018) has been drafted, it has not been enacted yet.

Sewage Treatment

The most crucial aspect of centralised sanitation systems are the sewage treatment plants (STP). Even if there is an extensive sewerage system, as there is in Jaipur, which conveys the sewage to the STPs, unless there is adequate sewage treatment capacity, the sewage will be released untreated into the environment as is happening in most parts of the country. The details of the current sewage treatment capacity in Jaipur are given in Table 2 below. The total STP installed capacity at present is 442 MLD which is not only much more than the current design wastewater load of about 330 MLD but enough to meet the projected growth for the next ten years.

Table 2: Sewage Treatment Plants in Jaipur 2019

Sl. No.	STP	Treat-ment Process	Capacity (MLD)	Supervising Agency
1.	Delawas Unit I	ASP	62.5	JMC
2.	Delawas Unit II	"	62.5	"
3.	Amer Road	"	27	"
4.	Jaisinghpura	"	50	"
5.	Vidyadharnagar	MBBR	1	"
6.	Jawahar Circle	"	1	JDA
7.	Kiron Ki Dhani	"	1	"
8.	Ramniwas Bagh	"	1	"
9.	Central Park	"	1	"
10.	Paldi Meena	"	3	"
11.	Sahakar Marg (CETP)	"	1	"
12.	Swarna Jayanti Park	"	1	"
13.	Gajodharpura	ASP	30	"
14.	Ralawata	"	30	"
15.	Bissi Sitarampura	SBR	20	"
16.	Devri	"	15	"
17.	Sanganer	"	100	"
18.	Bambala	"	25	"
19.	Goner	"	10	"
	Total		442	

Source: JMC and JDA

However, installed capacity by itself is not enough as proper operation and maintenance of STPs is required for them to be able to treat the sewage flowing in so that the effluent that is released or reused meets the standards set by the CPCB. Therefore, it is necessary to review the functioning of the STPs in Jaipur. The biggest STP in Jaipur is the one at Delawas which has an installed capacity of 125 MLD which uses the activated sludge process of treatment. The specific characteristics of this STP are as given in Table 3 below.

Table 3: Details of STP at Delawas in Jaipur

Sl. No.	Characteristic	Value	Sl. No.	Characteristic	Value
1.	Number of Units	2	8.	Secondary Settling Tank Vol. (m3)	8792
2.	Installed Capacity (MLD)	125	9.	SST Retention Time (hrs)	2.15
3.	Primary Settling Tank Volume (m3)	2604	10.	Waste Sludge Rate (m3/day)	1300
4.	Primary Sludge Rate (m3/day)	1100	11.	Sludge Digester Volume (m3)	12400
5.	Aeration Tank Volume (m3)	31320	12.	Power Requirement (Kwh/day)	16000
6.	Aeration Capacity (m3/hour)	7080	13.	Biogas Produced (m3/day)	12000
7.	Aeration Tank Retention Time (hrs)	6	14.	Power Generated (Kwh/day)	9600

Source: CPCB 2015

This STP, by using the activated sludge process, reduces the cost of chemical dosing because it uses the bacteria in part of the sludge to pre treat the sewage inflow. Also it digests the sludge to produce biogas, mainly methane, which is then scrubbed and cleaned and burnt to generate energy which is used in running the aeration pumps. The typical monthlycost of O&M for activated sludge process STPs for treating the waste water as per the relevant standards is about Rs15,00,000 per MLD per year and the energy required is 200 Kwh per million litres (Majumdar, 2004). Thus, the STP requires for its operation 91,25,000 Kwhs of electricity of which 35,04,000 kwhs are generated from the gasification of sludge. Consequently, assuming a rate of Rs 7 per Kwh of electricity there is a saving of Rs 17.5 Lakhs per month on the electricity cost.However, in winter when the retention times are high and in the monsoons when the sludge content of the wastewater is lower, the gas prodution is much less and so is the electricity generation.

However, according to the CPCB evaluation report mentioned earlier, the STP is not operating to full capacity and it is also not treating the water to the prescribed standards before releasing it into the Dravyavati River. As much as 30 percent of the incoming sewage is being bypassed and some of the water quality parameters of the treated effluent being released into the Dravyavati River are not as per standards as shown in Table 4 below. This table also gives the water quality parameters of the treated water and the treating efficiency of some of the other STPs in Jaipur which were evaluated by the CPCB in 2015. The treated effluent is also not being chlorinated before release and as a consequence there is a higher than permissible level of faecal coliform in it. A later evaluation report by the Rajasthan State Pollution Control Board found the Biological Oxygen Demand (BOD) of the treated water in the Delwas STP to be as high as 79 mg/l and 99 mg/l in the two units which is very high (ToI, 2016).

Table 4: Treated Effluent Parameters of STPs in Jaipur

Sl. No.	STP	Treatment Process	C apacity (MLD)	Operating Efficienty (%)	Chlorination of Treated Effluent	Parameters of Treated Effluent			
						pH	BOD (mg/l)	COD (mg/l)	TSS (mg/l)
1.	Delawas Unit I	ASP	62.5	70	Absent	7.62	52	171	62
2.	Delawas Unit II	"	62.5	70	"	7.76	46	152	33
3.	Amer Road	"	27	70	"	7.81	50	167	34
4.	Jaisinghpura	"	50	20	"	7.94	17	54	32
5.	Jawahar Circle	MBBR	1	50	"	7.63	11	34	28
6.	Ramniwas	"	1	80	"	8.1	15	49	49
7.	Vidyadhar	"	1	60	"	7.63	23	76	80
8.	Gajodharpura	ASP	30	50	Done	8.15	26	80	89
	Permissible Value of Effluent Parameters				CPCB	5.5 - 9	10	50	20
					IS 2296	6.5 – 8.5	3	0	0

Source: CPCB 2015

Thus, even by the CPCB standards for effluents, the Biological Oxygen Demand (BOD) ,Chemical Oxygen Demand (COD) and Total Suspended Solids (TSS) levels and so the polluted nature of the effluents is high and due to lack of chlorination the disease potential is also high. When compared to the much stricter standards required for surface water as per IS 2296 , the inadequately treated water being released into the Dravyavati and Bandi Rivers are a serious health hazard. Apart from these STPs there is a newer

one constructed by the JDA of 30 MLD at Ralawta with ASP as treatment process which had a BOD value less than 30 mg/l but higher than 10 mg/l in 2016. Apart from Delawas, the sludge from all the other STPs is not being disposed of properly and constitutes a health hazard as it is being dumped arbitrarily in open areas near the STPs. Even in the Delawas STP there is not much effort to sell the manure slurry that is being produced after digestion of the sludge to produce biogas.

The newly implemented Dravyavati Riverfront project too suffers from the same problem of inadequate treatment of the wastewater that is coming into its five STPs. The waste water used to drain into the Dravyavati through a number of drains opening into it earlier but now the water is directed to the STPs and released from there in a concentrated manner. The residents near the STPs have been protesting about the stench from the released water (ToI, 2018). The water looks turbid even after it has travelled a few kilometers downstream from the STPs.

Thus, even though there is adequate sewage treatment capacity in Jaipur it is not being properly utilised at present resulting in polluted water being released into the rivers by the STPs. This operational inefficiency also means that the potential for reuse of the waste water and the treated sludge is not being exploited to the full leading to loss of revenue. A detailed financial analysis follows that reveals the lack of financial resources that plagues the sanitation sector in Jaipur.

Financial Analysis

The financials of the sanitation related functions of the JMC are analysed first followed by the financial analysis of the JMC as a whole. The budget estimates for the Public Health Department of the JMC are given in Table 5 below.

Table 5: JMC Revenue Expenditure and Receipts for Public Health Department

Sl. No	Expenditure					Receipt
	Items of Expenditure	2014-15 Est. (Rs Crore)	2014-15 Act. (Rs Crore)	2014-15 Shortfall (%)	2015 -16 Est. (Rs Crore)	2014-15 Act (Rs Crore)
1.	Salaries	232.00	204.25	12.0	231.93	1.13 by JMC and 4.0 by PHED
2.	Cleaning of Roads and Gutters	85.00	25.93	69.5	75.00	
3.	O&M of Sewers, STPs and SWM	108.75	81.28	25.3	115.00	
	Total	**425.75**	**311.46**	**26.8**	**421.93**	**5.13**

Source: Municipal Budgets of JMC (JMC, 2015), (JMC, 2017)
** The PHED collects the sewerage and sewage treatment charges for the JMC with the water supply charges*

Clearly, there is a considerable shortfall of 70 per cent in the actual expenditures on the cleaning of roads and gutters from the budget estimate. Even in the O&M of sewers, STPs and Solid Waste Management there is a 25.3 per cent shortfall. Even though the shortfall in salary payment is only 12 per cent, this is after the estimates themselves being less due to many sanctioned posts remaining unfilled over the years. The O&M of the sanitation assets is outsourced to private contractors and that is why the heavy shortfall in that expenditure indicates deficiency of service. The actual revenue receipts from sanitation charges in 2014-15 were only Rs 5.13 crores or a paltry 1.6 per cent of the actual expenditures. The O&M cost for SWM in the last category is Rs 44.61 crores (JMC, 2015). Therefore, the O&M cost of the sewerage and STP is Rs 36.67 crores. Comparing this with the standard costs required for STP and Sewer O&M, we can estimate the proportion of actual expenditure to the standard expenditure. The salaries are being paid for supervision and some of the cleaning of roads and gutters only as all the STP and Sewer O&M and most of the road and gutter cleaning is being done by private operators on contract. Thus, it can be assumed that their expenditure is being met from

the O&M component and no salary expenditure is being incurred directly by JMC on them. This is shown in Table 6 below.

Table 6: Comparison of Actual O&M Exp on STPs and Sewers with Standard Exp. (2015)

Sl. No.	Type of Service	Total Capacity*	Standard Annual Expenditure		Actual JMC Expenditure (Rs Crore)	Shortfall (%)
			Per MLD or Km (Rs Lakhs)	Total (Rs Crores)		
1	STP ASP	202 MLD	15	30.30	20.87	32.2
2	STP MBBR	1 MLD	50	0.50		
3	Sewerage	730 Km	3	21.9	15.8	27.9
	Total			**62.7**	**36.67**	**41.5**

Source: Municipal Budgets of JMC (JMC, 2017), Majumdar, op cit.

** Only the STPs being supervised by the JMC have been considered here. The financial details of the STPs being supervised by the JDA are not available.*

The standard expenditure per kilometer for sewer cleaning and maintenance is that prescribed for sewers that are designed to have a self cleansing flow velocity of 1m/second. However, the actual flow velocity is much less in Jaipur in many areas because of less water supply and so more sedimentation and choking of sewers takes place requiring more cleaning. Thus, the data above shows that there is a considerable shortfall in the actual expenditures being incurred by the JMC in O&M of STPs and sewers and this is the reason for their performance not meeting the standards as was revealed earlier. The revised Manual on Sewerage and Sewage treatment published by the Central Public Health and Environmental Engineering Organisation (CPHEEO, 2013) identifies this serious lack of financial resources of ULBs as a major reason for the malfunctioning of centralised sewer systems and STPs in this country. The analysis of the expenditures of the JMC on public health above confirms this and especially of concern is the extremely low collection of 1.6 per cent of actual operating costs incurred as user charges for sanitation services . Considering that the actual costs are themselves much less than what they ideally should be, the under recovery of these costs is even more glaring as is the failure to earn revenue from the sale of treated wastewater and manure slurry. This financial under performance, in fact, extends to the whole of the

JMC and this has been analysed in detail below on the basis of the budget data in the following tables.

Table 7: Overall Finances of Jaipur Municipal Corporation

Item	2014-15 Estimates (Rs Lakhs)	2014-15 Actuals (Rs Lakhs	2014-15 Shortfall of Actuals to Estimates (%)	2015-16 Estimates (Rs Lakhs)	Per Capita for 2015-16* (Rs)
Revenue Receipts	65702.19	36872.52	43.9	61215.00	1826.99
Revenue Expenditure	58934.05	43277.64	26.6	59592.00	1778.55
Revenue Surplus	6768.14	-6405.12		1623.00	
CapitalReceipts	45810.02	23795.31	48.1	43997.00	1313.11
CapitalExpenditure	49440.02	12600.95	74.5	45620.00	1361.55
CapitalSurplus	-3630.00	-11195.36		-1623.00	

Source: Jaipur Municipal Corporation
**Calculated by assuming a cumulative population growth rate of 10% from 2011-2016*

There was a high budget estimate for Revenue Receipts in 2014-15 which was not met by actuals which fell short by 43.9 percent. Nevertheless, the budget estimate of revenue receipts, even though lower than the previous year, was still kept at an unrealistically high level for 2015-16. While the actual revenue receipts have been much lower, in the actual revenue expenditure for 2014-15 there is comparatively less of a shortfall of 26.6 percent. Consequently, while there is a budgeted revenue surplus of Rs 6768.14 lakhs in reality it has become a huge deficit of Rs 6405.12 lakhs. Own revenue should be the main source of resource mobilisation for an ULB and provide it with significant surpluses to fund its capital expenditures also if it is to achieve financial sustainability. That this is not so, is indicative of bad financial planning and resource mobilisation by the JMC.

The Capital Receipt estimates for 2014-15 too are not met by the actual receipts which are a substantial 48.1 per cent less. The actual capital expenditure for 2015-16 is a huge 74.5 per cent less than the estimates. The actual per capita revenue and capital expenditures in Jaipur are very low as the Indian averages for Tier I cities are Rs 8500 and Rs 7000 respectively as extrapolated from a study by the Mckinsey Global Institute (MGI, 2010). The Indian average for revenue expenditure in turn was only 2% of that in the UK, 9% of that in South Africa and 13% of that in China. Similarly the the Indian average for

capital expenditure was 4 per cent of that in the UK, 13 per centof that in South Africa and 15 per cent of that in China. This underlines the extent of under funding in Jaipur.

A break up of the revenue receipts is given in Table 8 below.

Table 8: Revenue Receipts of Jaipur Municipal Corporation

Item	2014-15 Estimates (Rs Lakhs)	2014-15 Actuals (Rs Lakhs	2014-15 Shortfall of Actuals to Estimates (%)	2015-16 Estimates (Rs Lakhs)
Tax	43921.15	27142.25	38.2	46313.00
Rent	500	225.74	54.9	300.00
Fees & User Charges	15146.03	9208.71	39.2	11491.00
Grants	5000.01	122.35	97.6	0.00
Investment Income	700.00	49.22	93.0	500.00
Miscellaneous	435.00	124.25	71.4	2611.00
Total	**65702.19**	**36872.52**	**43.9**	**61215.00**

Source: Jaipur Municipal Corporation

Taxes constituted the biggest component of revenue receipts. Fees and User Charges are the second most important source of income. Within taxes, Octroi Compensation from the State Government in lieu of octroi foregone by JMC constitutes a very high 84.3 per cent and collection from urban development and house taxes are low, primarily because in Rajasthan, urban local bodies have limited powers to collect property tax. An urban development tax is levied only on residential plots of area greater than 2700 square feet, residential flats of area greater than 1500 square feet and commercial plots of size greater than 900 square feet. This is a very low rate far below that required to fulfill the recommendation of the proportion of 25 per cent collection of the total revenue by urban local bodies from property taxes as mandated by the guidelines that had been prescribed by the Jawaharlal Nehru National Urban Renewal Mission (JNNURM, 2005). The logic behind this is that it is difficult to collect separate taxes for sanitation and other municipal services which cannot be metered unlike the supply of water. Therefore, the property tax should be high enough to cover at least the O&M costs incurred in the provision of such services and ideally provide for capital investments also. Moreover, the property tax is a progressive tax that is proportionately higher for those having larger area of property in higher value areas of the

city and so serves the purpose of equity also. Indeed it is this inability of ULBs in India to garner adequate resources from taxes and user charges that results in their poor per capita revenue and capital expenditures and consequent inability to provide good municipal services.

The operation and maintenance of the water supply system is with the Public Health Engineering Department. This too is in clear violation of the guidelines of JNNURM which provide for the establishment of a ring fenced water supply and sewerage board. Water Supply and Sanitation are closely interlinked in any habitation due to the fact that the amount of water supply determines the amount of waste water and the treatment and reuse of wastewater reduces the demand for potable water supply. Moreover, other supply side measures like water recharging and harvesting too need a coordinated approach integrating water supply and sanitation. This interlinkage increases as the size of the habitations increase and becomes critical in large towns and cities where socio-economic equity and environmental sustainability of water supply and sanitation become crucial issues. Moreover, in large cities the financial burden of providing centralised water supply and sanitation becomes large and invariably the ULBs' finances become overstressed due to the deficits in the water supply and sanitation system. That is why it has been suggested that it would be better to ringfence water supply and sanitation in a separate institution for integrated planning, investment, and operation with focused people's participation.

The revenue expenditure details are given in Table 9 below.

Table 9: Revenue Expenditure of Jaipur Municipal Corporation

Item	2014-15 Estimates (Rs Lakhs)	2014-15 Actuals (Rs Lakhs	2014-15 Shortfall of Actuals to Estimates (%)	2015-16 Estimates (Rs Lakhs)
Establishment	31304	27547.78	12.0	31012.00
Administration	1323.05	841.33	36.4	1564.00
O&M	22880.00	13251.82	42.1	23270.00
Interest	1000.00	660.59	33.9	500.00
Miscellaneous	2427.00	976.12	59.8	3246.00
Total	**58934.05**	**43277.64**	**26.6**	**59592.00**

Source: Jaipur Municipal Corporation

Most notable here is the substantial shortfall of 42.1 per cent in the O&M expenditures indicating that there is serious under funding leading to poor operation and maintenance. The lack of financial sustainability due to insufficient revenue mobilisation leading to a revenue deficit and shortfalls in revenue expenditure which in turn result in poor service quality are a matter of concern. The above data clearly show that the finances of the corporation are unsustainable and inadequate. Since the poor are unable to pay for services from private sources to improve their sanitation, this under spending by the municipal corporation adversely affects their well being and so it is inequitable also.

The Capital receipts details are given in Table 10 below.

Table 10: Capital Receipts of Jaipur Municipal Corporation

Item	2014-15 Estimates (Rs Lakhs)	2014-15 Actuals (Rs Lakhs	2014-15 Shortfall of Actuals to Estimates (%)	2015-16 Estimates (Rs Lakhs)
Grants	14000.01	11290.57	19.4	21717
Secured Loans	5000.01	0	100.0	1500
Deposits	4310	1572.42	63.5	1780
Other Liabilities	22500	10932.32	51.4	19000
Total	**45810.02**	**23795.31**	**48.1**	**43997**

Source: Jaipur Municipal Corporation

Capital receipts of JMC are heavily dependent on grants and loans from the Central and State Governments. While the shortfall in Grants in actual receipts from estimates is small, it is considerable in the case of loans with the JMC having failed to get any loans whatsoever. The shortfall in loans maybe due to the fact that the poor financial condition of the JMC discourages potential lenders from giving it loans for fear of default. This adversely impacts the implementation of development plans of JMC. The Capital expenditure details are given in Table 11 below.

Table 11 Capital Receipts of Jaipur Municipal Corporation

Item	2014-15 Estimates (Rs Lakhs)	2014-15 Actuals (Rs Lakhs	2014-15 Shortfall of Actuals to Estimates (%)	2015-16 Estimates (Rs Lakhs)
Fixed Assets	47240.01	12322.36	73.9	44310
Investments	0.01	0	100.0	0
Loans and Advances	2200	278.59	87.3	1310
Total	**49440.02**	**12600.95**	**74.5**	**45620**

Source: Jaipur Municipal Corporation

There is a huge shortfall in capital expenditures from the estimates for 2014-15 and so a substantial amount of the grants received from the central and state governments for the creation of city infrastructure have remained unspent. Despite the budget data providing a clear indication of the slippage points in revenue mobilisation and expenditures, financial planning is not being done to improve the unsatisfactory state of revenue mobilisation and expenditures. Consequently, despite heavy shortfalls in resource mobilisation and expenditure from estimates to actuals for 2014-15, these aren't addressed in the budget estimates for 2015-16.

Affordability Analysis of Sanitation Services

The foregoing financial analysis clearly shows that the JMC is not recovering the costs of sanitation services that it is providing. Let us assume that the total number of households paying the user charges for water supply will also be those that will need to pay sanitation charges for recovery of costs by the JMC and leave out other households on the grounds of equity. Thus, there were 3.91 Lakh users in 2015 (PHED, 2014). The per household sanitation charge per month required to cover the actual expenditures of the public health department of JMC would then be –

311.46 crores /3.91 lakhs/12 = Rs 663.

The Average urban monthly Household Consumer Expenditure in the 68th round of the National Sample Survey Organisation survey for Rajasthan in 2011-12 was Rs 2205 (NSSO, 2013). Assuming a household of five persons this gives the average monthly household consumer expenditure in 2011-12 to be Rs 11,025. Assuming an average annual consumer price inflation rate of 6% from 2011-12 to 2016 the average monthly household consumer expenditure in 2015-16 will be Rs 14,754. Thus, for recovery of costs the sanitation surcharge works out to 4.5 per cent of the average monthly household expenditure which is an unacceptably high proportion. The proportion of households who had monthly consumer expenditure less than the average is 65 per cent of whom the bottom 30 per cent will have to be exempted as being too poor to pay. Thus, as much as 35 per cent of the population would have to spend 4.5 per cent or more of their monthly consumer expenditure on sanitation which is not affordable by any means. As we have seen, the actual expenditures are grossly inadequate leading to poor sewerage and sewage treatment. For ensuring proper O&M of the public health department of JMC, the costs would have to be higher and the corresponding charges also would amount to 6 per cent or more of the monthly household consumption expenditure putting a big question mark on the economic viability of centralised sanitation. The recovery of the huge capital expenditures would lead to even higher sanitation charges.

Water Supply

Apart from finances another major requirement for the proper operation and maintenance of centralised sewerage systems is adequate water supply as mentioned in the Manual on Sewerage and Sewage Treatment (CPHEEO, 2013). A minimum water supply of 135 litres per capita per day (lpcd) is necessary for there to be enough flow in the sewers to carry the sludge by gravity to the STPs. Otherwise, the sludge settles down and clogs the sewers and the acids and other chemicals in it scour the sewer walls reducing their life. This results in greater maintenance costs in cleaning of sewers and often in the absence of mechanical sewer cleaning machines, this is done manually in violation of the law leading to deaths of sanitation workers. Therefore, the water supply service in Jaipur which is provided by the PHED has been analysed here.

The main source of water supply for Jaipur is the reservoir of the Bisalpur dam on the River Banas situated 110 kms away with a hydraulic head difference of 95m. The designated capacity of water supply is 275 MLD but due to insufficient water in the dam, the actual supply currently is only 221 MLD (PHED, 2019). Even in this there are losses due to leakages of about 10 per cent and so the supply that reaches homes is about 200 MLD. Apart from this the PHED also has an installed capacity of 100 MLD of water from tubewells. Since this too is affected by insufficiency of water, the actual supply from tubewells is 50 MLD. There are also many private tubewells which can be assumed to be supplying another 50 MLD. Thus, the total actual supply of water to households in Jaipur city is about 300 MLD. The current population of Jaipur assuming a 10 percent cumulative increase from 2011 is 33.5 lakhs. Thus, the average supply is 90 lpcd even though the design supply according to the PHED is 125 lpcd (PHED, 2014). Matters are compounded by the fact that many households have septic tanks and they connect only the outflow from those to the sewers and so the flow in the sewers decreases even further. This is grossly insufficient for maintaining adequate flow in the sewers and so they get clogged frequently and have to be cleaned regularly. Chemical corrosion leads to scouring of the sewers and as a result as much as 200 kms of sewers in Jaipur have become prone to leakage. This is leading to pollution of the groundwater.

The economic and environmental costs of this water supply are huge. The water from Bisalpur costs Rs 18 per kilolitre which includes both the production and the distribution expenses and 80 per cent of this is expended on electricity charges. The user charges for Domestic consumers who consume 90 per cent of the water supplied, on the other hand, are very low as shown in Table 12 below and there is considerable non revenue water of up to 45 percent of the total supply (PHED, op cit). The outstanding under recovery of water charges at present is as high as Rs 50 crores (ToI, 2019).

Table 12 : Domestic Water Tarrifs for Jaipur

Item	2014-15 Estimates (Rs Lakhs)	2014-15 Actuals (Rs Lakhs
Less than 15,000 litres per month	-	27.5
Greater than 15,000 but less than 40,000 litres per month	4.84	55
Greater than 40,000 liters per month	6.05	242

Source: Public Health Engineering Department, Jaipur

Since the charges are low there is a high amount of wastage of water by the users. Moreover, since the Bisalpur dam supplies water to the towns of Ajmer and Tonk and other smaller towns in the three districts also, there is no water left for irrigation and this has angered the farmers who have been deprived of water for farming. Even after the huge investments made in the construction of the dams, filtration plants and pipelines, there is not enough water in the dam due to lesser rains. The evaporation loss is as high as 25 percent. Therefore a plan is being drawn up for even greater investment to link the Brahmani River to the Banas, so as to augment the water reaching the Bisalpur dam. The height of the dam is also to be raised to store the extra water.

Simultaneously, there is excessive extraction of ground water of 600 per cent of the recharge potential (PHED op cit). Moreover, due to the continuous increase in built up area, the recharge potential is also decreasing drastically. In many areas of the city, tubewells are going dry and in others the yield is declining precipitately. The ground water quality is also being affected more severely due to pollution from leaking sewers as the yields go down due to the greater concentration of pollutants in the water.

Non-implementation of State Policies on Sanitation

The foregoing discussion establishes the operational, economic and environmental inefficiency of the centralised sanitation systems that are in operation in Jaipur. Moreover , even after extensive coverage by sewers, 20 per cent of the households are still served by onsite systems like septic tanks and pit latrines and these are not being serviced as prescribed in the policy on FSSM. The specific non-implementation of the prescriptions of the two State Policies on Sanitation are as follows –

- A City Sanitation Plan along with detailed digitised maps and an MIS with the details of all sanitation assets have not been prepared.
- Sewers are not being cleaned properly leading to blockage of flow. Manual cleaning of sewers is still prevalent in violation of the law.
- Highrise buildings, hotels, hospitals and the like with high discharge of waste water do not have on site STPs nor do they reuse treated waste water or generate energy from digestion of sludge.
- The STPs are not treating waste water as per prescribed standards and not reusing it in agriculture and industry. There is lack of appropriate infrastructure to facilitate reuse.
- The sludge from the STPs is not being properly digested and reused as manure and neither is energy being generated except to a certain extent in the Delawas STP.
- Charges, fees and taxes are not being levied to recover the O&M costs of centralised sanitation systems. The “polluter pays” principle is not being applied to prevent industries from releasing untreated effluents into the water bodies.
- Treated waste water, manure and energy is not being sold to recover costs except to some extent in the Delawas STP.
- Public awareness campaigns are not being conducted to the extent necessary to ensure proper treatment and disposal of wastewater.
- Timely and safe collection and transport of faecal sludge and septage is not being ensured.
- Faecal sludge is being disposed untreated in open spaces creating a serious health hazard.
- A ring fenced water supply and sewerage board has not yet been created to ensure better financing and O&M of sanitation services.

Co-treatment of Faecal Sludge

Faecal sludge from septic tanks and pit latrines is currently collected and transported to nearby drains or farms and emptied there, leading to pollution of both surface and ground water in violation of the state policy on faecal sludge management (GoR, 2017). The main problem in this is the cost of transportation. As prices of diesel have gone up the cost of transportation has increased tremendously and that is why the JMC and the private operators empty the sludge into drains and farms that are close to the on site system being emptied of sludge. Since the STPs in Jaipur are mostly running at less than their installed capacity and the waste water coming into them in most cases is diluted and does not have enough sludge that can be used to generate energy, emptying of faecal sludge into them for co-treatment is an excellent option .

Co-treatment of faecal sludge in STPs is being successfully at a few locations in India and the main features of this are as follows (Gupta et al, 2018) –

- The septage load that can be added to the various STPs without affecting adversely their operational efficiency has to be estimated.
- The maximum catchment area that can be taken for providing this amount of septage load has then to be estimated.
- Infrastructure has to be built at the STP for emptying of septage trucks into the STP. Even though in some cities septage is also added to the sewer system this is not recommended for Jaipur given the lower flow that already leads to blockage of sewers.
- Regulations have to be notified for private operators to empty septage in STPs and the costs worked out in consultation with them.
- A public campaign has to be initiated to build up awareness among owners of on-site sanitation systems regarding regular cleaning of their systems and proper treatment and disposal of faecal sludge.

An important consideration in co-treatment is the prohibitive cost of transportation of septage to the STPs from areas that are situated at a distance from them. Therefore, provisions have to be made for setting up transfer stations in areas that are distant from the STPs for collection of faecal sludge at a cost that is acceptable to the owner of the on site sanitation system. Thereafter, large vehicles can be used to transport the sludge from

the transfer stations to the STPs and the cost borne by the JMC. This cost can be recovered through the greater production of energy from the sludge in the STPs and the sale of slurry as fertiliser since the STPs will be working to full capacity.

There is also the alternative of directly supplying the septage to farms near the city if precautions are taken that these farms are producing commercial crops like mulberry and cotton and there is no immediate contact with humans till the sludge gets oxidised by bacterial action (NIUA, 2018b).

Recommendations for Improvement

There is a need to explore ways in which the operation of the existing sewerage system and STPs can be improved and alternative systems can be introduced to make the provision of sanitation services more sustainable and equitable.

- **Reuse of Treated Waste Water**

Currently apart from a few small STPs most of the treated waste water is not being reused because the treatment is not up to reusable standards and also because systems have not been put in place for reuse that can bring in revenue. The examples of Udaipur and Bhilwara are there, where two private corporations have set up STPs to treat and reuse the waste water for their industrial processes. There are some industries in Jaipur like the cloth and leather dyeing companies which use considerable amounts of water which later become chemically polluted waste water. There are other industries like chemicals, rubber and plastic which too require considerable amounts of water. These are all either being supplied with costly Bisalpur water for which they are not paying the price that they should or they are extracting ground water at a high environmental cost. The setting up of sumps, pumping stations and pipelines to deliver treated waste water to them from the STPs would cost much less than the huge investments required for augmenting the supply from Bisalpur by raising the height of the dam there and constructing another dam on the Brahmani river to divert water to it as is being planned. The firms in Udaipur and Bhilwara mentioned earlier were forced to invest in wastewater treatment because they had no other alternative. Similarly, if the JMC were to strictly stop supplying Bisalpur water to industries and the district administration were to strictly enforce the ban on the use of groundwater for industries, then the latter would have no other alternative to using and paying for treated waste water . Given that treated wastewater costs only Rs 3 per kilolitre even after amortising the capital cost on the infrastructure required to deliver it to users, it is much cheaper than the Bisalpur water which costs Rs 18 per kilolitre.

- **Generation of Energy and Production of Manure from Sludge**

There is some generation of energy from digestion of sludge in the Delawas STP even though this is below the potential due to the diluted influent waste

water having less faecal matter in it and bypassing of wastewater without treatment. The slurry after the production of gas can also be sold for use as fertilisers but not enough effort is being made to do so as only Rs 6.15 lakhs was earned from sale of manure in 2014-15 . There is an increasing demand for organic manure from farmers. Therefore, if arrangements are made for the manure from STPs to be transported to manure dumps created in nearby villages, then the farmers will buy the manure if it is offered at a rate competitive with that of animal manure. The other STPs in Jaipur which are also using the Activated Sludge Process and so have the potential to generate energy and sell the digested slurry as fertilisers are not doing so. Thus, a very big opportunity for reducing the O&M cost of the STPs is being foregone and instead these STPs are being operated well below their installed capacity and the prescribed standards due to lack of finances.

- **Recharge and Harvesting of Storm Water**

Extensive water recharging and wastewater treatment and reuse must be done for a sustainable hybrid ground cum surface water combination of water supply. There are already rules that all private buildings of an area more than 300sq. mtrs and all public establishments must have water recharging systems in place so that all the storm water is filtered and recharged within these building premises in a decentralised manner. However, these rules are not being followed. The cost of installing a water recharge system is about 2 per cent of the total building cost and it goes down proportionately as the size of the building increases, yet this is not being done. The benefits in terms of obviating the need for extensive centralised storm water drainage systems and increasing the groundwater availability far outweigh these costs. Moreover, since these costs will be borne by the building owners themselves it is a progressive measure wherein those with better economic capacity are made to bear the costs directly without burdening the ULBs. The Central Groundwater Board has prepared a detailed artificial recharge master plan for the whole of the country to replenish the available groundwater storage capacity. The details of the measures to be adopted have been given in this document (CGWB 2016). If this plan were to be implemented, then the availability of groundwater would be improved considerably. Moreover, the many surface water bodies in the city would be suitably replenished.

Apart from recharging, water harvesting can also be done by those households, commercial establishments and government institutions which

have the space and the finances to construct underground sumps for storing the harvested water. Rajasthan has a tradition of harvesting and recharging water from the medieval times when modern day pumping was not available as an option. This tradition has fallen into disuse due to easy availability of elecricity for pumping water from great depths. This valuable tradition needs to be revived and implemented with public participation.

- **Decentralised Sanitation Systems**

As with storm water so with wastewater it is much cheaper to treat and reuse or recharge it in a decentralised manner. The Dhas Gramin Vikas Kendra in Indore has installed such a decentralised system in its office premises in which the bathroom and kitchen wastewater is filtered through a soak pit and recharged into the ground with a BOD of less than 30 mg/litres which is the permissible limit for discharge into the ground (Pillai, 2012). The toilet wastewater is first directed into a septic tank. This septic tank has an aerator installed in it that causes aerobic digestion of the waste to take place. Thus, the inlet water which has a BOD of about 500mg/litre is treated by the aeration process resulting in a BOD of about 55 mg/litres of the water flowing out of the septic tank. This water is then filtered through a soak pit and the final water that seeps into the ground has a BOD within the permissible limit of 30 mg/litres. The installation cost of this system is less than 1 per centof the total building cost while the running cost of the aerator is only Rs 2/1000 litres/day of toilet sewage. Moreover, due to the oxidation of sewage through aeration there is less generation of sludge which gets pulverised by the aeration and passes out with the effluent into the soak pit and there are nofoul smelling gases. The grey water is treated and recycled for use in flushing and gardening. The water required for flushing of toilets and gardening together constitute close to 47 per centof the domestic water use (CPHEEO, 1999).

There are many other cost effective and environmentally sound decentralised treatment options, some of which have been detailed in the CPHEEO manual on sewerage and sewage treatment (CPHEEO, 2013) and by the Consortium for DEWATS Dissemination Society (CDD & NIUA, 2017). The main considerations for implementing decentralised waste treatment systems are the area required and the capital and O&M expenses. These depend on the technology used. The use of bio remediation technologies reduces the area required but increases the capital and O&M costs due to the use of sophisticated infrastructure

and higher amounts of energy and enzymes. Therefore, depending on the availability of space and finances, an appropriate decentralised method can be adopted either at the household level or at the community level.

The greater availability of treated wastewater for reuse and recharging will reduce the demand for expensive potable water. Increase in availability of groundwater will mean lesser use of electrical energy which in turn means the lesser production of greenhouse gases. Thus, alternative decentralised systems will also have a positive climate change mitigation impact by reducing the demand for electricity. These measures will also reduce considerably the need for capital intensive and operationally expensive centralised water supply and sanitation systems which are currently in operation in Jaipur and are not being able to meet the needs of the population and the environment despite such huge expenditure.

- **Sustainable and Equitable Sanitation Management**

Storm water recharge and harvesting combined with wastewater treatment and recharge and reuse done in a decentralised manner, is a much more sustainable alternative in financial, social and environmental terms. This kind of hybrid alternative system has also been recommended by a committee formed to recommend National Sustainable Habitat Standards for the Urban Water Supply and Sewerage sector under the National Mission for Sustainable Habitat (NMSH, 2011). Instead of relying on taxes, user charges and grants to fund hugely expensive centralised systems, this alternative system would put the onus on the more affluent citizens, corporations, private institutions and government institutions, who are all in possession of a considerable portion of urban land, to tackle their water supply and wastewater disposal needs in a decentralised manner and so leave the ULBs to take care of the water supply and sanitation needs of the those residents only who are not in a position to bear these costs. The water supply and sanitation functions of Jaipur have to be ringfenced under a separate water supply and sewerage board that will oversee the proper implementation of the SSWWP, SPFSSM and the Rajasthan State Water Policy.

- **Better Financial Managment**

There is a need for better financial management. First and foremost, the share of property taxes in total revenue receipts of JMC will have to be

increased to at least 25 percent. The total sanitation tax and collection by PHED of sewerage and sewage treatment charges is very low and covers only 1.6 percent of the expenditure of the pubic health department of JMC and so this also needs to be increased by charging more from households in a progressive manner. While the poor have to be exempted from charges, the others will have to be charged proportionately more in accordance with the area and location of their properties like it is in the case of property tax. There is provision in the SSWWP for the involvement of private parties in sanitation management and also the setting up of STPs in high rise apartments, industrial establishments, hotels and hospitals which have a high output of wastewater and a corresponding high demand for water for functions requiring non-potable use which can be met from reuse of treated waste water. These avenues of reducing the financial load on the JMC should be pursued vigorously.

- **Public Awareness Campaigns**

The SSWWP has listed all the recommendations that have been made above but in the absence of adequate public awareness regarding the principles on which this sustainable and equitable sanitation model is based, both the government and citizens are loathe to implement its provisions. Consequently, the policy is being followed only in the breach. Therefore, there is a need for holding a large number of public consultations and training workshops so that the rationale behind the SSWWP can be explained to the people and the engineers and administrators.

Conclusion

The study reveals that there is a significant hiatus between policy and implementation with regard to sanitation managment in the city of Jaipur . Whereas, the State Sewerage and Wastewater Policy, has extensive provisions for environmentally sustainable, economically viable and socially equitable sanitation systems, the actual sanitation management of Jaipur is not following these in practice. A city sanitation plan is yet to be prepared based on the principles enunciated in the SSWWP and the efficiency and equity of operation and management of sanitation services needs to improve. Even though the proportion of onsite sanitation systems is comparatively low at 20 percent but with regard to these also the management of faecal sludge is being done in violation of the provisions of the state policy on faecal sludge management and the law against manual scavenging.

Therefore, an extensive review of the prevailing sanitation situation in Jaipur followed by appopriate planning and implementation along the lines detailed in the earlier section on recommendations is in order. The high costs of setting up and operating centralised sanitation systems in accordance with prescribed standards are a prohibitive burden on the urban local bodies and a major reason for their poor operation and this has been noted in other studies of urban sanitation in India (Banerjee & Dey, 2017). Consequently, the alternative options of decentralised and natural sanitation systems must be considered in preparing the city sanitation plan.

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