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WATER, WASTEWATER AND STORMWATER MANAGEMENT IN RECENTLY TRANSITIONED PERI-URBAN AREAS

A CASE STUDY OF BIJNOR, UTTAR PRADESH

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WATER, WASTEWATER AND STORMWATER MANAGEMENT IN RECENTLY TRANSITIONED PERI-URBAN AREAS

A CASE STUDY OF BIJNOR, UTTAR PRADESH

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Production: Rakesh Shrivastava and Gundhar Das

Supported by TATA TRUSTS

Citation: Jyoti Parsad Dadhich and Harsh Yadava, 2026, *Water, wastewater and stormwater management in recently transitioned peri-urban areas: A case study of Bijnor, Uttar Pradesh*, Centre for Science and Environment, New Delhi

Published by
Centre for Science and Environment
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Executive summary

The peri-urban wards newly incorporated into the Bijnor Nagar Palika Parishad (BNPP)—Wards 6, 7, 13, 17 and 32—highlight the challenges of integrating rapidly urbanizing settlements into formal urban service systems. Added to the municipal boundary in December 2020, these wards brought 14 peri-urban villages under the BNPP. However, infrastructure, governance, and service delivery still reflect legacy rural conditions, creating major gaps in water supply, sanitation, and stormwater management.

Satellite analysis from 2014–2025 shows rapid land-use change, with agricultural land and open spaces converted into dense residential and mixed-use developments. Wards 17 and 6 are relatively more urbanized and planned, while Wards 13 and 32 remain largely unplanned with weaker infrastructure and lower service levels.

Large disparities exist in water supply between the core city and newly added wards. In the core BNPP area, 33 operational tubewells and 12 overhead tanks supply about 17.5–20 MLD, serving 75–87 per cent of households at 138–174 (liters per capita per day) LPCD, meeting national benchmarks. In contrast, peri-urban wards receive intermittent piped supply, often limited to four hours daily, with uneven coverage and heavy reliance on private borewells (120–220 feet), handpumps, and household storage tanks (500–3000 L). Lack of groundwater regulation has resulted in widespread unmonitored extraction and wastewater generation beyond municipal estimates.

Sanitation services also depend heavily on on-site systems, with over 95 per cent of households using septic tanks or pits. Although Bijnor has a 24 MLD sewage treatment plant (STP) and a 20 KLD faecal sludge co-treatment unit, sewer connections remain minimal and wastewater is largely conveyed through open drains. In peri-urban wards, desludging is irregular—typically once every 1–15 years—and mostly handled by private operators, leaving the co-treatment facility operating at only about 30 per cent capacity.

Stormwater management is the most critical service gap. None of the studied wards have a dedicated stormwater drainage network; instead, open drains carry stormwater, greywater, and blackwater together. While drain coverage is relatively high (66–100 per cent), most drains are narrow, poorly graded, and discontinuous.

Greywater forms the major share of flows, while 5–25 per cent contains blackwater from septic overflows or direct discharge. Solid waste accumulation is reported by 45–72 per cent of households, and 34–80 per cent report foul odour, contributing to frequent waterlogging and pollution.

Rapid urbanization is also degrading local ecosystems. Water bodies such as Rampur Bakli pond and Nawab ka Hatha wetland increasingly receive untreated wastewater and face encroachment, raising risks of groundwater contamination and public health impacts.

The Government's AMRUT 2.0 programme seeks to address water supply gaps through 100 per cent household tap connections in the expanded municipal area. According to the City Water Supply Augmentation Plan, Bijnor is expected to have 46,933 households by 2025, of which 21,390 (45.6 per cent) currently have tap connections. The scheme proposes 25,543 additional connections, six new water supply zones, and overhead tanks, with an investment of about Rs 9,191.8 lakh for a projected population of 2.65 lakh by 2055.

Overall, the findings highlight the urgent need for integrated peri-urban service planning, including groundwater regulation, improved faecal sludge management, dedicated stormwater infrastructure, and stronger institutional coordination. Without targeted interventions, rapid growth in Bijnor's peri-urban areas could widen service inequities and intensify environmental and public health risks.

1. Introduction

1.1 Background and context

India's urbanization over the last two decades has significantly transformed the rural–urban interface. Towns are expanding outward, absorbing nearby villages and creating peri-urban belts that are neither fully rural nor formally urban. These areas often grow along highways and arterial roads, driven by improved mobility, changing land markets, and the integration of village economies with nearby cities. However, infrastructure planning, governance systems, and public services have not kept pace. As a result, peri-urban settlements experience major gaps in water supply, sanitation, wastewater management, and stormwater drainage.

International evidence from countries such as Ethiopia, Ghana, and Brazil shows similar trends. Even where piped water exists, reliability remains low. Sanitation systems rely largely on latrines, septic tanks, or informal soakage arrangements, while wastewater is commonly discharged into open drains or low-lying areas. High population densities—often exceeding 300–400 persons per hectare—make conventional on-site systems increasingly unviable. Poor drainage, limited right-of-way, and inadequate space for treatment facilities further heighten environmental risks, highlighting the need for integrated planning and decentralized solutions.

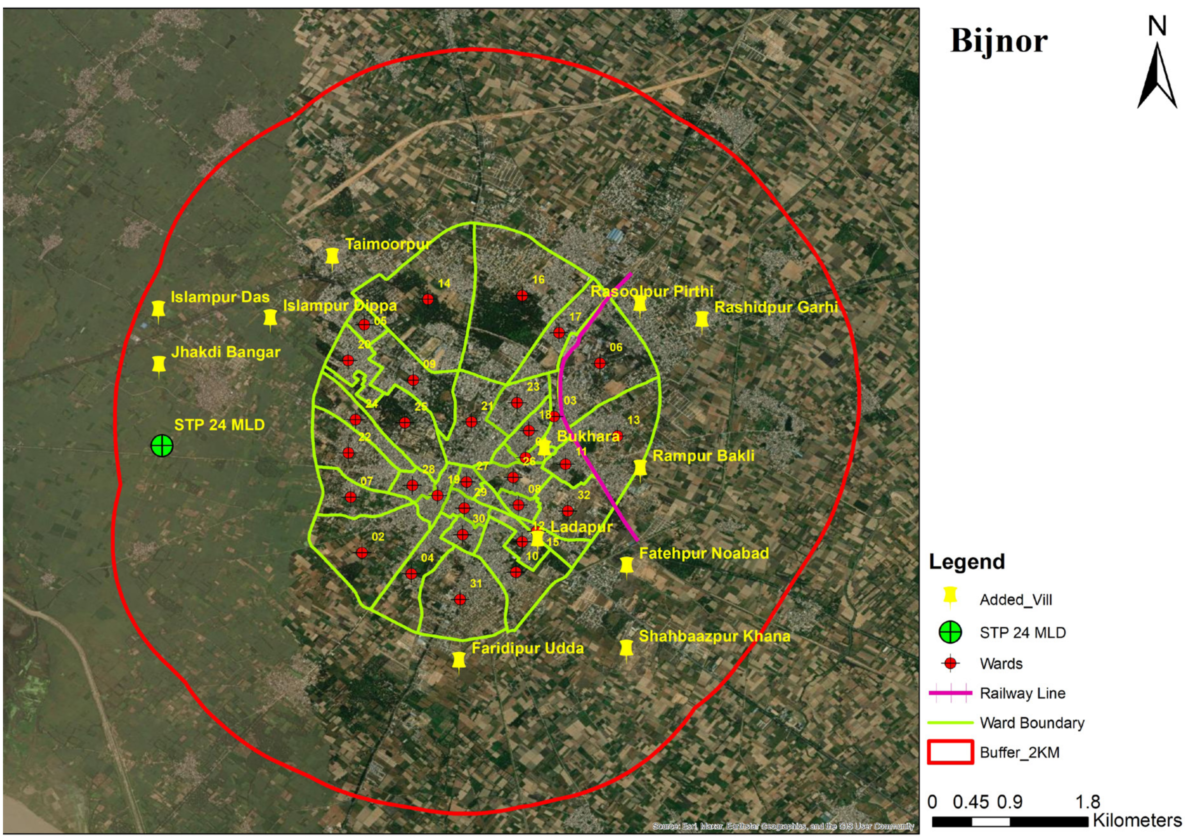
Peri-urban areas combine rural-style housing and land-use patterns with urban-level density and service demands. Rapid population growth, migration, and land subdivision intensify pressures on infrastructure. Yet, because this growth is rarely anticipated in planning exercises, peri-urban regions often fall into a governance vacuum. They are too urban for rural schemes like the Jal Jeevan Mission, yet insufficiently formal for urban programmes such as AMRUT or SBM-Urban.

Bijnor represents a typical peri-urban transition in India. Located in the upper Indo-Gangetic plains, the town expanded its boundary in 2020 to incorporate fourteen surrounding villages into the BNPP, nearly doubling the administrative population and municipal service responsibilities. The newly added villages retain rural characteristics—mixed residential-agricultural land use, narrow lanes, unplanned growth, and dependence on on-site sanitation—while residents increasingly demand urban-level services.

Water supply networks are being extended with a planned provision of 135 LPCD, yet many households still rely on private submersible pumps and handpumps due to intermittent or absent piped supply. Water quality monitoring and conservation practices remain limited, while sanitation and stormwater management are more critical challenges.

Drains are shallow, discontinuous, poorly aligned with natural catchments, and frequently blocked by solid waste, raised roads, and the railway corridor, causing regular monsoon flooding in low-lying settlements. These conditions reflect the interconnected challenges of water, sanitation, and drainage in peri-urban areas. The transition from Gram Panchayat to Nagar Palika Parishad has further created service gaps due to unclear responsibilities, weak maintenance, limited capacity, and restricted access across the railway line, leaving residents taxed as urban but served through inadequate rural arrangements.

Map 1: Bijnor city with newly added villages



Source: Compiled by CSE

1.2 Need for the study

The complexity of peri-urban transition in India has been widely documented. Aijaz (2019)[1] and Prakash (2020)[2] highlight the unique water security challenges and governance fragmentation, while Vaidya (2019)[3] and Raman (2019)[4] emphasize the technical difficulties of extending sanitation services to the urban fringe. Patel (2012)[5] advocates for community-centric data models. However, a major gap remains at the national level in integrated 'Water-Wastewater-Stormwater' strategies.

This study addresses that gap by developing evidence-based, actionable strategies that reflect peri-urban realities in national planning—an aspect largely absent from regional plans, master plans, and zonal plans.

Bijnor's 2020 municipal expansion, which incorporated fourteen peri-urban villages, has created a rapidly changing landscape where rural settlement patterns coexist with demands for urban-level services. Compared to the core city, peri-urban wards face fragmented infrastructure, unreliable water supply, inadequate sanitation and wastewater systems, recurrent flooding, and wastewater stagnation. These issues are worsened by narrow lanes, unplanned construction, and the railway line as a physical barrier. Yet, systematic and disaggregated data on these newly added areas remains limited.

At the policy level, peri-urban settlements fall into a governance vacuum. Rural schemes such as JJM and SBM-G no longer apply, while urban programmes rarely address recently transitioned areas. This results in delayed service extension, unclear maintenance responsibilities, and ad-hoc responses to flooding, wastewater disposal, and pollution. Without targeted interventions, peri-urban Bijnor risks continued dependence on inadequate rural-type sanitation systems unsuited to higher densities, increasing environmental degradation, health risks, and public dissatisfaction.

These realities make peri-urban Bijnor a critical case for detailed study. By generating granular evidence on water, sanitation, and stormwater gaps, the study aims to support the Bijnor Nagar Palika Parishad (BNPP) in prioritizing investments and enabling an equitable, resilient, and sustainable urban transition.

1.3 Aim

To assess the challenges and opportunities of water supply, wastewater and stormwater management in Bijnor's newly added peri-urban villages, and to propose inclusive and sustainable strategies for intervention.

1.4 Objectives

- To assess the existing infrastructural situation related to water, sanitation and stormwater in peri-urban villages of Bijnor.
- To identify and analyze specific issues and challenges of ongoing or planned infrastructural augmentation in these peri-urban settlements.
- To understand how existing urban policies and programs address (or fail to address) peri-urban settlement needs, and suggest corrective measures.
- To document community perspectives, practices, and aspirations related to water and sanitation in peri-urban areas.
- To explore feasible technical, institutional, and community-led solutions for inclusive peri-urban water and wastewater management.

1.5 Scope of the study

The study covers five selected peri-urban wards from the 14 villages recently merged into the BNPP. It assesses emerging challenges in water supply, sanitation and stormwater management following their integration into the municipal system.

The sanitation assessment focuses on wastewater and septage management, including household containment systems, desludging practices and sewer connectivity, while excluding solid waste management. The study also examines institutional and governance challenges affecting service delivery in the newly incorporated areas.

The study aims to identify key service gaps and governance constraints and propose practical strategies to improve water, wastewater and stormwater management in these peri-urban settlements.

The findings provide a representative understanding of conditions in peri-urban Bijnor, but are not intended to be exhaustive for all 14 villages. The selected villages represent different geographic locations and settlement typologies, considering population size, socio-economic characteristics and infrastructure access.

The analysis is based on secondary data review, primary field surveys, stakeholder consultations and technical assessments but does not assess the impacts of extreme weather events or climate-related risks.

Key research questions addressed in this study are as follows:

Water

- What are the key water sources used by households in peri-urban Bijnor, and how are they accessed?

- What challenges do communities face in water availability, access and quality?
- To what extent are households dependent on groundwater for domestic use?
- How effective are existing government initiatives in addressing water challenges in peri-urban areas?

Sanitation

- What is the status of household sanitation systems, including septic tanks, containment structures and plumbing?
- What are the current desludging practices, service arrangements and associated costs?
- What proportion of households are connected to the sewer network, and will planned sewerage expansion adequately address wastewater generation?
- Can the existing sewerage infrastructure and STP capacity manage the additional load from peri-urban areas, and will services be inclusive of marginalized communities?

Stormwater

- What is the current status of stormwater drainage systems in the selected villages?
- How will ongoing sewerage augmentation plans affect stormwater drainage?
- What are the current and future drainage challenges, based on drainage mapping of the selected villages?
- Are there opportunities for stormwater harvesting and groundwater recharge?

1.6 Methodology

The study adopted a mixed-methods research approach, combining desk-based review, primary field investigations, participatory consultations and technical assessments. The assessment focused on five selected peri-urban wards recently incorporated into the jurisdiction of the BNPP, representing a substantial share of the city's newly added urban fringe.

The methodology comprised the following key components:

- Secondary research through a review of existing policies, guidelines, frameworks, reports and web-portals, supplemented by telephonic interactions with relevant officials and practitioners.
- Stakeholder identification and mapping to understand institutional roles, responsibilities and inter-linkages across water supply, sanitation and stormwater management.

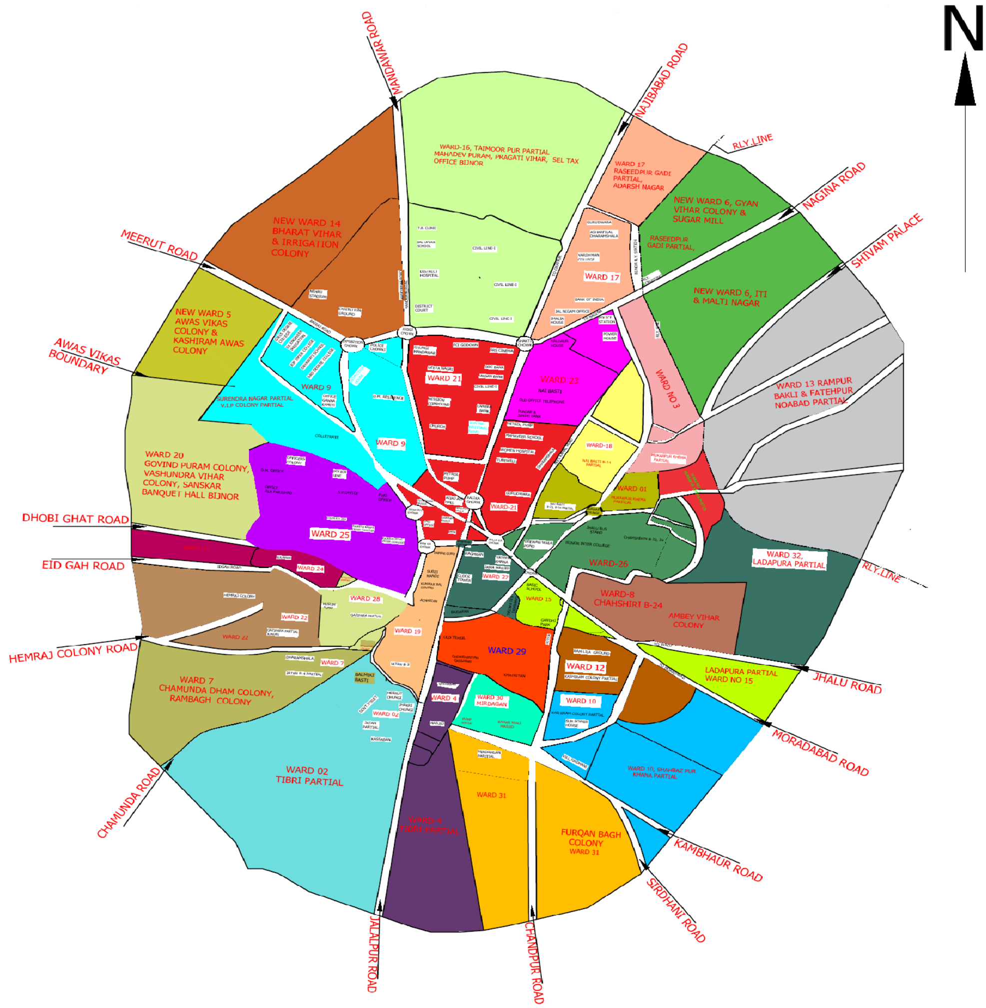
- Demarcating the wards where newly added five villages are added and mapping.
- Infrastructure mapping of existing water supply, sanitation and stormwater systems across the selected peri-urban villages.
- Development of thematic survey tools, including structured questionnaires covering three domains—water, sanitation and stormwater—integrated with socio-economic indicators.
- Primary household and institutional surveys to assess access to water services, sanitation practices and stormwater-related challenges.
- Key informant interviews (KIIs) and focus group discussions (FGDs) with community members to capture gender-specific, social and economic dimensions of service delivery.
- Stakeholder consultations with government departments and local institutions, including the Nagar Palika Parishad, Jal Nigam, JalKal Department, Agriculture Department, Industrial Department, Village Water and Sanitation Committees (VWSCs), Gram Panchayats and other village-level bodies.
- Data analysis for identification of critical issues, service gaps and systemic challenges.
- Technical assessments and feasibility analysis of potential interventions.
- Comparative evaluation of alternative solutions, supported by consultations with subject-matter experts.
- Formulation of recommendations and suggestive measures aligned with local context and institutional capacity.

1.6.1 Selection methodology of five representative sample peri-urban wards

The previous municipal boundary of the BNPP had 25 wards spanning an area of 3.65 square kilometers (sq. km). Following the expansion of boundaries, the revised municipal area now covers a total of 11 sq. km, including 14 nearby villages totaling 7.4 sq. km. This extension is three times the current administrative area under the BNPP, necessitating additional efforts and resources to provide public services to the expanded region.

Expansion of the BNPP increased number of wards from 25 to 32. It led to the reshuffling of boundaries of all existing wards across Bijnor to accommodate these 14 villages.

Map 2: Nagar Palika Parishad Bijnor (ward-wise) 2022



Source: Nagar Palika Parishad, Bijnor

For this study, five wards were selected from Bijnor's 32 wards, focusing on newly added peri-urban settlements. These wards include nine partially integrated villages and colonies previously outside municipal limits and represent about 60 per cent of the newly added peri-urban area. They were selected because, despite being incorporated into the urban boundary, they still lack adequate urban services and show limited progress in merger formalities, making them a representative peri-urban case study.

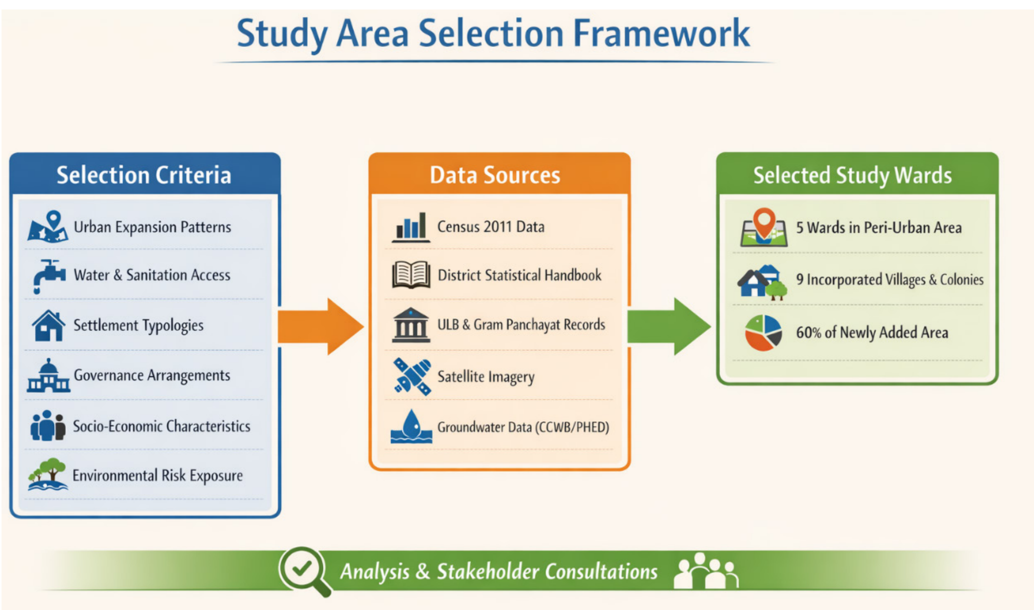
Following criteria was considered in selection of five peri-urban villages:

- *Urban expansion patterns—Geographic orientation:* Peri-urban villages were selected from all the directions of ULB and the degree of expansion. Population and area of newly added villages were also considered.

- *Access to water supply, wastewater and stormwater management systems:* All the selected wards represent the varied access to water and wastewater facilities. While some wards had relatively good access to these services, others remained inadequately served. The sanitation and wastewater systems observed across the wards included septic tanks, pit latrines, sewer connections and open drains.
- *Settlement types:* The selected wards represent a spectrum of settlement types—government housing colonies, rehabilitated slums, rural-type villages and mixed rural–urban settlements—ensuring that the study captures diverse infrastructural conditions and community contexts.
- *Governance arrangements:* Priority of the local governance considered but during interviews it was found that the governance priority is on demand basis. Therefore, equal weightage was given to all wards during ward selection.
- *Socio-economic characteristics:* Populations with higher civic awareness, economic stability, modern housing and industrial employment.
- *Environmental risk exposure:* Hydrological characteristics, such as slope and vulnerability to waterlogging.

The above information was compiled from multiple sources, including Census 2011 and projected population data, District Statistical Handbook, ULB and Gram Panchayat records, satellite imagery, groundwater data (CGWB/PHED) and rapid reconnaissance field visits.

Figure 1: Study area selection framework



Source: Compiled by CSE

Based on this analysis and consultations with stakeholders, five wards were selected for detailed assessment under the study. Below are the details of the study area:

Table 1: Wards selected for detailed assessment

S. no.	Ward details	Ward population	Sewerage status	Settlement type & demography	Water supply, wastewater and stormwater	Key observation/ Environmental concerns
1.	Ward 7 – Chamunda Dham Colony & Rambagh Colony	Not available	Partially sewered	• Sparsely populated • Predominantly scattered, rural-type housing	• Limited stormwater infrastructure • Natural slope towards river Ganga; wastewater flows towards STP	• Chamunda Dham Colony remains unsewered • Partial connectivity may limit effective wastewater capture
2.	Ward 6 – ITI & Malti Nagar, Gyan Vihar Colony, Rasheedpur Gadi, Rasulpur Pirthi Village	Not available	Non-sewered	• Mixed demography (farmers, sugar mill workers, small businesses) • Includes peri-urban colonies and partial village areas	• Area prone to waterlogging (notably Nawab ka Hatta behind Malti Nagar) • Slope away from Ganga • Limited formal drainage	• Ward divided by railway line • Presence of large sugar mill and staff colony • Rasulpur Pirthi (8.24 ha) & Rasheedpur Gadi (58.19 ha) partially included • Gyan Vihar Colony frequently waterlogged
3.	Ward 32 – Ladapura	Not available	Partially sewered	• Mixed rural–urban settlement • Transitional peri-urban character	• Natural slope towards Ganga	• Sai Puram area remains unsewered • Includes part of Ladapura village • Incomplete coverage limits full wastewater conveyance
4.	Ward 17 – Rashidpur Gadhi & Adarsh Nagar	Not available	Non-sewered (only partial wastewater reaches STP)	• Mixed rural and urban typology	• Incomplete stormwater drains • Ongoing water supply infrastructure works • Mixed slopes (partly towards and partly away from Ganga)	• Presence of pond (talab) at ward entrance • Wastewater accumulation risk due to partial flow diversion
5.	Ward 13 – Rampur Bakli	Not available	Entirely non-sewered (onsite sanitation systems); no wastewater reaches STP	• Predominantly rural but densely populated	• Stormwater and wastewater accumulate in pond near Kabristan	• Large pond near railway line receives wastewater from Ward 13 and adjacent core city wards • Significant environmental and public health risk • Represents high-risk peri-urban zone

Note: Ward-wise population data is currently unavailable as ward boundaries were recently restructured following the municipal expansion. Updated population figures are under preparation by municipal authorities.

Source: Compiled by CSE

1.6.2 Survey methodology

The survey methodology included a mixed-methods approach combining quantitative surveys, qualitative assessments, institutional consultations and spatial analysis to comprehensively understand peri-urban issues.

1. Household surveys

A total 217 households were surveyed across five selected wards using a stratified random sampling approach. Stratification was based on settlement typology (sewered/non-sewered), socio-economic characteristics, and spatial location within the ward to ensure representation of diverse sanitation practices and service access levels. The household survey captured information on:

- Type of sanitation system (sewered/onsite)
- Desludging practices and frequency
- Water supply sources
- Drainage and flooding issues
- Awareness and perception of sanitation services

S. no.	Ward no.	No. of HHs surveyed
1.	6	40
2.	7	50
3.	13	46
4.	17	41
5.	32	40

2. Institutional and commercial surveys

Structured surveys were conducted with key public institutions (schools, health centers and community facilities) and commercial establishments to assess sanitation infrastructure and wastewater management systems, sludge disposal practices, water consumption and drainage connectivity and compliance with environmental norms.

3. Key informant interviews (KIIs)

A total of 25 KIIs (five per ward) were conducted with a range of stakeholders, including sanitation workers and desludging operators, ward councillors and local leaders, service providers and plant operators, and community representatives and beneficiaries.

These interviews provided insights into operational challenges, governance gaps, informal practices and institutional coordination mechanisms.

4. Focus group discussions (FGDs)

Ten FGDs (two per ward) were conducted across selected villages to capture community-level perspectives. Separate FGDs were conducted to ensure representation of underprivileged and marginalized groups. The discussions focused on sanitation access and affordability, waterlogging and environmental concerns, perceived health risks and community willingness to adopt improved systems.

5. Stakeholder consultations

Structured consultations were held with local and district-level institutions, including:

- Nagar Palika Parishad, Bijnor
- Uttar Pradesh Jal Nigam
- JalKal department
- Agriculture and industrial departments
- Medical and public health experts
- Ward councillors
- Members of City Sanitation Task Force (CSTF)

These consultations aimed to triangulate field findings, understand institutional mandates, assess coordination mechanisms and explore policy-level solutions.

6. Spatial mapping and infrastructure assessment

A GIS-based spatial mapping exercise was undertaken to analyze drainage and wastewater flow directions, location of water bodies and ponds, tapping points and discharge locations, water supply sources, existing STPs and sewer networks. This spatial analysis supported risk identification, prioritization and infrastructure gap assessment.

7. Data validation and triangulation

Findings from household surveys, KIIs, FGDs and institutional consultations were cross-verified to ensure reliability and consistency. Spatial observations and secondary data were used to validate reported infrastructure and flow patterns.

2. Peri-urban transition dynamics in Bijnor

Peri-urbanization in India refers to the spatial, economic, and social transformation at city edges, where rural areas acquire urban characteristics without fully integrating into planned urban systems. These zones, often outside municipal boundaries, are shaped by urban expansion, land markets, infrastructure spillover, and changing livelihoods, creating fragmented landscapes where rural and urban features coexist.

Scholars describe peri-urban areas from different perspectives. Adell (1999) describes the urban fringe as "the space into which the town extends… only partly assimilated into the growing urban complex."[6] Allen (2003) characterizes peri-urban areas as spaces that often lose rural attributes while lacking adequate urban services and infrastructure. Davis (2004) describes them as a new rural–urban hybrid form of urbanism. As per Douglas Webster, 2009, peri-urbanization is a dynamic process in which rural areas located in the hinterland of urban settlements gradually acquire urban characteristics through changes in land use, economic activities, and population patterns.

In these areas, agricultural land is rapidly converted into residential, industrial, transport, and commercial uses through largely unplanned growth. Population density and built-up areas increase faster than infrastructure provision, while water supply, sanitation, drainage, and solid waste systems continue to follow rural norms. A key feature is institutional lag, where governance reforms and administrative recognition occur only after substantial physical growth, resulting in fragmented responsibilities and uneven service delivery.

Peri-urbanization also shifts livelihoods from agriculture to informal manufacturing, construction, transport, and service-sector work, increasing environmental stress through groundwater over-extraction, loss of agricultural land, encroachment on water bodies, and inadequate wastewater and stormwater management.

Peri-urban growth in Bijnor

Bijnor, the district headquarters of Uttar Pradesh, is located about 460 km from Lucknow and 162 km from Delhi, with strong road and rail connectivity. As a tier-II city in western UP, it has experienced steady urban expansion driven by population growth, land-use change, improved connectivity, and spillover from the urban core.

Growth has mainly occurred along the urban fringe, where villages near transport corridors, industries, and existing urban wards have gradually transformed into semi-urban settlements. These areas show irregular housing, emerging commercial activity, and dependence on groundwater-based water supply, without corresponding expansion of piped water, sewerage, or planned drainage, forming Bijnor's peri-urban zones.

By 2020, many of these villages already displayed urban characteristics—higher densities, non-agricultural livelihoods, and rising service demand—while still functioning under Gram Panchayat-era infrastructure and governance. On 23 December 2020, the Government of Uttar Pradesh expanded the BNPP to include 14 adjacent villages to improve planning and service delivery.

This expansion was part of a synchronized state-level "Seema Vistar" initiative in late 2020 to integrate peri-urban villages into urban jurisdictions to modernize governance and infrastructure.

On 23 December 2020, Bijnor's expansion was finalized alongside those of Hathras, Khurja, Mohammadi, Jalaun and Sarsawan. This followed an initial wave of notifications issued just days prior; Chitrakoot Dham was notified on 18 December, while a larger group—including Kannauj, Jais, Nawabganj, Bahraich, Gaura Barhaj and Pukhrayan, along with the Nagar Panchayats of Chopan and Auras—was officially expanded on 20 December.

The official letters of expansion can be accessed here (in notification section): https://www.indiacode.nic.in/handle/123456789/16228?col=123456789%2F2510

The table below presents details of revenue villages that have been partially or fully integrated into the urban limits of Bijnor town. It highlights the extent of land and population transferred from rural governance to urban jurisdiction.

Overall, 796.58 hectares of land and a population of 78,367 persons (census 2011) have been added to the municipal area. Two villages—Mukarpur Khema urf Bukhara and Ladapur—have been fully integrated, while the remaining villages have been partially merged, resulting in split rural–urban governance arrangements. Large additions such as Taimoorpur Deepa, Bijnor Rural, Rampur

Table 2: Areas of the villages added in the Nagar Palika boundary

S. no.	Revenue village name	Status (Partial/ Full)	Area added (hectare)	Population (2011 census)	Development block	Remaining area (hectare)/ Population (rural)
1.	Adampur	Partial	33.463	385	Bijnor	18.698/173
2.	Rasulpur Pirthi	Partial	8.241	841	Bijnor	284.536/4599
3.	Rashidpur Garhi	Partial	58.193	4016	Bijnor	84.044/3854
4.	Islampur Das	Partial	20.867	1934	Bijnor	128.960/2607
5.	Jhakri Banger	Partial	29.791	28	Bijnor	219.389/732
6.	Fatehpur Nauabad	Partial	29.832	5790	Bijnor	88.554/NA
7.	Mukarpur Khema urf Bukhara	Full	55.28	31800	Bijnor	0
8.	Ladapur	Full	50.149	14100	Bijnor	0.463/NA
9.	Rampur Baqli	Partial	58.987	7240	Bijnor	60.922/NA
10.	Taimoorpur Deepa	Partial	157.424	4770	Bijnor	165.234/5195
11.	Shahbazpur Khana	Partial	44.154	2245	Bijnor	11.627/82
12.	Faridpur Uda	Partial	38.498	741	Bijnor	13.849/NA
13.	Fareedpur Qazi	Partial	38.709	1045	Bijnor	323.362/2320
14.	Bijnor Rural	Partial	172.992	3432	Bijnor	733.470/0
	Total		796.58	78,367		

Source: Nagar Palika Parishad, Bijnor

Baqli, and Rashidpur Garhi represent significant peri-urban transition zones, where mixed settlement patterns, reliance on onsite sanitation systems and incomplete infrastructure are common.

Although this administrative inclusion has enabled access to urban development programmes such as AMRUT 2.0 and Swachh Bharat Mission (Urban), it has also increased the institutional and infrastructural burden on the urban local body (ULB). The municipality is now required to extend services to previously unplanned and informally developed settlements, many of which lack basic infrastructure. Consequently, while these areas are now formally part of the municipal jurisdiction, the transition to fully urban service standards remains incomplete. Water supply, sanitation, drainage and environmental management systems in several newly added settlements continue to fall short of urban norms. The following sections examine the key characteristics of this rural–urban transition, including land-use change patterns, administrative and governance shifts, settlement characteristics of the newly added wards and their socio-economic and environmental features.

2.1 Land use growth pattern

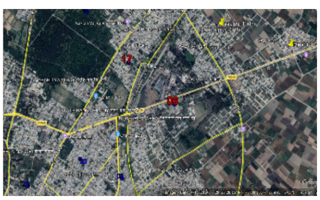
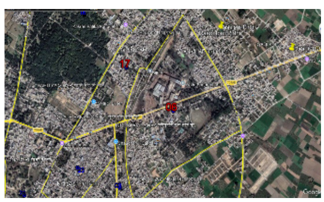
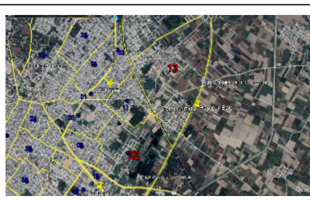
This section outlines how land use across selected wards has evolved over time in response to population growth, economic activity and expanding urban boundaries. Using multi-temporal satellite imagery, the analysis captures the transition of areas from agricultural and open land to residential, commercial and industrial uses.

Ward 17 has transformed rapidly from a mixed residential-open landscape to a densely built urban area. In 2014, established neighborhoods coexisted with sizeable green and vacant plots. By 2021, most open land had been converted into built-up areas, increasing density. By 2025, the ward is almost fully developed, with very little open space left, indicating intensive infill urbanization.

Ward 6 reflects industrial-led urban growth. In 2014, the Wave Sugar Industry dominated the ward, surrounded by large tracts of vacant or agricultural land. By 2021, these open areas showed early signs of subdivision and development. By 2025, continued urban expansion had significantly reduced vacant land, with residential and commercial uses spreading around the industrial periphery.

Ward 13 shows a clear shift from a rural to an urban land-use pattern. In April 2014, the area was almost entirely agricultural, with large farming plots and

Land use pattern – Bijnor

Ward no.	April, 2014	February, 2021	October, 2025
17 & 6			
13 & 32			
7			

Source: Google Earth; compiled by CSE

negligible built development. By May 2021, the land had been systematically subdivided, with a grid of roads indicating planned residential and commercial plotting. By October 2025, rapid construction on these plots had transformed the ward into a suburban-urban area, marking a complete departure from its earlier agricultural character.

Ward 32 follows a similar but slightly later development trajectory. In April 2014, the ward remained fully agricultural with no visible infrastructure. By May 2021, land clearing and plot subdivision signaled the start of urban expansion, particularly toward the southern edge of the city. By October 2025, a noticeable increase in buildings and defined plots had emerged, closely mirroring the urbanization pattern observed in the adjacent Ward 13.

Ward 7 illustrates a gradual process of inner-city densification. In April 2014, a large central green space or orchard formed the core of the ward, bordered by established residential areas such as Moh. Gazipara Junubi and Jatan. By May 2021, this open area had begun to shrink as new housing and road extensions expanded inward. By October 2025, densification was nearly complete, with most of the former green space replaced by buildings and paved surfaces, fully integrating the ward into the surrounding urban fabric.

2.2 Administrative expansion and governance shifts

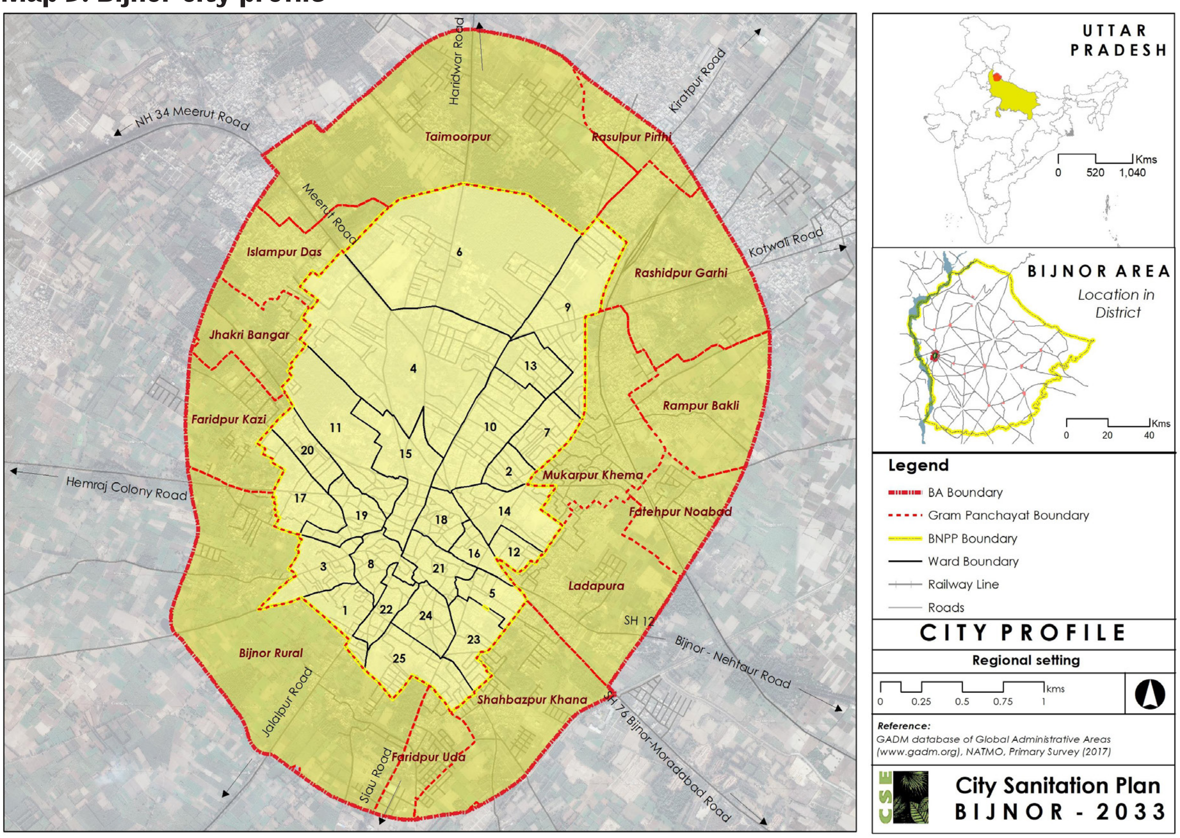
With the notification on 23 December 2020, the Government of Uttar Pradesh formally expanded BNPP's jurisdiction to include 14 adjacent peri-urban villages (Notification No. 877/9-2-2020-09). This aimed to bring rapidly growing and largely unplanned settlements under urban planning and service delivery frameworks.

However, the transition has created governance gap in these areas—rural governance structures have been withdrawn, while urban systems are still being established. Many newly added wards are administratively urban but functionally continue under rural infrastructure norms. Before the 2020 notification, areas including Wards 6, 7, 13, 17, and 32 were governed by Gram Panchayats. Local leadership through the Gram Pradhan managed village-level funds, and infrastructure provision followed rural standards (e.g., water supply of 55 LPCD). With the expansion of the BNPP boundary, several erstwhile revenue villages at the urban periphery, as evident from the map (see *Map 2*), have been absorbed into the municipal area and reclassified as urban wards. This transition has shifted governance from Gram Pradhans to elected ward-based Parshads, relocating planning, budgeting and service delivery decisions to the city level. However, the peripheral location of these newly added wards places them in direct competition with the established urban core for limited financial and administrative resources, often resulting in delayed or inadequate infrastructure investments. While land and properties in these areas are now governed by urban bylaws, municipal taxation and development control regulations, enforcement remains challenging due to organic settlement patterns, narrow lanes, irregular plot layouts and legacy constructions that evolved under rural governance. These spatial and institutional constraints highlight the need for differentiated, context-sensitive planning approaches for transitioning peri-urban wards within the BNPP.

Bijnor's peri-urban transition is marked by fragmented institutional responsibilities, particularly in water supply.

Water supply: Piped systems installed under the Gram Panchayat continue to be operated by the UP Jal Nigam (Gramin) at rural service levels (~55 LPCD), with operational control not yet transferred to the BNPP. While new infrastructure is

Map 3: Bijnor city profile



Source: City Sanitation Plan Bijnor compiled by CSE, 2018 executed by the UP Jal Nigam (Urban) under AMRUT 2.0, targeting 135 LPCD in these areas. This dual-agency scenario has created governance gaps and resident confusion over grievance redressal—whether to approach Gramin or Urban authorities. This transition also introduced the changes in service level taxation. Rural households used to give Rs 50/month water charges now face higher urban tariffs and property taxes without immediate service improvements.

Wastewater: Earlier, sanitation in the villages that later became Bijnor's extended area was mainly handled by the Gram Panchayat, with limited technical or financial capacity. In practice, households managed wastewater individually through septic tanks or pits, and emptying/disposal was done by informal private operators without systematic regulation. The BNPP had no jurisdiction or responsibility in these villages before their inclusion in the municipal boundary.

After their inclusion within the municipal limits, wastewater management is being gradually brought under the city's formal sanitation system, with continued reliance on onsite systems (partially sewerage but not with HH connection) but increasing focus on regulated desludging and treatment. The existing city infrastructure, including the sewage treatment plant with co-treatment facility, is now being used and augmented for co-treatment of faecal sludge from both the core city and the extended area. Overall responsibility rests with the BNPP, supported by state agencies, flagship schemes and technical partners such as UPJN (Urban), AMRUT, SBM etc.

In terms of sanitation, the norms prescribe one Level-I Sanitary Inspector and two Level-II Sanitary Inspectors, but at present, all sanitation-related responsibilities are being handled by a single Level-I Sanitary Inspector. This reflects an additional capacity constraint in managing sanitation services effectively.

Stormwater: Earlier, stormwater management was largely informal, with runoff flowing through natural slopes, roadside kutcha drains, open fields, and village ponds, managed loosely by individual Gram Panchayats. There was no planned drainage network, and maintenance was minimal, leading to frequent waterlogging during monsoons. After the inclusion of the 14 villages within municipal limits, stormwater management has come under the purview of the BNPP. However, much of the extended area still depends on open drains and natural drainage paths, with systematic upgrades being implemented in a phased manner.

2.3 Settlement characteristics of newly added wards

The Bijnor Extended Area (BEA) includes a heterogeneous mix of residential blocks, industrial zones, and traditional agrarian settlements. Based on the City Sanitation Plan (CSP) and household surveys.

- **Ward 17:** Half of Ward 17 comprises the old city; newly annexed areas have well-planned residential blocks and designed housing, with high civic awareness and self-maintained open drains.
- **Ward 6:** Over 60 per cent land use is industrial. Despite railway-induced pockets with rural traits, most of the ward is highly urbanized with good housing design and community-led maintenance.
- **Ward 7:** is predominantly rural (livestock presence, mixed Kachha/Pakka housing), but contains Chamunda Vihar, a planned colony, representing urban development within a rural matrix.
- **Wards 13 & 32**: These wards remain largely rural with minimal infrastructure. Civic maintenance is low, and households rarely undertake collective action to manage open drains, leading to deteriorated environmental conditions.

Settlement ward 13, 7 and 6 (clockwise)

Table 3: Settlement characteristics in selected wards

Ward no.	Settlement type	Key characteristics	WASH infrastructures
Ward 17	Mostly urban type settlement, well planned colonies	High civic awareness, pucca housing, stable incomes	Partially sewered, organized drains
Ward 6	Mixed demography, major industries, colonies settled on converted farmlands.	Sugar mill, railway, modern housing	Entirely non-sewered; wastewater accumulates in Nawab ka Hatta, improperly designed drain
Ward 7	Sparsely populated, mostly rural-type housing	Livestock, mixed housing, planned colony pocket	Partially sewered, predominantly natural open drains
Ward 13	Predominantly rural and densely populated	Dense, unplanned, poor civic maintenance	Entirely non-sewered; WW collects in pond, few newly constructed drains were found
Ward 32	Mixed rural-urban type settlement, highly congested	Densely populated, mix of low- and high-income group people	Partially sewered, both Kachha-Pucca drains

Source: Compiled by CSE

The table (see *Table 3*) shows housing typology and settlement types in selected wards. Wards 17 and 6 are planned and more urban in nature, with good-quality pakka houses and high levels of cleanliness and upkeep, supported either by households themselves or by active community efforts. Ward 7 sits in between, with a mix of kachha and pakka houses and moderate maintenance, where rural practices like livestock keeping affect overall cleanliness. On the other hand, Wards 13 and 32, despite having pakka houses, are unplanned and peri-urban, leading to poor maintenance and visible neglect due to weak municipal services.

2.4 Socio-economic and environmental features

The BEA area shows a clear gap between urban governance on paper and ground reality. Although these areas are now part of the city, growth has been largely unplanned, putting heavy pressure on natural systems like ponds, wetlands, and drains.

- There is a strong socio-economic difference across wards. Wards 17 and 6 have relatively better living conditions, with stable incomes, modern houses, and higher awareness of civic services. In contrast, Wards 7, 13, and 32 are more vulnerable, with households depending on livestock and informal work, and showing lower awareness and use of sanitation and municipal services.
- Natural water bodies are being used as dumping points for wastewater. The Rampur Bakli pond in Ward 13 receives untreated greywater and blackwater from nearby areas and is in a highly degraded condition. The Nawab ka Hatha wetland in Ward 6 is under threat from industrial discharge, waste dumping, and gradual encroachment. Ponds near the sugar mill and railway areas also receive industrial effluent and domestic waste.

- Most households depend on hand pumps and submersible pumps for water. This increases the risk of contamination, as wastewater is openly discharged and can seep into the groundwater.
- Poorly maintained and blocked drains, especially in Wards 13 and 32, lead to stagnant water. These conditions create breeding grounds for mosquitoes and increase health risks.
- Residents in rural-transition wards frequently complain about bad odour, mainly due to open drains, stagnant wastewater, and cow dung lying in public spaces.

Overall, Bijnor's peri-urban growth is at a critical stage. Ponds and wetlands that once helped absorb rainwater and recharge groundwater are turning into open cesspools. For the BNPP, the focus should not only be on providing toilets and pipelines, but also on protecting and restoring ponds and wetlands as part of a combined sanitation and environmental management approach.

3. Situational assessment

3.1 Water supply

Access to safe and adequate water supply is critical for survival; its absence or inadequacy can have severe implications for public health, food security, and household livelihoods.

Urban and peri-urban areas differ in this regard. Urban areas mostly struggle with the demand supply gap of water due to limited fresh water resources whereas some of these features remain same in the peri-urban areas also. Water supply in these areas is often limited and inadequate, with residents facing restricted access to formal, piped networks due to issues like lack of legal tenure or infrastructure gaps. These transitional areas often rely on informal, unregulated water sources, resulting in higher health risks and lower service quality compared to urban centers.[7]

In Bijnor district, water sources include river water, groundwater, and rainwater. Although the River Ganga flows along the south-western and southern parts of the district, household water supply for drinking and domestic purposes remains majorly dependent on groundwater.

Bijnor district holds a dynamic groundwater reserve of 92,752 ham. With a development stage of 67.45 per cent (63.39 per cent in the Mohammedpur Deomal block), the area is classified as 'Safe' by the CGWB (2022). The hydrogeology features a three-tier aquifer system extending 450 meters, separated by two major clay aquitards at depths of 80–90m and 250m.

Groundwater levels are resilient, averaging 11.45m deep with minimal seasonal fluctuation (0.40m). Recharge is primarily driven by the River Ganga, while a vertical rock formation along Najibabad Road acts as a hydrogeological barrier, stabilizing local water levels.

Untreated effluents from "Red Category" industries have caused localized contamination of the shallow aquifer up to 60 feet. This poses a severe health risk to peri-urban households reliant on shallow private handpumps and borewells.

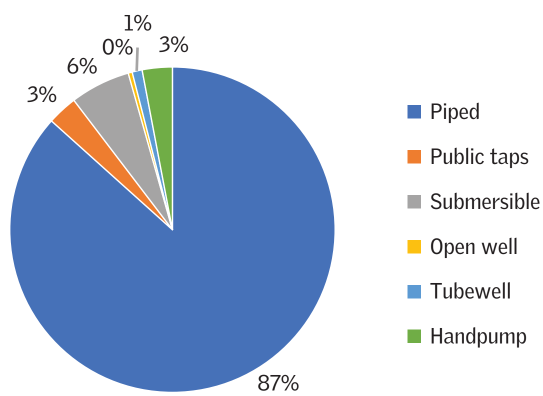
During the key informant interview (KII), the Executive Officer of the BNPP stated that the municipality currently has no regulatory framework, by-laws, or controls governing groundwater extraction at the household level.

Sources of water supply in Core Bijnor city

Deep borewells are extensively used across the city. Water is extracted using pumps and stored in overhead tanks before being supplied to households. According to the Jalkal Department, the core city of Bijnor is currently supplied water through 33 tubewells, with two more tubewells expected to be added in the coming months. Chlorine is mixed with the water through dosing systems installed at all tubewells, after which the treated water is pumped and stored in 12 overhead tanks (OHTs) located within the core city. Overall, around 17.5–20 MLD of water is supplied daily.

KII with water works department revealed that 75 per cent of the HHs have piped water supply in the BNPP. However, primary surveys concluded that 87 per cent of the respondents have piped water supply in their houses (see *Graph 1*). As shown in the graph, the second largest primary source of water was private submersibles pumps (used by 6 per cent of the population).

Graph 1: Water supply scenario in Bijnor



Source: City Sanitation Plan Bijnor compiled by CSE, 2018

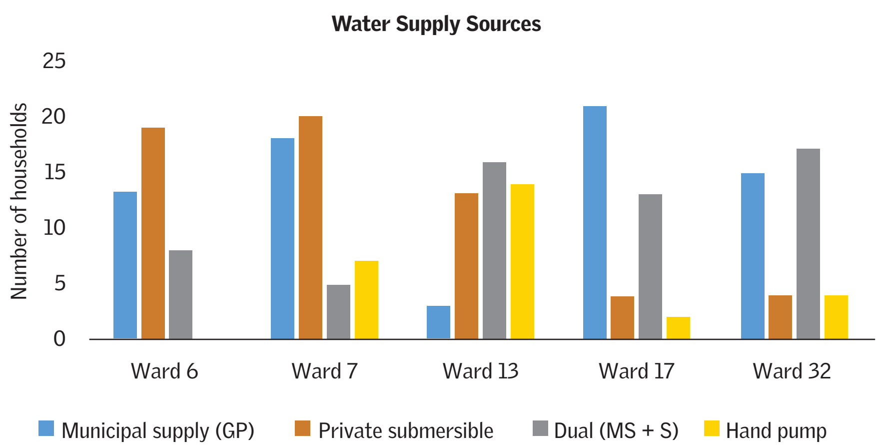
Sources of water supply in transitional villages

In Bijnor, the recent expansion of the municipal boundary to include peri-urban villages has significantly altered both the spatial extent and functional demands of the city's water supply system. While piped water infrastructure exists across parts of the city, service delivery in the newly added wards remains uneven and intermittent, and is heavily supplemented by private groundwater abstraction.

Bijnor's water supply system is primarily based on groundwater abstraction, with limited supplementation from surface water sources, as detailed in the city's Detailed Project Report (DPR). The municipal network was originally designed to serve the pre-2021 urban area, with trunk mains and distribution pipelines largely concentrated within the core city. As a result, peri-urban villages added to the Nagar Palika Parishad (NPP) remain only partially integrated into the formal urban water supply system.

The data gathered from surveys reveal that there are five dominant sources of water, which includes municipal supply (GP), private submersible, dual (municipal + submersible) and hand pump—across all five wards (6, 7, 13, 17 and 32). The transitioned peri-urban area still receives water from three elevated service reservoirs (ESRs) and four OHTs situated in rural villages, however it cannot be defined which ESR serves how much area and how much peri-urban area is being served by ESRs situated in the BNPP jurisdiction.

Graph 2: Households dependency on water sources in studied wards



Source: Household survey; compiled by CSE

The graph above shows (see *Graph 2*) that household supply conditions vary significantly across wards, as observed during the field survey:

- **Wards 17 and 7** show relatively higher dependence on Gram Panchayat like piped supply, particularly in older and more consolidated residential clusters. These piped water schemes were commissioned prior to the administrative expansion and continue to function largely unchanged, despite now falling under the jurisdiction of the ULB. Key characteristics of these legacy GP systems include approximately 55 liters per capita per day (LPCD) supply for about four hours per day, typically divided into two hours each in the mornings and evenings.
- **Ward 32** (**Ladapura village**) has partial piped water coverage, with pipelines largely confined to main roads and denser settlement pockets.

- **Ward 13** exhibits limited and fragmented coverage, with several habitations relying almost entirely on groundwater sources.
- In **Ward 6**, the presence of the railway line and surrounding industrial land use has constrained both historical and current expansion of the piped network.

In wards such as Ward 13 and Ward 32, piped coverage is fragmented and largely confined to main roads. Interior habitations are almost entirely dependent on groundwater. In contrast, Ward 17 and Ward 6 show relatively higher piped coverage. However, even in these wards, households rely heavily on private abstraction to meet domestic, livestock, and commercial needs.

All the wards have borewells ranging from 120 to 220 feet deep in their household premises and extract the groundwater whenever it is required through submersible pump.

Technically, water supply coverage in peri-urban Bijnor appears moderate on paper but remains weak in practice. This reflects unmet demand and unreliable pressure.

Per capita water supply and consumption in Core Bijnor city

According to the declaration submitted by the BNPP to the 14th Finance Commission, the city receives an average water supply of approximately 138.68 liters per capita per day (LPCD), which is slightly higher than the Service Level Benchmark (SLB) of 135 LPCD prescribed for urban water supply supplied for 20 hours per day. In terms of the data related to non-revenue water (NRW), the team was not able to get appropriate information, hence it is not considered for water supply calculations.

However, calculations based on primary survey findings indicate a discrepancy between the reported and estimated figures (see *Table 4*). When the per capita supply is recalculated based on the population actually served by the piped water supply system, the effective water supply in the city is estimated to be around 174 LPCD.

Per capita water supply and consumption in transitional villages

based on primary household surveys conducted in the BEA, per capita water consumption in the transitional villages is estimated to range between 100–150 LPCD. Graph 3 demonstrates clear disparities in water supply hours across peri-urban wards, suggesting uneven infrastructure coverage and service delivery.

Table 4: Per capita water supply and consumption in Core Bijnor city

Attribute	Calculation/BNPP Data
A) Population served	
Total properties in the BNPP	16,902
Coverage of piped water supply	75 per cent
Estimated households served	16,902 × 0.75 = 12,676 households
Average family size	5.82 persons
Estimated population served	12,676 × 5.82 = **73,777 persons**
B) Water demand based on reported LPCD	
Reported per capita water supply	138.68 LPCD
Estimated water demand	73,777 × 138.68 LPCD = **10.3 MLD**
C) Actual water supplied by the BNPP	
Total water supplied	**12.85 MLD**
Additional water pumped beyond calculated demand	**12.85 – 10.3 = 2.55 MLD**
D) Recalculated per capita water supply	
Water supplied	12.85 MLD
Population served	73,777
Actual per capita supply	**12.85 MLD ÷ 73,777 = 174 LPCD**

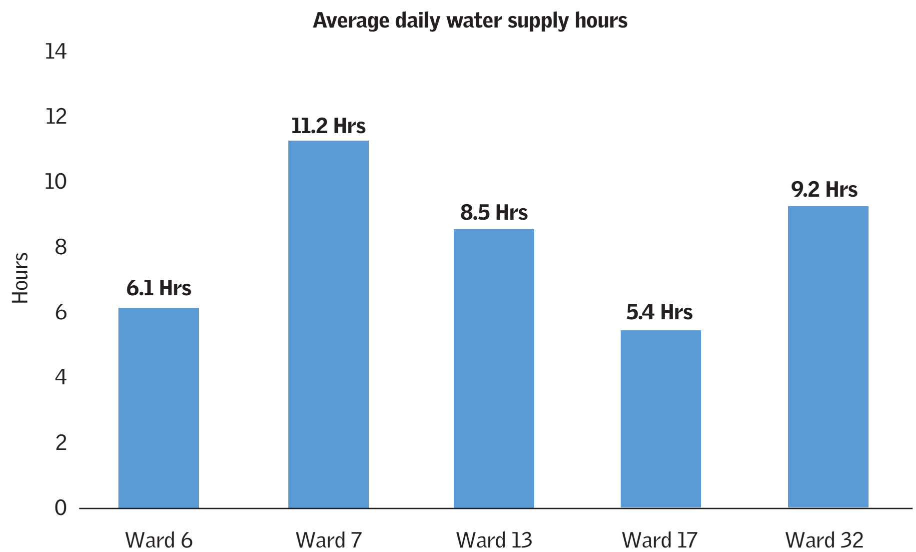
Source: Compiled by CSE

Among the surveyed wards, Ward 7 receives the longest average water supply duration at approximately 11.2 hours per day, indicating relatively better access to water services compared to other areas. Ward 32 follows with an average of about 9.2 hours, while Ward 13 receives around 8.5 hours of supply daily, suggesting moderate availability.

Ward 6 and Ward 17 experience comparatively shorter supply durations, receiving approximately 6.1 hours and 5.4 hours per day, respectively. Ward 17 records the lowest supply duration among the surveyed wards, reflecting greater limitations in water availability and reliability.

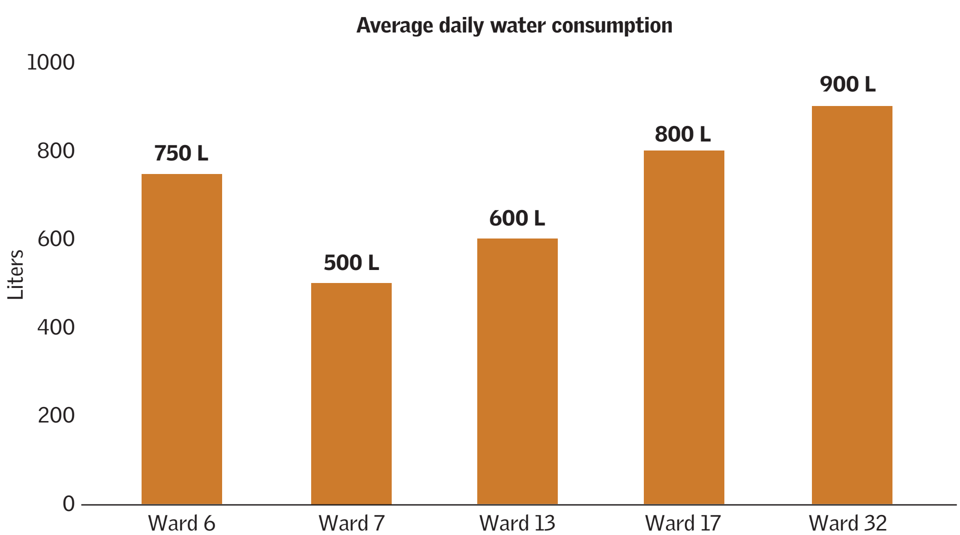
The graph below (see *Graph 3*) illustrates the average daily duration of water supply (in hours) across five selected wards in the Bijnor Extended Area (BEA), highlighting significant variations in supply reliability between locations.

Graph 3: Average daily water supply hours



Source: Household survey; compiled by CSE

Graph 4: Average daily water consumption



Source: Household survey; compiled by CSE

Across all surveyed wards, the majority of households reported daily water consumption between 500 and 900 liters per household, as illustrated in the graph above (see *Graph 4*).

Assuming an average household size of five members, this translates to an approximate per capita consumption of 100–150 liters per capita per day (LPCD). The estimation is also informed by the observed dependence on household water storage systems, as nearly all surveyed households rely on storage tanks to manage intermittent water supply. The supply duration varies significantly across the wards. While some households have access for several hours, others are restricted to a very short window.

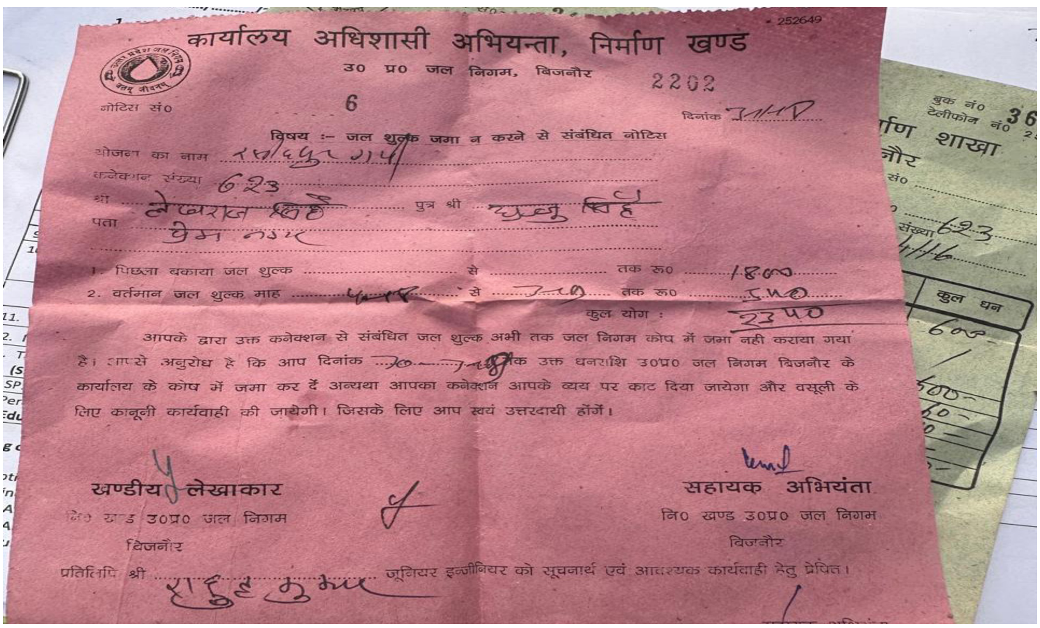
The most commonly observed storage capacities are 500 liters and 1,000 liters. However, in Ward 6 and Ward 17, larger storage tanks ranging from 2,000 to 3,000 liters are more prevalent. The presence of larger storage infrastructure in these wards likely reflects a coping strategy adopted by households to buffer against limited supply hours and irregular water availability. These systems remain the primary formal source of piped water for many households in the newly added peri-urban wards, highlighting a transitional phase where rural service standards persist within an urban administrative framework.

As a result, water access in BEA is characterized by lower per capita availability, higher dependence on storage infrastructure, and greater variability in supply reliability. Additionally, Gram Panchayat era piped water systems continue to operate across all five wards. These systems were designed for rural service norms of approximately 55 LPCD with limited supply duration of around four hours per day. Household surveys also indicate that while piped connections exist in most settlements, over 70 to 80 per cent of households across wards supplement municipal supply with private submersible pumps.

Community water use practices and user perceptions
During field visits community as well as concerned officials highlighted quantity as well as quality related issues. Households primarily depend on a mix of municipal supply and groundwater through submersible pumps, often using more than one source to secure safer drinking water. In the few wards, municipal water supply doesn't have much frequent quality issues but it is not supplied regularly hence seems to be less reliable source whereas groundwater seen as an easy getting option, most common across the selected wards but often affected by hardness, turbidity, and unpleasant odour, reducing public confidence.

Concerns over water quality have shaped household behaviour, with many residents preferring to store water and selectively use it for drinking and cooking. A few households reported incidences of waterborne illness, which has further heightened awareness of quality-related risks. In response, some households have adopted household-level treatment methods, mainly RO systems, despite the added financial burden, while others continue using untreated water due to cost constraints or long-standing practices. Overall, community perceptions indicate that water quality remains a key concern, and households rely on individual coping mechanisms to manage perceived health risks linked to drinking water.

Users generally pay a flat fee (often Rs 50/month or approximately Rs 600/year) (see image *Water bill from Ward 17 peri-urban area*). There is a general willingness to transition to the Bijnor Municipal system if it promises the higher urban standard of 135 LPCD and better pressure, as current legacy lines often suffer from low pressure during the brief supply hours.



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कार्यालय अधिशासी अभियन्ता, निर्माण खण्ड

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दिनांक

विषय :– जल शुल्क जमा न करने से संबंधित नोटिस

योजना का नाम

कनेक्शन संख्या 623

श्री .... पुत्र श्री ....

पता

1. पिछला बकाया जल शुल्क .... से .... तक रू0 1800

2. वर्तमान जल शुल्क माह .... से .... तक रू0 540

कुल योग : 2340

आपके द्वारा उक्त कनेक्शन से संबंधित जल शुल्क अभी तक जल निगम कोष में जमा नही कराया गया है। आपसे अनुरोध है कि आप दिनांक .... तक उक्त धनराशि उ0प्र0 जल निगम बिजनौर के कार्यालय के कोष में जमा कर दें अन्यथा आपका कनेक्शन आपके व्यय पर काट दिया जायेगा और वसूली के लिए कानूनी कार्यवाही की जायेगी। जिसके लिए आप स्वयं उत्तरदायी होंगें।

खण्डीय लेखाकार
नि0 खण्ड उ0प्र0 जल निगम
बिजनौर

सहायक अभियंता
नि0 खण्ड उ0प्र0 जल निगम
बिजनौर

प्रतिलिपि श्री .... जूनियर इन्जीनियर को सूचनार्थ एवं आवश्यक कार्यवाही हेतु प्रेषित।

Water bill from Ward 17 peri-urban area

3.2 Sanitation: Wastewater and faecal sludge management

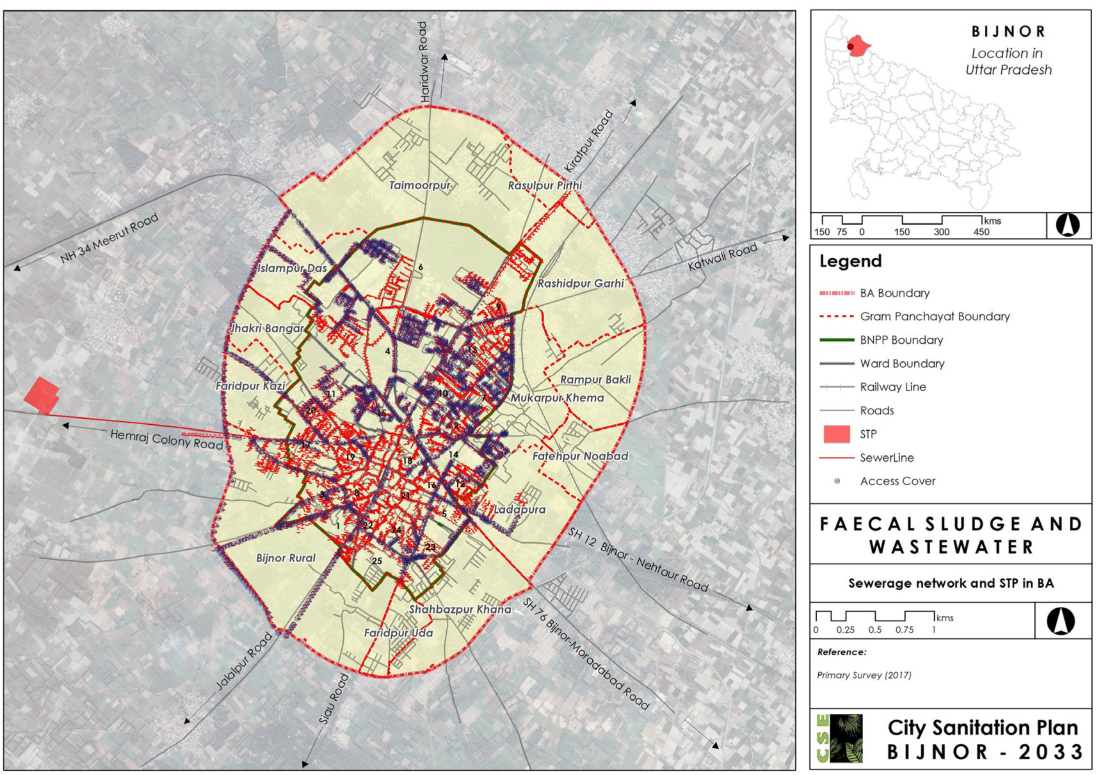
Wastewater and faecal sludge management (FSM) is a critical component of achieving citywide sanitation outcomes. In Bijnor, sanitation service delivery has struggled to keep pace with the city's expanding administrative boundaries. Since the inclusion of peri-urban villages into the municipal limits in 2021, the Nagar Palika Parishad (NPP) has faced increasing challenges in managing wastewater and faecal sludge across a larger and more heterogeneous urban landscape.

3.2.1 Sewerage network coverage and treatment infrastructure

Sewerage network coverage and treatment infrastructure in core Bijnor city: Bijnor district lies within the Ganga catchment area and is characterized by gentle regional slopes that facilitate gravity-based drainage. Under the Bijnor Sewerage Scheme, a sewerage project with a 24 MLD sewage treatment plant (STP) was approved in 2009. Construction of approximately 80 km of gravity-based sewer network commenced in 2010, followed by the construction of the STP in 2015. The plant was commissioned in 2019. Due to funding constraints, household sewer connections were not provided, and wastewater is discharged in the open drains carrying mixed wastewater (greywater and blackwater). By the time sewer networks and treatment facilities become operational, city populations and spatial extents have already expanded, leaving large areas dependent on OSS. In Bijnor, more than 95 per cent of the core city population relied on OSS as per the 2020 Shit Flow Diagram.

Following directions from the National Green Tribunal in the notification to improve STP utilization, Bijnor NPP implemented interception and diversion of open drains as an interim measure. Seven interception points were constructed

Map 4: Faecal sludge and wastewater network in Bijnor



Source: City Sanitation Plan, Bijnor, 2018 in 2019, and the total number has since increased to 17. These interventions have significantly increased inflow to the 24 MLD STP located at Kherki village (see *Map 4*). As a result, only wastewater flowing through open drains—primarily greywater mixed with some blackwater—is conveyed to the centralized STP through interception and diversion structures. Several sewer lines that were constructed but remained inactive prior to municipal expansion were operationalized in 2022 to align with existing drainage patterns and slopes.

Sewerage network coverage and treatment infrastructure in transitional villages:

Nearly 100 per cent of the peri-urban villages added in 2021 depended on OSS (City Sanitation Plan, 2018). Ladapura village (Ward 32) is the only peri-urban settlement partially covered by sewer lines. However, due to the absence of household sewer connections, blackwater is not conveyed through the sewer network. Instead, households discharge blackwater into OSS, with effluent released into open drains (see image *Household wastewater outlets in ward 7*).

Household wastewater outlets in Ward 7

During the field survey, multiple rounds of focus group discussions (FGDs) and key informant interviews (KIIs) were conducted with STP staff, sewer in-charge personnel, STP operators, and sanitation workers of NPP Bijnor. These interactions provided critical operational insights into wastewater flow patterns, interception points, and conveyance routes. Based on these discussions, along with field observations, indicative estimates of wastewater quantities and conveyance coverage from the selected wards were derived.

- **Ward 17:** Approximately 80 per cent of wastewater is intercepted at three locations and conveyed to the STP via gravity. The remaining wastewater accumulates in areas lacking adequate drainage (see image *Wastewater accumulation in ward 17*).
    - o The wastewater from this ward is tapped at three locations, namely, the gates of Shantiniketan Colony near Saint Mary's School; Sahitya Vihar Colony near Vardhman College and near Gopal Hospital.
- **Ward 6:** No wastewater reaches the STP. Around 50 per cent accumulates in the Nawab ka Hatta area, while the remainder drains eastward towards the Choya River flowing nearly 5 km east of city center.

Wastewater accumulation in Ward 17

- **Ward 13**: Nearly 100 per cent of wastewater collects in a pond near the cremation ground. In addition 25 to 30 per cent of wastewater from ward 03 and ward 11 is making its way through a railway underpass drain (see image *Railway underpass drain in Ward 13*).

Railway underpass drain in Ward 13

- **Ward 32:** Only 15–20 per cent of wastewater reaches the STP via intercepted drains. Most wastewater accumulates in open land behind Healers Hospital and other vacant plots (see image *Wastewater accumulation in plots and open land, (upper two images) and wastewater interception (bottom two images) in ward 32*).
    - o The interception of drains is done in front of UP Jal Nigam Office in Ladapura village.

Wastewater accumulation in plots and open land, (upper two images) and wastewater interception (bottom two images) in Ward 32

Wastewater accumulation in empty plot (left) and wastewater interception point in Ward 7 (right)

Ward 7: Approximately 60 per cent of wastewater reaches the STP through a natural drain intercepted near the plant. The remainder accumulates in areas without drainage infrastructure, particularly in Chamunda Dham Colony (see image *Wastewater accumulation in empty plot (left) and wastewater interception point in ward 7 (right)*).

- The wastewater from Ward 7 is tapped and merged into sewer line going to STP at Chamunda Mandir.

FGDs with STP staff revealed that the plant has been operating close to full capacity since the municipal expansion. During monsoon periods, conditions worsen due to large volumes of stormwater and solid waste entering the system via open drains, leading to frequent choking of trunk sewers and flooding within the STP premises. Although the STP was designed to cater to projected flows up to 2025, effective capacity utilization was achieved as early as 2022.

3.2.2 Onsite sanitation practices in peri-urban Bijnor

The spatial expansion of Bijnor and its peri-urban villages has predominantly occurred towards the eastern and north-eastern directions. Except along the southern and south-western municipal boundaries, most newly added settlements exhibit growth patterns oriented towards the core city. This trend is evident in villages such as Taimoorpur, Mukurpur Khema, and Rashidpur Garhi, which show accelerated urbanization.

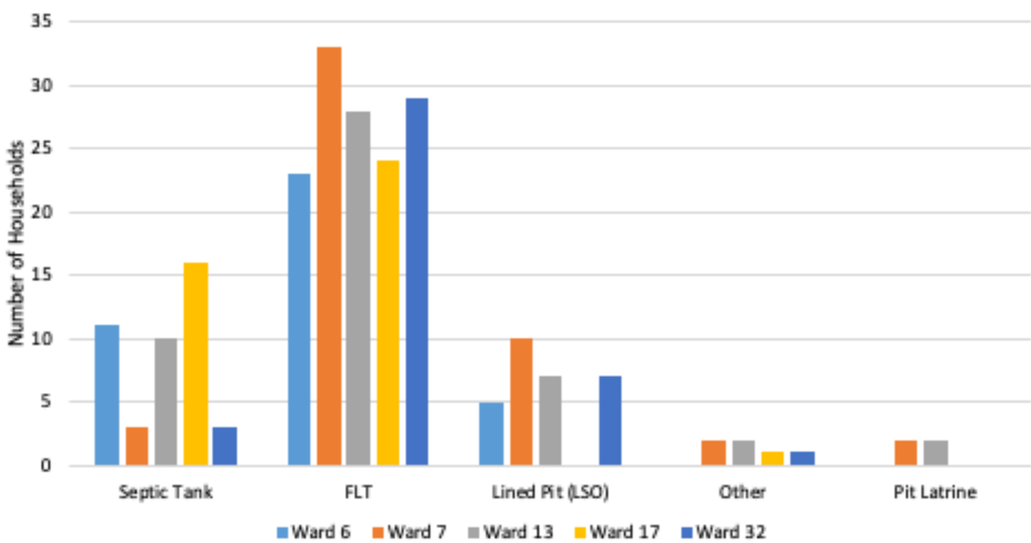
Field observations indicate that sanitation practices in these peri-urban areas are evolving alongside increasing urban characteristics.

Key constraints affecting sanitation service delivery include limited underground sewerage coverage, the physical barrier posed by the railway line dividing the city, wastewater generation exceeding supplied water volumes due to widespread use of private submersibles and handpumps, and narrow internal lanes that restrict access for desludging vehicles. As a result, a substantial proportion of the city—particularly the newly added peri-urban areas—continues to depend on on-site sanitation systems (OSS).

3.2.2.1 Containment

While northern wards such as 17 and 6 predominantly use septic tanks and fully lined containment systems, wards such as 13 and 32 still exhibit a mix of semi-lined pits, lined pits with open bottoms, and twin-pit systems.

Graph 5: Comparison of containment typologies in studied wards



Source: Household survey; compiled by CSE

Ward 17

A total of 41 households were surveyed across all localities of Ward 17. Approximately half of the ward formed part of the original municipal boundary and is fully covered by the sewer network.

All 100 per cent households reported having individual toilets, with both cistern-flush and pour-flush systems in use. Containment structures are fully lined tank (55 per cent) is the most common toilet connection type followed by septic tank (40 per cent) is the second most common. Only 1 household (2.5 per cent) is connected to unlined pit. The size of the tanks show moderate uniformity, with most units built around medium dimensions (approximately 6 × 5 × 7 ft range). Very few extremely small or very large structures exist, indicating general consistency in construction practices.

Containment structures typically discharge effluent into open drains, while in some cases outlets discharge directly into open plots or low-lying areas. No public or community toilets were observed within the ward.

Around 72 per cent of households have emptied their tanks using desludging services, predominantly relying on private operators (~92 per cent) rather than government services. Among private users, mechanical desludging is common (~81 per cent), though manual emptying still persists (~19 per cent), highlighting ongoing safety and sanitation concerns.

Ward 6

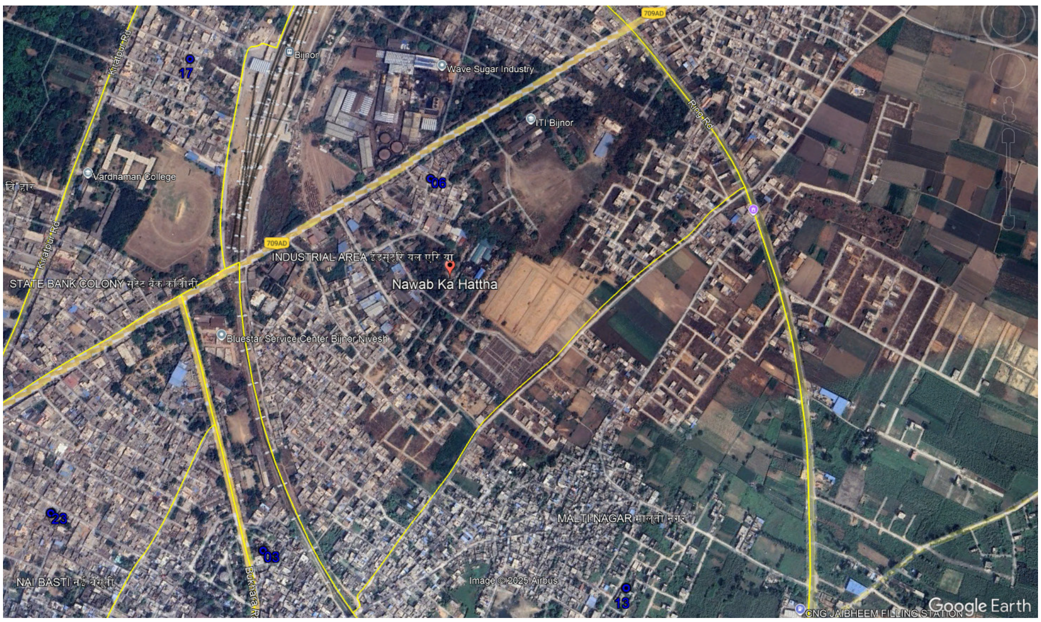
Ward 6, located to the north-east of Bijnor and separated from the core city by the railway line, includes a substantial industrial estate and sugar mill colony. Approximately 40 households were surveyed.

Approximately 95 per cent of households reported having an individual household toilet, while only about 5 per cent reported no in-house toilet access. Regarding containment systems, fully lined tanks account for 63 per cent, followed by septic tanks at about 25 per cent, while lined pits (semi-permeable) constitute less than 10 per cent. Unlined pits are negligible (around 2 per cent), indicating a strong preference for safer containment options. The size of the tanks show moderate uniformity, with most units built around medium dimensions (approximately 6 × 4 × 8 ft range) and less than 10 per cent representing very small or very large structures, reflecting broadly consistent construction practices across households.

Industrial housing areas consist of planned, gated colonies with uniform housing typologies. Open drains are present throughout these areas, carrying stormwater and greywater. Other residential pockets also exhibit predominantly urban characteristics, with universal household toilet coverage. Most households use lined containment systems discharging into open drains. No community toilets were observed, and only one public toilet exists near the railway station boundary.

Due to an atypical local slope towards the north-east, wastewater does not cross the railway line towards the core city. Instead, it accumulates in open lands, particularly around the Nawab ka Hatha area (see *Map 5*).

Map 5: Ward 6 – Google earth view



Source: Google Earth

Ward 13

Ward 13 lies on the eastern periphery of Bijnor, beyond the railway line, and exhibits the strongest rural characteristics among the surveyed wards. A total of 46 households were surveyed. Housing conditions are relatively poor, with congested settlements and narrow internal lanes (figure: showing narrow lanes of ward 13).

Nearly 98–100 per cent of households reported having an individual household toilet, with negligible absence of in-house sanitation. Toilets are primarily cistern- or pour-flush, connected to containments that discharge into open drains. There is only one public toilet exists near the railway line, and no community toilets were observed. In terms of containment systems, fully lined tanks account for about 53 per cent, followed by septic tanks at around 32 per cent, while lined pits with semi-permeable walls constitute roughly 12 per cent. Unlined pits remain minimal (3 per cent), reflecting a clear preference for safer and more durable containment options. Tank dimensions show moderate uniformity, with around 65–70 per cent of structures falling within medium size ranges (approximately 5 × 5 × 7 ft).

Containment outlets in open drain (top left); narrow lanes (top right) and Google Earth view (bottom) in Ward 13

Ward 32

Ward 32 largely comprises Ladapura village, where approximately 40 households were surveyed. Although sewer lines were laid under the Bijnor Sewerage Scheme, household connections are absent. Settlements are concentrated closer to the core city, reinforcing the tendency of peri-urban growth towards urban centres.

All 100 per cent of households have in-house toilets, which are predominantly pour-flush or cistern-flush systems, connected to on-site containment structures, with most outlets discharging into open drains. In terms of containment systems, fully lined tanks account for 73 per cent of connections, followed by lined pits with semi-permeable walls at 17 per cent, and septic tanks at 8 per cent. Lined impermeable pits account for 2 per cent, while unlined pits are absent. Tank dimensions show moderate uniformity, with 68 per cent of structures falling within medium size ranges (approximately 5 × 4 × 8 ft), indicating broadly consistent construction practices across households.

Ward 32 with areas having no wastewater drains

Ward 7

Ward 7 includes Chamunda Vihar Colony, Mohalla Jatan B, and informal settlements, with nearly 50 households surveyed. Around 60 per cent of the ward consists of vacant land, agricultural fields, or orchards.

3.2.2.2 Desludging practices and service arrangements

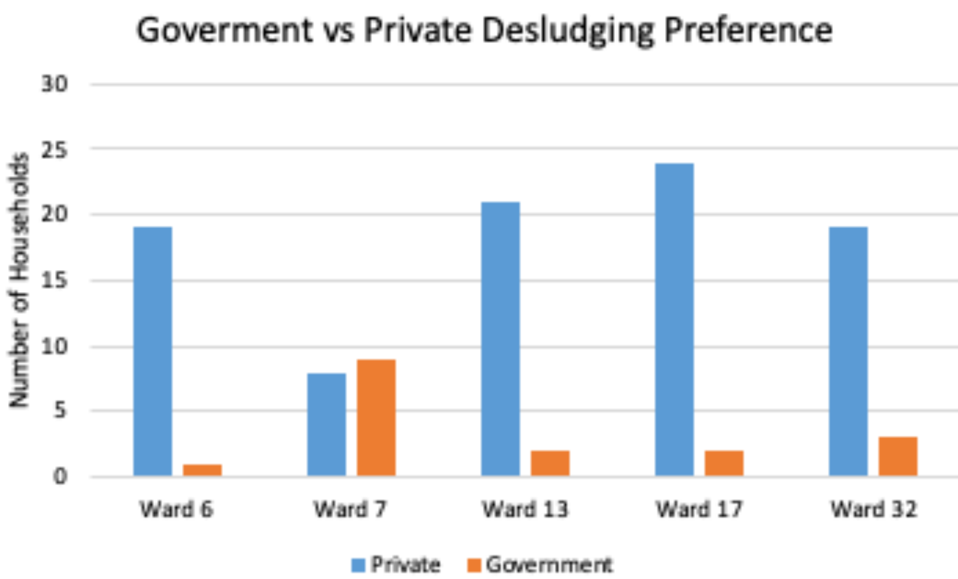
Desludging services in the surveyed wards are largely market-driven and dominated by private operators, with minimal municipal oversight. Households primarily rely on mechanical emptying using tractor-mounted vacuum tankers, which accounts for more than 80 per cent of desludging practices across most wards. The widespread adoption of mechanized emptying is a positive development from an occupational health and safety perspective, as it reduces the need for direct human contact with faecal sludge. However, these services currently operate largely outside a structured regulatory framework.

Households prefer private operators primarily due to their quick response time and easy accessibility, rather than cost considerations. Private desludging operators are typically locally based and widely advertise their services, often displaying contact numbers on electric poles and public spaces. As a result, residents can access services through a simple phone call, and vacuum tankers usually arrive within a few hours. In contrast, the municipal service requires a formal application process and often experiences delays, making private services more attractive during emergencies.

At present, desludging in Bijnor is reactive rather than scheduled, with most households seeking emptying services only when pits or tanks overflow or malfunction. Survey responses indicate that desludging intervals vary widely—from one to fifteen years, with many households reporting that their containment systems have never been emptied. This is particularly common in Ward 7 and Ward 32, where many houses have been constructed within the past five to eight years, or where larger containment systems delay the need for desludging. These patterns suggest that the current sanitation approach remains focused primarily on toilet construction rather than the long-term management of faecal sludge.

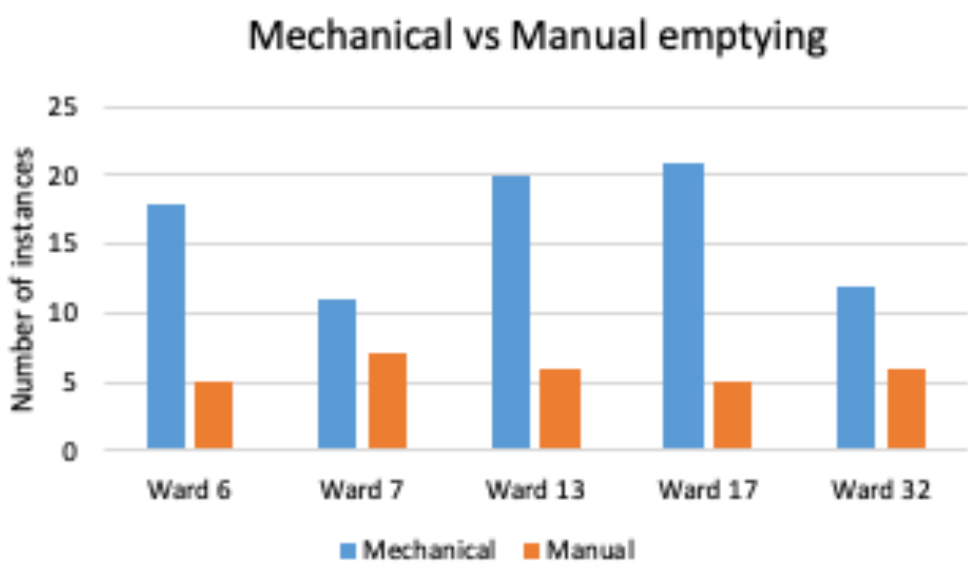
The BNPP currently operates one government vacuum tanker with a capacity of 5 KL, while five private operators are officially registered and licensed annually to provide desludging and transport services. Licensed operators are required to renew their permits each year through the payment of a license fee. All service providers are formally instructed to dispose of collected faecal sludge at the 20 KLD co-treatment facility located within the 24 MLD STP premises. However, discussions with private operators during focus group discussions revealed inconsistencies in actual disposal practices.

Graph 6: Government vs private desludging preference



Source: Household survey; compiled by CSE

Graph 7: Emptying methods



Source: Household survey; compiled by CSE

Although mechanical emptying is dominant, manual desludging continues to occur in specific situations where vacuum tankers cannot operate effectively. This is particularly common in lined pits with semi-permeable walls and open-bottom pits, where liquid infiltrates into the surrounding soil, leaving behind dense and compact sludge that is difficult to remove through suction. Manual emptying is also prevalent in low-income settlements with narrow lanes, where tanker access is physically restricted. In some cases, households resort to self-emptying pits and disposing of sludge on nearby farmland or vacant land, posing significant environmental and public health risks due to direct exposure to untreated faecal waste.

The cost structure of manual emptying further reflects these constraints. Manual desludging is charged based on pit depth, at approximately Rs 300 per foot, and requires a team of three to four workers. For a standard eight-foot pit, the total cost may equal or exceed that of mechanical desludging. Consequently, households usually opt for manual emptying only when mechanical services are not feasible.

Narrow lanes where mechanical desludging is not possible in Ward 13

3.2.2.3 Faecal sludge treatment and disposal

To address the growing demand for the safe management of faecal sludge and septage (FSS) within the city, a 20 KLD co-treatment unit was established as a dedicated component of the existing 24 MLD sewage treatment plant (STP) (see image *20 KLD co-treatment plant, Bijnor*).

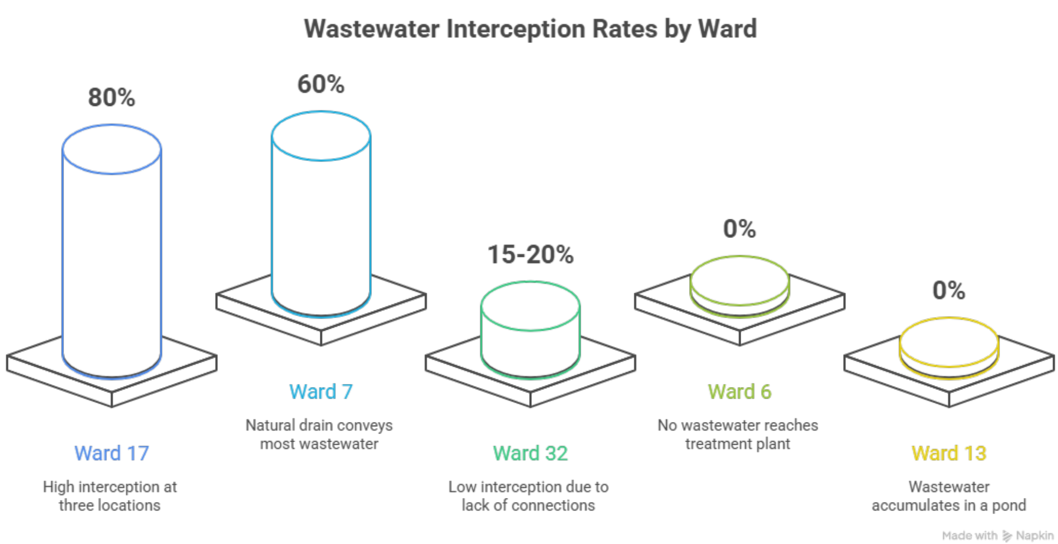
Commissioned in 2022, the unit has been operational for nearly three years; however, it is currently underutilized, operating at only 30 per cent of its installed

20 KLD co-treatment plant, Bijnor

capacity. Key informant interviews (KII) with the plant operator revealed a significant disparity in the utilization of this facility between public and private service providers. While government-operated vacuum tankers almost exclusively decant emptied septage at the treatment unit, private operators—who manage the bulk of the city's desludging—frequently bypass the plant to save on fuel costs and turnaround time. This issue is particularly pronounced in the geographically distant wards on the North and East sides of the city, such as Wards 6, 13, and 17, where the distance to the co-treatment site acts as a logistical and financial deterrent for private tankers.

Ward-wise wastewater flow analysis highlights stark spatial inequities. In Ward 17, approximately 80 per cent of wastewater is intercepted at three locations and conveyed to the sewage treatment plant, while the remainder stagnates locally. In Ward 7, around 60 per cent of wastewater reaches the sewage treatment plant via a natural drain, though internal pockets remain unserved. In Ward 32, only 15 to 20 per cent of wastewater reaches the sewage treatment plant despite the presence of sewer lines. This is due to the absence of household connections. In Ward 6, no wastewater reaches the sewage treatment plant and flows accumulate in Nawab ka Hatta or drain eastward. In Ward 13, nearly 100 per cent of wastewater accumulates in a pond near the cremation ground, which also receives inflows from adjacent wards.

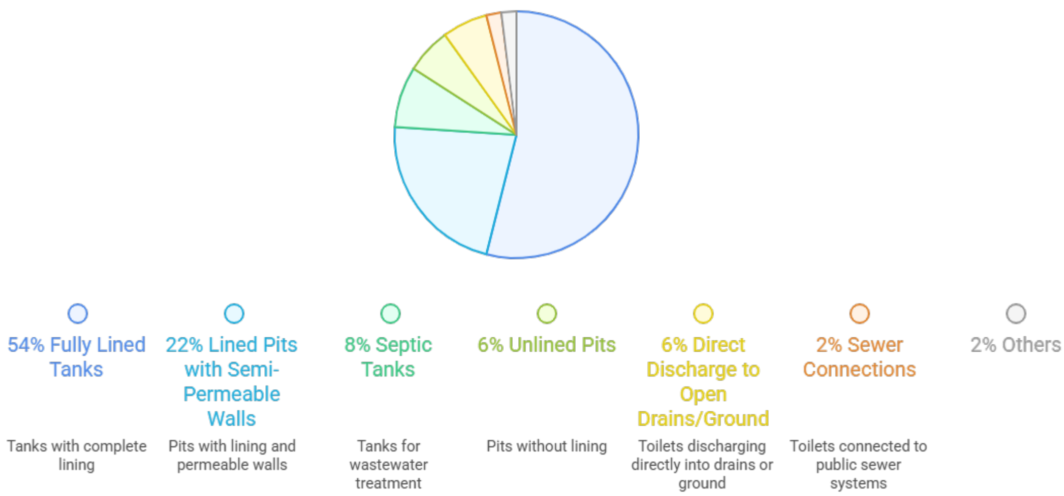
Figure 2: Wastewater interception rates by ward



Source: Compiled by CSE

All 100 per cent of households have in-house toilets, with mix of pour-flush or cistern-flush systems, connected to on-site containment structures, with most outlets discharging into open drains. In terms of containment systems, fully lined tanks constitute 54 per cent of connections, followed by lined pits with semi-permeable walls at 22 per cent, and septic tanks at 8 per cent. Unlined pits account for 6 per cent, direct discharge to open drains/ground accounts for 6 per cent, and sewer connections account for 2 per cent, indicating that a small but significant proportion of toilets remain linked to unsafe disposal pathways.

Figure 3: Distribution of toilet containment systems in Bijnor



Source: Household survey; compiled by CSE

Analysis of the household surveys across the five wards reveals a high degree of commonality in containment design, with a clear preference for impermeable structures. Ward 32 shows the highest adoption, with 72.5 per cent of households using FLTs. Ward 13 and Ward 7 follow closely, with FLTs making up over 60 per cent of containment systems. The preference for FLTs in these areas is a response to the high water table characteristic of Bijnor. Residents invest in concrete-lined bases and plastered walls to prevent groundwater from entering the tank (which would cause rapid filling) and to prevent raw sewage from leaching into the soil near their own hand pumps and submersibles.

Tank dimensions show moderate uniformity, with around 70 per cent of structures falling within medium size ranges (approximately 5 × 4 × 7 ft), reflecting largely consistent construction practices across households. Open drains are present but discontinuous, particularly in interior areas. Wastewater from the main road corridor is conveyed via a natural drain intercepted directly at the STP.

In terms of emptying, Ward 17 and Ward 13 show the highest rates of mechanization, with over 75 per cent of those who have emptied their tanks opting for vacuum tankers. Manual Emptying (MA) accounts for roughly 15–20 per cent of activity across the wards. This is often necessitated when the sludge has been left for too long (becoming too thick for pumps) or when households are located in narrow lanes"gallis" where a tractor-mounted tanker cannot reach.

From an operational standpoint, desludging services are almost entirely private sector driven. Over 80 per cent of households prefer private mechanized operators due to faster response times. While the BNPP has one government vacuum tanker and five licensed private operators, enforcement of disposal at the 20 KLD co-treatment unit remains weak. As a result, the facility operates at only around 30 per cent of its capacity, despite high desludging demand, particularly from distant wards.

A critical finding across all wards is the disposal of effluent. In Ward 17, nearly 95 per cent of containment systems have outlets connected directly to Open Drains (OD). Even in Ward 6 and Ward 32, connection to open drains exceeds 80 per cent. This practice effectively turns stormwater drains into open sewers, creating a major environmental hazard in these newly urbanized zones.

Institutionally, faecal sludge management remains disconnected from routine municipal monitoring, asset mapping, and financial planning. Emptying is reactive and occurs once every three to ten years. There is no scheduled desludging framework or digital tracking of sludge movement.

3.3 Stormwater and drainage management

Bijnor's recent urban expansion, marked by the incorporation of peri-urban villages into the municipal boundary, has significantly increased pressure on the city's stormwater and drainage systems. These areas were historically rural, relying on natural drainage channels, open ponds, and agricultural fields to manage runoff. Rapid land-use changes, growing built-up areas, and a sharp increase in impermeable surfaces have disrupted these natural systems, resulting in higher surface runoff, frequent waterlogging, and localized flooding. In this context, this section presents a holistic assessment of existing stormwater and drainage conditions, identifies key challenges, which will help in outlining feasible project and planning interventions aligned with sustainable and climate-resilient stormwater management principles.

Bijnor falls within the humid sub-tropical climatic zone, experiencing distinct summer, monsoon, and winter seasons. Summers extend from April to June, with maximum temperatures ranging between 40°C and 42.5°C. The south-west monsoon typically begins in early June and continues until September, bringing the bulk of the annual rainfall. Winters occur between December and February, with temperatures occasionally dropping to near-freezing levels; minimum temperatures as low as 1.5°C have been recorded, along with dense fog during January that frequently disrupts daily activities.

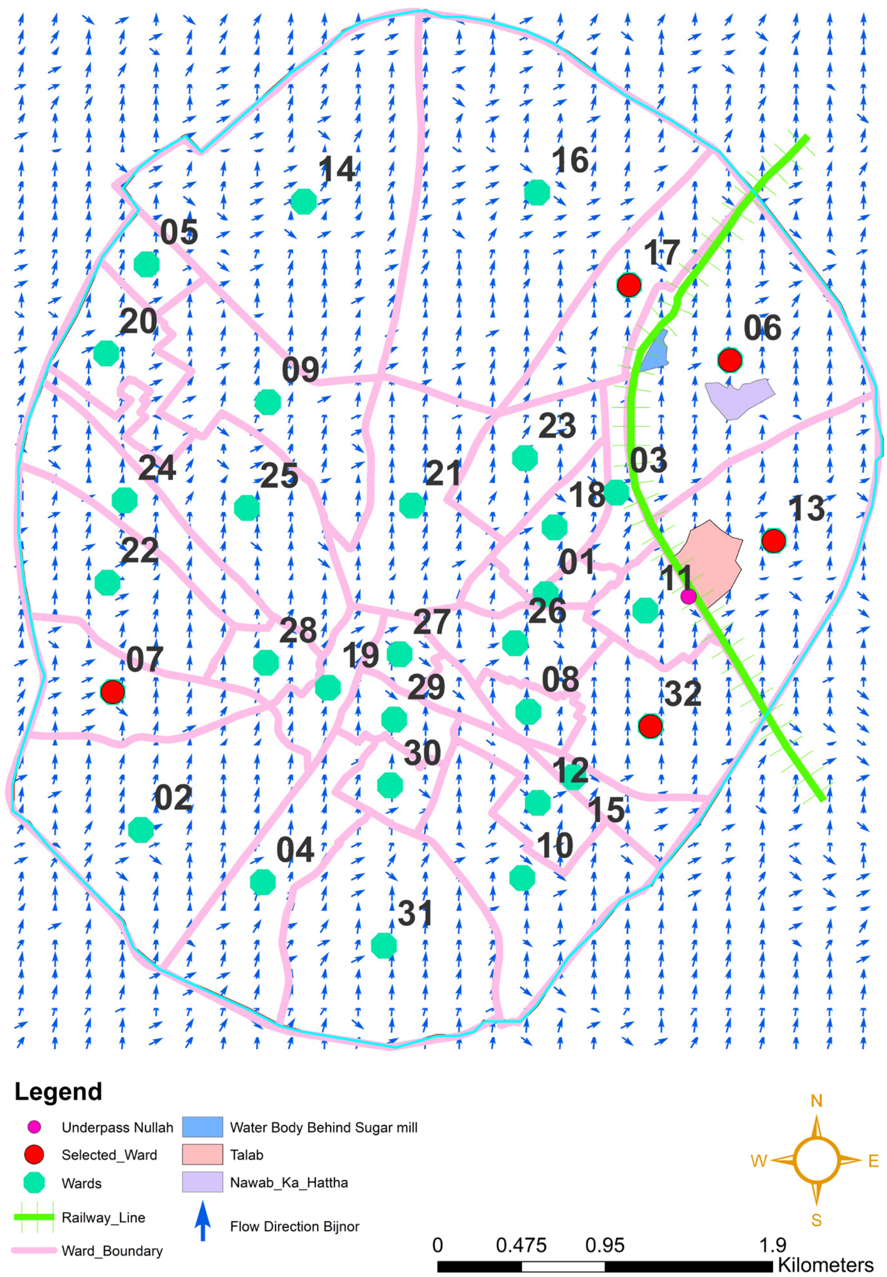
Bijnor receives an average annual rainfall of approximately 1,106.85 mm, close to the national average. Nearly three-quarters of this rainfall occurs during the monsoon months, leading to short-duration, high-intensity precipitation events. Such seasonal concentration of rainfall directly influences surface runoff generation, drainage design requirements, and the frequency of flooding and waterlogging, particularly in newly urbanizing peri-urban areas where drainage infrastructure remains underdeveloped.

Physiographically, Bijnor lies within the Indo-Gangetic Plains, characterized by flat to gently sloping terrain formed by alluvial deposits of the Ganga river system. The area has fertile soils, shallow natural gradients of approximately 0.2 m per kilometer, and is interspersed with ponds, canals, and riverine channels. While these features support agriculture and groundwater recharge, the low slopes and increasing alteration of natural drainage paths heighten vulnerability to surface water stagnation during heavy rainfall. A clear understanding of these climatic and physiographic conditions is therefore essential for planning effective stormwater drainage networks and implementing climate-resilient flood management strategies for Bijnor's expanding urban and peri-urban areas.

The map below (see *Map 6*) illustrates surface drainage and flow patterns across Bijnor city, divided into 32 administrative wards. Blue arrows indicate the direction of surface water movement, while key physical features such as the eastern railway line, identified water bodies (including a talab, a water body behind the sugar mill, and an underpass nullah near Ward 11), and local landmarks like Nawab Ka Hattha provide important spatial context.

Overall, drainage flow in Bijnor shows a dominant movement from the northern areas toward the south and south-east. Western wards such as Ward 07 generally drain southward and south-eastward, while variations appear near the railway line in the north-east—Ward 17 (west of the railway line) shows south-westward flow, whereas wards east of the railway line (Wards 06 and 13) consistently drain toward the south-east. This south-eastward trend continues in the lower parts of the city, including Ward 32, indicating a largely uniform citywide surface flow pattern influenced by infrastructure and terrain.

Map 6: Flow direction map – Bijnor



Source: Prepared by CSE

Existing drainage infrastructure, coverage and functional performance in transitional villages

Bijnor currently lacks a dedicated and integrated stormwater drainage network. As per the field observations, the peri-urban villages recently added to the municipal area have no separate system for stormwater conveyance; instead, roadside drains function as multipurpose channels carrying stormwater along with greywater and, in many cases, household blackwater. These drains are often without proper outlets, leading to frequent stagnation of water. Many of these settlements do not have formally designed drains, natural drainage paths have been blocked by unplanned construction, and there is no defined stormwater routing plan. Wastewater overflow is commonly discharged directly into open drains, further compounding the problem.

The physical condition of the existing drainage infrastructure is also poor. The roadside drains are narrow, discontinuous, and damaged at notable locations, restricting flow and causing waterlogging during the monsoon season. In the newly added peri-urban wards, where drains are often kutcha or only partially constructed, these deficiencies are even more pronounced. The drains are not properly designed to handle high flow or fast-moving runoff. They do not have adequate slopes or gradients and sometime gets clogged due to silt and solid waste. Additionally, frequent crossings such as culverts block the drains, further reducing their capacity to carry water.

Compounding these structural and design issues is the mixing of stormwater with greywater and wastewater in open drains, as highlighted in the City Sanitation Plan (CSP) as well. During rainfall events, this mixed flow increases health and environmental risks in peri-urban areas, as residents are directly exposed to contaminated water. The presence of wastewater accelerates silt deposition, reduces hydraulic efficiency, and generates strong foul odors. Stagnant and slow-moving water in these drains also creates favorable conditions for mosquito breeding, exacerbating public health concerns.

Ward-wise observations from the primary survey reveals the following data:

Ward 6

- About 88 per cent of households have drains nearby, while nearly 12 per cent remain unserved, indicating last-mile gaps and the absence of roadside drains along some streets.
- 100 per cent household connections discharge into open, man-made drains; no covered or natural drains were observed, resulting in direct exposure of

wastewater to the environment.

- Nearly 95 per cent of drains carry mixed wastewater (stormwater, greywater, and blackwater) due to the absence of separate systems; drains along Gyan Vihar Street were observed carrying substantial blackwater.
- Drain design and condition are poor, with narrow sections, uneven slopes, damaged stretches, heavy siltation, and chokepoints at culverts and covered segments, leading to reduced carrying capacity and stagnation.

Plot filled with overflowing drain (top left) and open drains (top right); drain filled with effluent coming from household(bottom left); Bio-remediation plant on drain (bottom right) – Ward 17

- Solid waste dumping and encroachments are widespread, with 72.5 per cent of households reporting visible waste accumulation, contributing significantly to choking and overflows.
- Several drains lack proper outfalls and terminate in low-lying plots, creating pond-like conditions and localized waterlogging.
- Flooding impacts are localized but recurrent: 37.5 per cent of households experience flooding during rainfall, around 10 per cent face post-rain waterlogging lasting from 1 hour up to 24 hours, while 52.5 per cent reported no flooding.
- Foul odours from drains were reported by about 67–70 per cent of households, indicating stagnation and high organic loading.
- Drain cleaning and maintenance are uneven and largely reactive; 75 per cent reported weekly cleaning, 5 per cent monthly cleaning, while 20 per cent stated drains are never cleaned.
- Only about 5 per cent of households reported that drain-related issues are resolved within 5–7 days, with most unable to specify a clear response timeframe.
- Around 55 per cent of households depend solely on government cleaning services, while others resort to self-cleaning or private cleaners, reflecting informal coping mechanisms.
- Nearly 90 per cent of households do not pay for drain cleaning; limited expenditures (Rs 40–Rs 200) occur mainly during emergencies or private interventions.
- Poor maintenance, especially in covered drain sections, has resulted in unhygienic conditions, mosquito breeding, and associated public health risks.
- Field observations also noted instances of chemical effluents being discharged into open drains and a dysfunctional bioremediation unit, indicating ineffective pollution control and weak O&M practices.

Ward 13

- Around 90 per cent of households reported the availability of drains near their houses, while about 10 per cent lack any nearby drainage facility, indicating relatively high but incomplete drainage coverage.
- All households with drainage access are connected to open, man-made drains, with no covered or natural drains observed, reflecting complete dependence on open drainage infrastructure.
- Drains largely function as open sewers: 96 per cent of households reported mixed wastewater (stormwater combined with toilet, bathroom, and kitchen wastewater), while the remaining drains carry stormwater mixed with greywater only.

- Stormwater drains also receive inflows from upstream nullahs of adjacent wards, significantly increasing hydraulic and pollution loads.
- Drain design and construction are substandard, with predominantly narrow, lined drains not conforming to engineering norms, resulting in limited carrying capacity.

Bio-remediation plant on open drain (top left); solid waste choked open drain (top right); narrow lanes and open drains (bottom left); multiple outlets coming on open drains in Ward 13 (bottom right)

- Heavy accumulation of solid waste and sediments was widely observed; 64 per cent of households reported regular waste trapping and 24 per cent reported occasional accumulation, making solid waste dumping a major cause of choking.
- As a result of reduced capacity, flooding is common during rainfall: 56 per cent of households experience flooding while it is raining, and nearly 36 per cent face post-rain waterlogging lasting from 1 hour to several days.
- Foul odours from drains are widespread, with about 80 per cent of households experiencing regular or occasional smells, consistent with stagnant mixed wastewater conditions.
- Operation and maintenance practices are uneven and reactive: cleaning is reported as weekly by 46 per cent of households, monthly by 20 per cent, daily or alternate days by 14 per cent, while 20 per cent stated that drains are never cleaned.
- In case of drain choking, 54 per cent of households rely solely on government cleaning services, while the remaining households resort to self-cleaning or private cleaners, indicating informal coping due to inconsistent service delivery.
- Most households (82 per cent) do not pay for drain cleaning, while 18 per cent incur out-of-pocket expenses of Rs 100–Rs 200 during emergencies or when engaging private cleaners.
- The time taken to resolve drain-related issues is largely unclear to households, suggesting the absence of a defined grievance redressal mechanism or service response timeline.
- Drains were observed to discharge directly into ponds and low-lying water bodies, leading to the accumulation of untreated sewage and sludge and contributing to environmental degradation.
- Field observations noted stagnant sewage, uncontrolled household outlets, non-functional bioremediation systems, and poorly maintained drain sections, posing public health risks, potential groundwater contamination, and highlighting systemic design and O&M gaps.

Ward 17

- 100 per cent of households reporting the availability of drains near their houses, indicating comprehensive physical coverage in the surveyed area.
- The drainage system is entirely open in nature: 90.2 per cent of households are connected to open man-made drains and 9.8 per cent to open natural drains; 0 per cent covered drains were observed.
- Drains largely function as informal combined sewers, with 95.1 per cent of households reporting mixed wastewater flow (stormwater combined with

toilet, bathroom, and kitchen wastewater), while 4.9 per cent reported stormwater mixed with greywater only.

- Despite being designated as stormwater drains, nearly 100 per cent of drains were observed to be contaminated with wastewater, indicating limited functional separation of flows.
- In cases of drain choking, 65.9 per cent of households rely on government cleaning services, 14.6 per cent engage private cleaners, and 19.5 per cent undertake self-cleaning, reflecting partial household-level coping mechanisms.
- Most households (92.7 per cent) do not pay for drain cleaning, while 7.3 per cent reported paying approximately Rs 100, mainly where private intervention was required.
- Resolution timelines for drain-related issues are unclear for the majority of households; less than 10 per cent reported issue resolution within about 24 hours, indicating irregular and non-transparent service delivery.
- Drain cleaning frequency varies: 70.7 per cent reported weekly cleaning, 12.2 per cent daily cleaning, 4.9 per cent monthly cleaning, while 12.2 per cent gave unclear or no responses, pointing to uneven O&M practices.
- Odour issues are comparatively limited: 65.9 per cent of households reported no foul smell, while 34.1 per cent experienced occasional odour, suggesting generally better flow conditions but persistent localized issues.
- Solid waste accumulation is intermittent: 56.1 per cent of households did not observe waste in drains, 39 per cent observed waste occasionally, and 4.9 per cent reported frequent solid waste presence.
- Hydraulic performance is relatively good, with 95.1 per cent of households reporting no flooding or water stagnation; only 4.9 per cent experienced waterlogging, which typically drained within a few hours.
- Correspondingly, around 95 per cent of households reported no post-rain impact on property, indicating flooding is localized rather than widespread.
- In peri-urban pockets such as Adarsh Nagar, a significant share of households have constructed self-made drains to discharge greywater into street drains due to the absence of sewerage connections, resulting in localized unhygienic conditions.
- Field observations showed multiple drain stretches filled with trash, plastic, and construction debris, which reduced carrying capacity and caused stagnation or overflow into adjacent open plots even during moderate rainfall.
- The drainage network in peri-urban transition zones was observed to be discontinuous and poorly planned, with visible encroachments and disrupted natural drainage paths, leading to stagnant water in open plots.

Drains in Ward 17

- At interception and diversion points near institutional areas, high levels of sludge and floating waste were observed, indicating that existing interception mechanisms are inadequate or overloaded by mixed wastewater and stormwater flows.

Ward 7

- Drain availability is nearly universal, with 98 per cent of households reporting drains near their houses, while 2 per cent lack nearby drainage, indicating minor last-mile gaps.
- The drainage system is entirely open: 94 per cent of households are connected to open man-made drains, 4 per cent to other open (including natural) drains, and 2 per cent rely on non-standard or self-made arrangements; 0 per cent covered drains were observed.
- Drains largely function as open sewers, with 88 per cent of households reporting mixed wastewater (stormwater combined with toilet, bathroom, and kitchen wastewater), 8 per cent reporting stormwater mixed with greywater only, and 4 per cent reporting stormwater-only or other non-standard flows.
- In cases of drain choking, 63 per cent of households depend solely on government cleaning services, 21 per cent rely on a combination of government and private cleaners, and 16 per cent depend entirely on private cleaners, indicating partial reliance on non-municipal arrangements.
- Most households (80 per cent) reported no drain cleaning charges, while 20 per cent incur out-of-pocket expenses (typically around Rs 100), mainly where private cleaning is required.
- The time taken to resolve drain-related issues was largely unclear to households, suggesting the absence of a defined or predictable service response timeline.
- Drain cleaning is reported as weekly by about 70–78 per cent of households, daily or alternate-day by around 10 per cent, while 12–20 per cent reported irregular or unclear cleaning frequency, indicating uneven O&M practices despite routine schedules.
- Odour issues remain significant: 40–45 per cent of households reported persistent foul smell and 45 per cent reported regular or occasional odour, while around 55 per cent reported no smell, reflecting mixed performance of open drains carrying wastewater.
- Solid waste accumulation is intermittent but widespread: 45–50 per cent of households observed regular or occasional solid waste in drains, while 50–55 per cent did not, indicating dumping and poor waste control rather than continuous blockage.
- Drainage performance during rainfall is weak: 42 per cent of households reported water draining within a few hours, while 30–38 per cent experienced waterlogging lasting several days or requiring motorized pumping, and 20 per cent reported no flooding or not applicable.
- Post-rain impacts are severe for a significant share of households: 48 per cent reported flooding affecting property for more than 24 hours, 24 per cent up to 24 hours, 10 per cent for 1–4 hours, and only 18 per cent reported no post-rain flooding impact.

- Field observations found several drains to be under construction or terminating abruptly, causing wastewater to flow into vacant plots and open fields instead of being conveyed through a continuous drainage network.
- Laying of new gas and water pipelines has damaged existing drains and obstructed flow paths, contributing to chronic stagnation and reduced hydraulic efficiency.

Household wastewater going on open ground (top left); newly constructed drains by NPP-Bijnor (top right); empty plot getting filled with household used water (bottom left); household constructed open drain (bottom right)

- Mixing of domestic wastewater with open drains has resulted in stagnant, foul-smelling pools, creating mosquito breeding grounds and increasing risks of waterborne and vector-borne diseases.
- Permanent on-site sanitation structures such as FLTs and septic tanks constructed within narrow street corridors were found to constrain straight and hydraulically effective drain alignments.
- Semi-kachha roads and frequent utility excavations have left multiple lanes muddy, uneven, and difficult to access, exacerbating drainage issues and affecting daily mobility and living conditions.

Ward 32

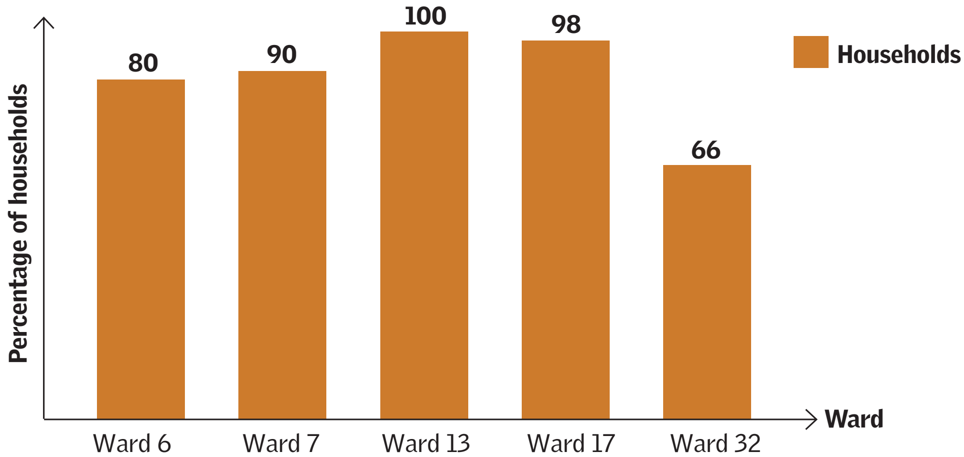
- Drainage coverage is low compared to other areas, with only 66 per cent of households reporting drains near their houses, while 34 per cent lack any nearby drainage, indicating substantial service gaps.
- All households with drainage access are connected to open, man-made drains (100 per cent), with no covered or natural drains reported, reflecting complete dependence on open drainage infrastructure.
- Drains largely function as open wastewater channels: about 90 per cent of households reported mixed wastewater (stormwater combined with toilet, bathroom, and kitchen wastewater), while 10 per cent reported stormwater mixed with greywater only.
- In cases of drain choking, 78 per cent of households rely on government cleaning services, while 22 per cent undertake self-cleaning, indicating limited private sector involvement and a significant household maintenance burden.
- 100 per cent of households reported paying no charges for drain cleaning, suggesting cleaning is either publicly provided or informally managed by households themselves.
- Service response timelines for drain-related issues are largely unclear or reported as not applicable, indicating the absence of a predictable grievance redressal or response mechanism.
- Drain cleaning frequency is inconsistent: 61 per cent reported weekly cleaning, 15 per cent daily cleaning, while 24 per cent reported irregular or unclear cleaning frequency.
- Environmental conditions are poor, with 73 per cent of households reporting regular foul smell from drains, reflecting stagnation and high organic loading.
- Solid waste dumping is a major contributor to blockage, with 63 per cent of households reporting visible solid waste accumulation in drains.
- Drain performance during rainfall is weak: 55 per cent of households reported water draining within a few hours, while 24 per cent experienced waterlogging lasting several days, indicating limited hydraulic capacity during heavy rainfall.

Household wastewater going on open ground (left); kachha drains outside households (middle); no roads and drains (right)

- Post-rain impacts are significant: 32 per cent of households experienced waterlogging for one to four hours, 20 per cent reported flooding lasting more than 24 hours, 17 per cent experienced flooding during rainfall only, while only 31 per cent reported no flooding impact.
- Field observations revealed a critical lack of paved roads and formal drainage networks in several residential streets, leaving settlements without structured surface runoff management.
- Domestic greywater lacks designated outlets, leading to continuous discharge and chronic stagnation directly in front of houses.
- Broken drains and adjacent open plots are used as informal dumping grounds, where accumulated solid waste further clogs flow paths and worsens unhygienic conditions.
- Rapid residential expansion has outpaced sanitation and drainage infrastructure provision, resulting in wastewater disposal into vacant plots, streets, and public pathways.
- The combined presence of stagnant water, household sewage, and decomposing solid waste has created hazardous breeding grounds for disease vectors close to residences, posing serious public health risks.

Overall ward 17 shows the highest coverage, with 100 per cent of households reporting the presence of nearby drains, followed by Ward 7 at approximately 98 per cent. Wards 6 and 13 also demonstrate relatively strong access, each with about 88–90 per cent coverage. In contrast, Ward 32 records the lowest availability among the sampled wards, with nearly 34 per cent of households lacking access to nearby drains.

Graph 8: Household drain access by ward

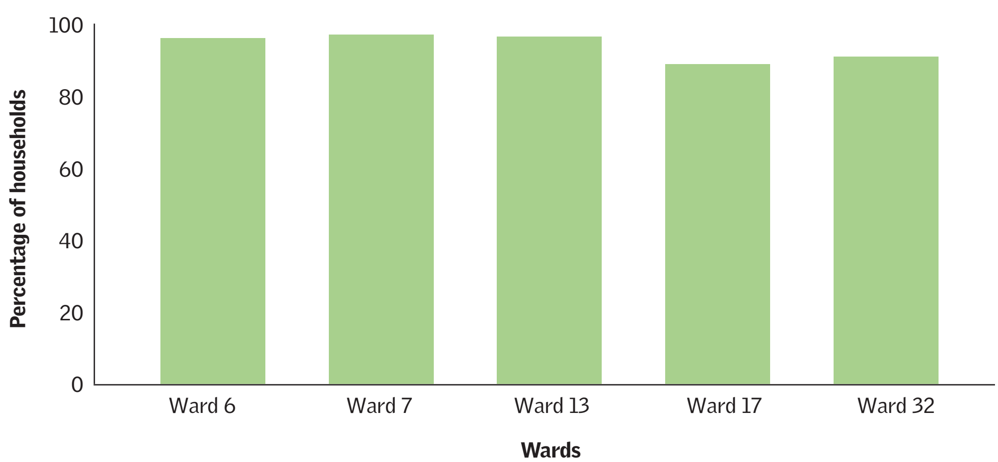


Source: Household survey; compiled by CSE

Despite the overall high coverage, the consistent presence of 0–34 per cent unserved households across wards highlights last-mile infrastructure gaps, particularly in peripheral or densely built pockets. These gaps can exacerbate localized waterlogging, unhygienic conditions, and environmental stress, underscoring the need for targeted drain extension and inclusion of uncovered households to achieve equitable and universal drainage access.

The survey findings, reaffirm that greywater dominates flows in drains across all surveyed wards; however, in practice, most drains function as combined wastewater carriers rather than greywater-only systems. Ward 32 continues to

Graph 9: Mixed wastewater in drains



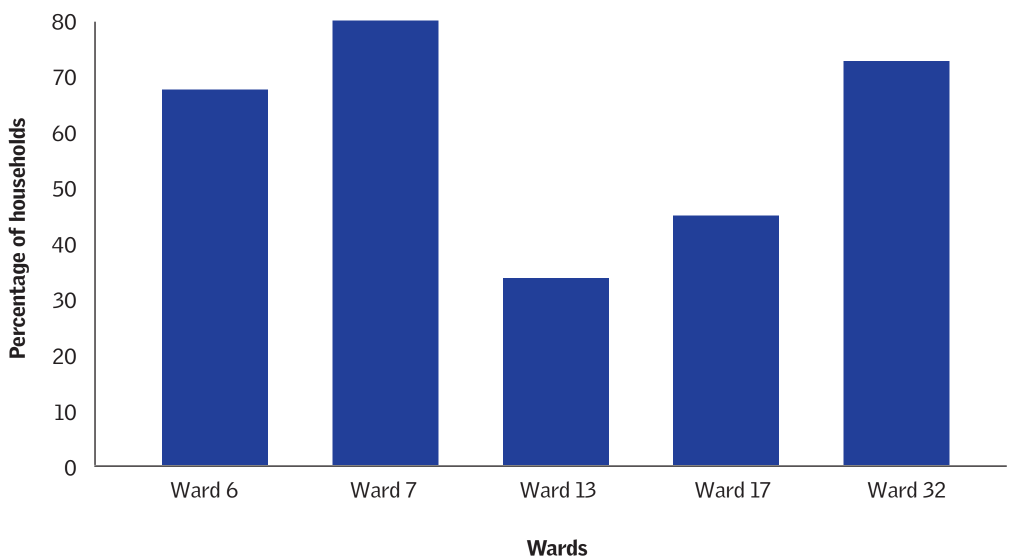
Source: Household survey; compiled by CSE

exhibit a high proportion of greywater-dominated perception, but field evidence shows that nearly 90 per cent of drains actually carry mixed wastewater. Similarly, Ward 7 (about 88 per cent), Ward 6 (around 95 per cent), Ward 17 (about 95 per cent), and Ward 13 (around 96 per cent) report that the majority of drains convey a combination of greywater, blackwater, and stormwater. This indicates widespread discharge of domestic wastewater into the drainage network and a near-complete absence of segregation between wastewater streams.

The presence of blackwater in open drains remains a significant concern across wards. Ward 17 continues to reflect notable blackwater mixing, consistent with earlier estimates, while Ward 6 also shows substantial blackwater discharge in specific stretches such as Gyan Vihar Street. Ward 13 and Ward 7 further confirm that most drains receive toilet outflows along with greywater, effectively operating as open sewers. Even in Ward 32, where blackwater presence appeared relatively lower in earlier estimates, the predominance of mixed wastewater indicates that contamination is more widespread than initially perceived.

Only a limited share of drains function as stormwater-only systems, and even these are often compromised. Ward 7 (around 4 per cent) and Ward 32 (about 10 per cent) report small proportions of stormwater or greywater-only drains, while in other wards such systems are almost absent. In Ward 13, additional inflows from

Graph 10: Household reporting odor in drains in studied wards



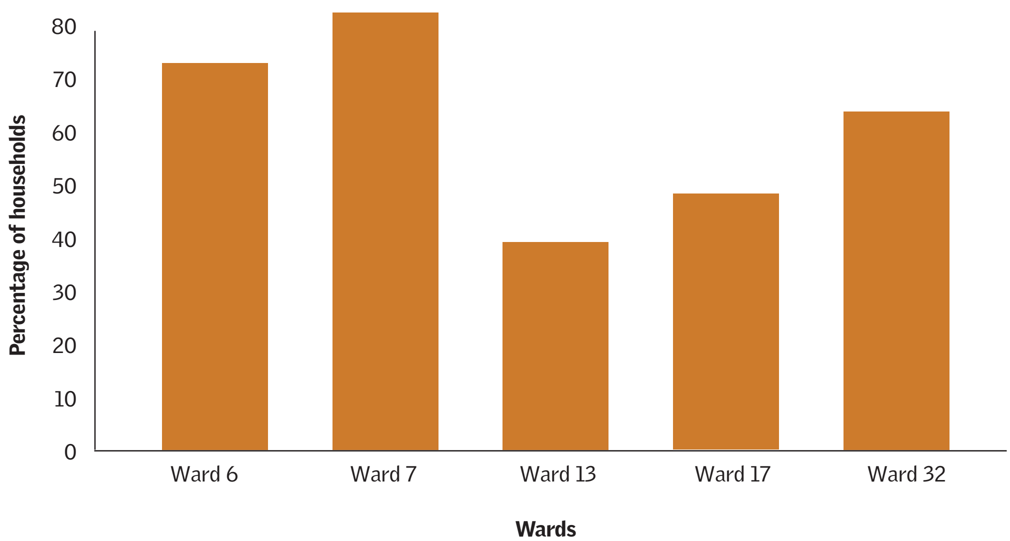
Source: Household survey; compiled by CSE

upstream nullahs further increase both hydraulic and pollution loads, reducing the functional distinction between stormwater and wastewater drains. Overall, the data highlights the predominance of combined wastewater flows across all wards.

The survey results indicate that odour nuisance from drains is a widespread issue across most wards, reflecting stagnation and high organic loading. Ward 13 reports the highest prevalence, with about 80 per cent of households experiencing foul smells, followed by Ward 32 at around 73 per cent and Ward 6 at about 67–70 per cent. Ward 7 presents a mixed scenario, where nearly half of households report odour issues while a slight majority report no noticeable smell. In contrast, Ward 17 shows relatively better conditions, with about 65.9 per cent of households reporting no foul smell, though localized odour problems persist.

As per field observations and household responses, solid waste accumulation within drains has emerged as a widespread and persistent issue across all wards. Ward 6 shows a high incidence, with about 72.5 per cent of households reporting visible waste in drains. Ward 13 also remains severely affected, with a majority reporting regular or occasional waste accumulation, followed by Ward 32 (around 63 per cent). Ward 7 shows moderate but notable accumulation (about 45–50 per cent), while Ward 17 reflects comparatively lower but still intermittent waste presence. In all wards, drains are choked with a mix of biodegradable and non-biodegradable waste such as plastics, cloth, and construction debris, primarily due to inadequate solid waste management systems and informal disposal practices.

Graph 11: Solid waste observed in drains



Source: Household survey; compiled by CSE

Overall, the integrated findings reinforce that drainage systems across all surveyed wards are dominated by mixed wastewater flows, with minimal functional separation between greywater, blackwater, and stormwater. Combined with poor drain design, solid waste dumping, and inconsistent maintenance, this has led to widespread stagnation, odour nuisance, and localized flooding. The data underscores systemic gaps in sewerage coverage, inadequate drainage infrastructure, and weak operation and maintenance practices, resulting in environmental contamination and heightened public health risks across peri-urban areas.

Localized flooding, waterlogging and vulnerable hotspots

Bijnor experiences several localized waterlogging hotspots, largely due to inadequate stormwater drains and the absence of proper outfalls. These issues are more pronounced in the newly added peri-urban wards, where the lack of paved roads and structured drainage results in seasonal flooding during heavy rainfall.

Google earth image of pond where wastewater collects in Ward 13 (top left); water logging Ward 32 (top right); plot logged with water in Ward 6 (bottom left); open ground behind healer hospital logged with water in Ward 32 (bottom right)

Water tends to stagnate in low-lying farm lands and residential clusters, restricting access to streets after rainfall events, while household wastewater frequently overflows onto roads, worsening both mobility and sanitation conditions.

Rapid urban expansion has also disrupted the city's natural drainage and storage systems. During the field observations it was noted that traditional drainage patterns have been altered, reducing natural percolation zones and increasing surface runoff. In peri-urban villages, ponds that once served as local storage and recharge areas are shrinking due to encroachment, and agricultural fields that earlier functioned as infiltration or temporary detention basins are being subdivided for construction. At the same time, the connectivity of local drains to main nallahs is weak, discontinuous, or blocked, further limiting effective stormwater conveyance.

These physical challenges are compounded by the lack of mapping and systematic planning. The local authorities confirmed that Bijnor does not have a dedicated stormwater drainage plan and GIS-based mapping is underway for the newly added wards. This planning gap is even more evident in the newly added wards, where cadastral and topographic maps are often unavailable, no comprehensive drain inventory exists, and natural flow paths, depressions, and catchment boundaries remain unmapped.

Solid waste accumulation and drainage performance

The key informant interviews with relevant stakeholder depicts that peri-urban areas, which were earlier rural in character, have not yet been fully integrated into the municipal solid waste management system. Residents indicated that door-to-door waste collection remains inconsistent and non-uniform across the newly added wards. In several locations, commercial establishments along main roads

Solid waste accumulation in drains in Ward 13 (left); solid waste accumulation in plots in Ward 32

Solid waste observed in drains in Ward 6 (left); Ward 12 (right)

and local markets often dispose of waste directly into drains. This undermines the effectiveness of existing collection efforts and leads to rapid blockage of drains.

Field observations further reveal that the problem is exacerbated during the monsoon season, when trapped solid waste obstructs stormwater flow, resulting in waterlogging, overflow of drains, and unhygienic conditions in residential lanes. As highlighted in previous section most peri-urban drains are shallow, discontinuous, and not designed for easy cleaning, making routine desilting and waste removal difficult. Overall, the issue reflects not only gaps in service delivery but also the transitional nature of peri-urban Bijnor, where urban service systems have not kept pace with rapid land-use change and rising waste generation.

4. Findings and gap analysis

The peri-urban wards newly added to the Bijnor Nagar Palika Parishad (BNPP), namely Wards 6, 7, 13, 17 and 32, present a complex service delivery environment shaped by rapid urbanization, legacy rural infrastructure and incomplete institutional transition. While these areas are now administratively urban, service levels, infrastructure design and operational practices continue to reflect rural norms. This has resulted in systemic gaps across water supply, sanitation, and stormwater management.

Land use growth pattern

Multi-temporal satellite analysis indicates rapid urban expansion and transformation across the selected wards between 2014 and 2025. Areas that were previously dominated by agricultural land, open spaces, or industrial surroundings have progressively transitioned into dense residential and mixed-use urban landscapes. Wards 13 and 32 demonstrate a clear shift from predominantly agricultural land to planned residential and commercial development through systematic land subdivision and rapid construction. Ward 17 has experienced intensive infill development, evolving from a mixed residential–open landscape to a nearly fully built-up urban area with minimal remaining open space. Ward 6 reflects industrial-led growth, where development has expanded outward from the Wave Sugar Industry, gradually converting surrounding vacant and agricultural land into urban uses. Ward 7, located within the older urban core, has undergone steady inner-city densification, with former green or orchard areas replaced by housing and paved surfaces. Overall, the analysis highlights a consistent pattern of urban expansion and densification across the wards, driven by population growth, economic activity, and the outward spread of the city's built environment.

Administrative expansion and governance shifts

The expansion of the BNPP in December 2020 incorporated 14 peri-urban villages into the municipal boundary to bring rapidly growing settlements under urban planning and service delivery systems. However, the transition has created an interim governance gap, as rural administrative structures have been withdrawn while urban systems are still being gradually established. Several wards that were previously governed by Gram Panchayats now fall under municipal administration, yet they continue to operate largely with legacy rural infrastructure and service standards. Fragmented institutional responsibilities—particularly between Uttar Pradesh Jal Nigam (Gramin) and Uttar Pradesh Jal Nigam (Urban)—have resulted in overlapping roles in water supply, while wastewater and stormwater management systems are also in transition from informal, village-based arrangements to formal municipal oversight. As a result, peri-urban wards face challenges such as limited infrastructure investment, regulatory enforcement constraints, and resident confusion over service responsibilities, highlighting the need for phased, context-specific planning and governance mechanisms to effectively integrate these areas into the urban service framework.

Settlement characteristics of newly added wards

The settlement pattern in the BEA reflects a diverse mix of urban, industrial, and rural characteristics across wards. Wards 17 and 6 are relatively urbanized, with planned residential layouts or industrial-led development, high-quality pakka housing, and strong community involvement in maintaining local infrastructure such as open drains. Ward 7 represents a transitional settlement pattern, combining rural features—such as livestock presence and mixed kachha–pakka housing—with pockets of planned urban colonies. In contrast, Wards 13 and 32 remain predominantly peri-urban with largely unplanned settlements, limited infrastructure, and low levels of civic maintenance. Overall, the findings highlight significant variation in settlement typologies and service conditions across the newly added wards, underscoring the need for differentiated planning and service delivery approaches in the extended municipal area.

Socio-economic and environmental features

The BEA demonstrates a significant gap between its formal urban status and on-ground living conditions. While Wards 17 and 6 show relatively better socio-economic conditions, with stable incomes, improved housing, and higher awareness of civic services, Wards 7, 13, and 32 remain more vulnerable and continue to reflect rural characteristics, with livelihoods dependent on livestock and informal work and lower awareness of sanitation services. Rapid and largely unplanned growth has also placed pressure on local environmental resources, with ponds, wetlands, and drains increasingly used for wastewater disposal. Key water bodies such as the Rampur Bakli pond and Nawab ka Hatha wetland are facing degradation due to untreated domestic wastewater, industrial discharge, and encroachment. Additionally, heavy dependence on hand pumps and submersible pumps for water supply, combined with poorly maintained drains and stagnant wastewater, raises risks of groundwater contamination, mosquito breeding, and public health concerns.

Water supply

The data received for core urban area and transitional villages reveals disparities in terms of provisioning of water supply and its infrastructure. The comparison is listed in the table below:

Table 5: Analytical comparison of water supply conditions in urban BNPP and transitional villages

Indicator	BNPP (Core City)	Transitional Villages
Administrative Structure	Established urban local body under the BNPP	Former rural settlements recently incorporated into the municipal limits (2021)
Main Water Source	Municipal groundwater supply through deep tubewells and overhead tanks	Mixed sources: Gram Panchayat legacy schemes, municipal extensions, private borewells, and handpumps
Institutional responsibility	Managed by municipal Jalkal Department	Transitional governance; legacy rural systems still operational
Water Infrastructure	33 operational tubewells supplying water through 12 overhead tanks	Limited piped networks; several habitations dependent on private groundwater extraction
Coverage of Piped Supply	~75 per cent of households (official estimate); ~87 per cent reported in primary surveys	Uneven and fragmented coverage across wards
Water Supply Volume	Approximately 17.5–20 MLD supplied daily	Not centrally monitored
Reported Per Capita Supply	138.68 LPCD (as declared to 14th Finance Commission)	No official estimate available
Estimated Per Capita Availability	~174 LPCD based on recalculation of population served	~100–150 LPCD based on household consumption estimates
Supply Duration	Relatively longer and more consistent	Intermittent supply, often limited to a few hours per day
Dependence on Groundwater	Moderate; primarily through municipal tubewells	High; widespread use of household borewells (120–220 ft) and handpumps
Household Water Storage	Moderate reliance	High reliance on storage tanks (500–1000 L common; 2000–3000 L in some wards)
Service Reliability	Comparatively stable municipal service	Irregular supply with significant ward-level variability
Water Quality Perception	Municipal water generally trusted but occasionally irregular	Groundwater widely used but often perceived as hard or turbid
Household Coping Strategies	Supplemental use of private submersible pumps	Multiple sources, water storage, and household treatment systems (RO filters)
Governance Challenges	Demand–supply balancing and infrastructure expansion	Integration of legacy rural systems, infrastructure gaps, and groundwater dependence

Source: Compiled by CSE

The comparison between the core urban area of the BNPP and the BEA highlights clear disparities in water supply coverage, service levels, and governance. In the core urban area, approximately 75–87 per cent of households are connected to the municipal piped network supplied through 33 operational tubewells and 12 overhead tanks, delivering about 17.5–20 MLD of water. The reported supply level is around 138.7 LPCD, with recalculations suggesting availability of about 174 LPCD, and supply is relatively more reliable. In contrast, the transitional villages receive only about 55 LPCD through legacy rural systems and fragmented networks, with uneven piped coverage and supply often limited to around four hours per day. Households in these areas depend heavily on private borewells (120–220 ft depth), handpumps, and large storage tanks (500–1000 L, and up to 2000–3000 L in some cases) to cope with irregular supply. These differences highlight the ongoing challenge of integrating the extended peri-urban areas into the city's formal water supply system while reducing dependence on groundwater. While the BNPP reports water supply levels above the Service Level Benchmark (135 LPCD), the transitional villages rely on hybrid water provisioning systems combining intermittent piped supply with groundwater extraction and household storage.

This dual source dependency has led to a significant increase in wastewater generation. Volumes far exceed estimates based on piped supply alone. The BNPP currently lacks any by-laws or regulatory mechanisms to monitor or control groundwater abstraction. This has resulted in unaccounted water use and planning blind spots. Although by-laws to regulate groundwater abstraction are proposed for the future, the present absence of regulation has resulted in widespread and unmonitored exploitation of groundwater resources, with limited concern for long-term sustainability.

From an institutional perspective, the coexistence of UP Jal Nigam (Gramin) operating legacy schemes and UP Jal Nigam (Urban) implementing AMRUT 2.0 infrastructure has created confusion regarding ownership, operation and maintenance responsibility, and grievance redressal.

Currently, the BNPP has only two junior engineers in total, of which just one engineer (JalKal Dept) is responsible for the entire water supply system across the municipal area. This single engineer is currently managing all planning, operation, maintenance, monitoring, and complaint redressal functions related to water supply.

Once the water supply infrastructures of extended peri-urban areas are fully handed over to the municipality, the same engineer is expected to take responsibility for these additional service areas as well. This will significantly increase the operational burden and may affect the efficiency, responsiveness, and quality of service delivery across the entire municipal area.

As per the government order (9-4099/46/2025 nagar vikas section 4, urban development department, dated: 27th February, 2026) for Level-2 Nagar Palika Parishads, the sanctioned technical staffing structure includes one Assistant Engineer and two Junior Engineers to oversee civil works. However, in the BNPP, only one Junior Engineer is currently in position, indicating a significant staffing gap. The order also does not make any explicit provision for a dedicated JalKal (water supply) department.

In terms of sanitation, the norms prescribe one Level-I Sanitary Inspector and two Level-II Sanitary Inspectors, but at present, all sanitation-related responsibilities are being handled by a single Level-I Sanitary Inspector. This reflects an additional capacity constraint in managing sanitation services effectively.

The Executive Officer has emphasized the urgent need to strengthen institutional capacity, particularly for water supply management. At a minimum, the municipality requires one Assistant Engineer and two Junior Engineers dedicated exclusively to water supply to ensure effective system management, timely operation and maintenance, proper supervision of infrastructure, and seamless service delivery across both the existing municipal area and the newly extended wards.

From a financial perspective, no dedicated budget is earmarked for the O&M of the water supply system. Instead, expenses are managed through funds received from the State Finance Commission (SFC). Ongoing infrastructure development is being financed under relevant government schemes. The municipality does not currently perceive any financial constraints in managing the water supply system.

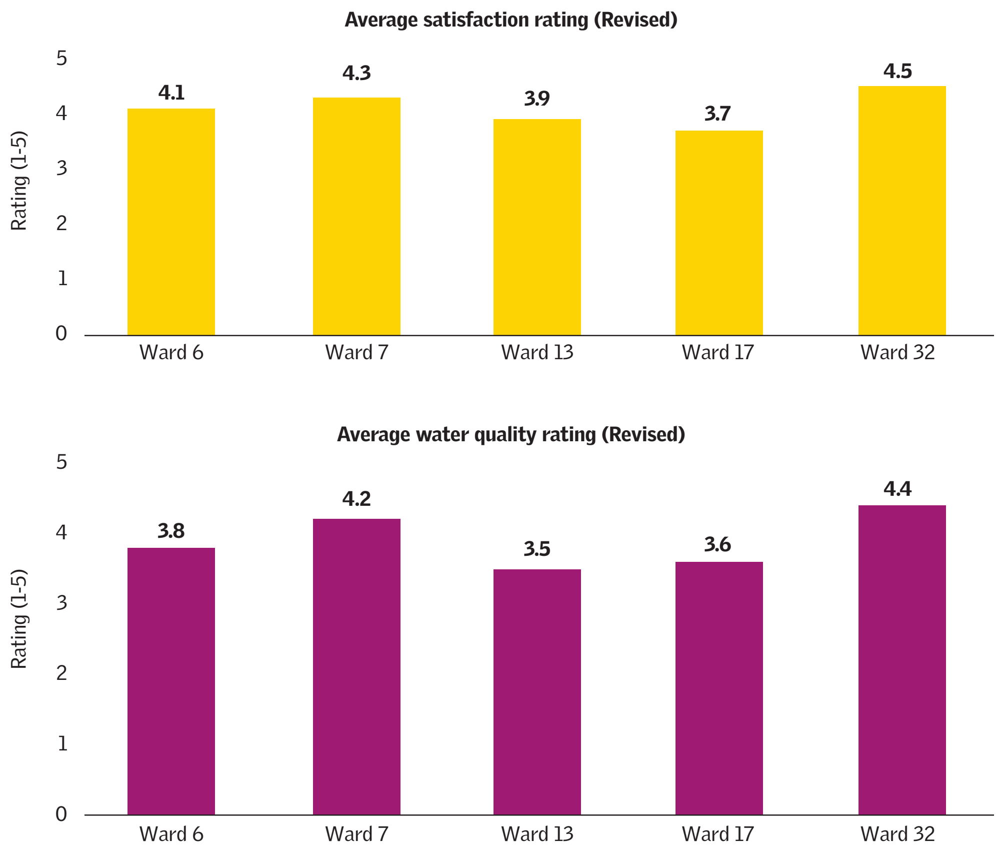
In terms of infrastructure, Bijnor Municipality has 33 tubewells and 12 overhead tanks (OHTs) in operation. Additionally, 6 more OHTs are under construction under AMRUT 2.0, which are expected to be sufficient to cater to the entire Bijnor area, including the extended regions.

Table 6: How residents perceive their water supply (Scale of 1 to 5)

Ward	Satisfaction Rating (Avg)	Quality Rating (Avg)	Common Complaints
Ward 6	4.1 / 5	3.8 / 5	Odor (O) and Turbidity (T) during rains.
Ward 7	4.3 / 5	4.2 / 5	Generally high satisfaction; occasional Hardness (H).
Ward 13	3.9 / 5	3.5 / 5	Significant complaints regarding "Iron smell" or Color (C).
Ward 17	3.7 / 5	3.6 / 5	Pressure issues and occasional salinity (S).
Ward 32	4.5 / 5	4.4 / 5	Best performing ward for quality.

Source: Household survey; compiled by CSE

Graph 12: Average satisfaction rating and average water quality rating



Source: Household survey; compiled by CSE

Ongoing government initiative towards access to safe water

The formal water supply infrastructure for Bijnor city is currently being expanded under the Atal Mission for Rejuvenation and Urban Transformation (AMRUT) 2.0. The mission aims to create infrastructure that responds directly to people's needs and improves service delivery outcomes. The key objectives of AMRUT 2.0 relevant to water supply include:

- Ensuring that every household has access to a tap with assured water supply and sewerage connection;
- Increasing the amenity value of cities by developing and maintaining green and open spaces; and
- Reducing pollution by promoting public transport and non-motorized transport infrastructure.

According to the City Water Supply Augmentation Plan (CWAP), the following scenario of household tap water connections is envisaged for Bijnor (see Table 7).

Table 7: City water supply scheme – Household tap water connections

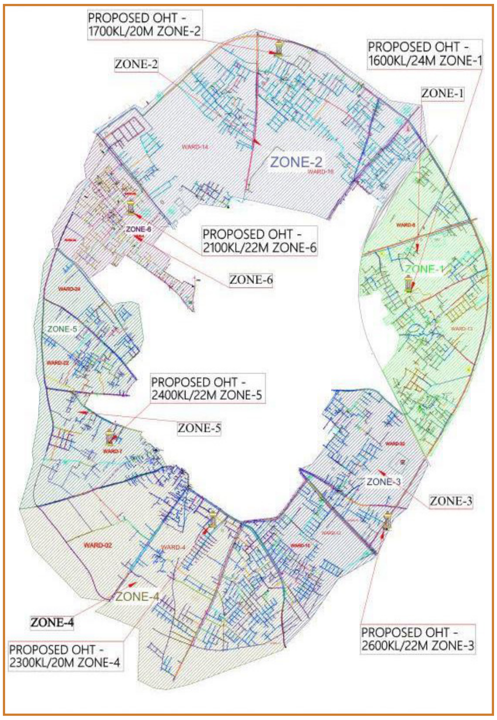
S. No.	Description	Number	Percentage
1	Total households as per CWAP (2025)	46,933	—
2	Households covered with tap water connections (to date)	21,390	45.58
3	Gap in household connections for universal coverage	25,543	54.42
4	Proposed connections under AMRUT 2.0 (Tranche 2)	25,543	54.42
5	Total households to be covered post-implementation	46,933	100

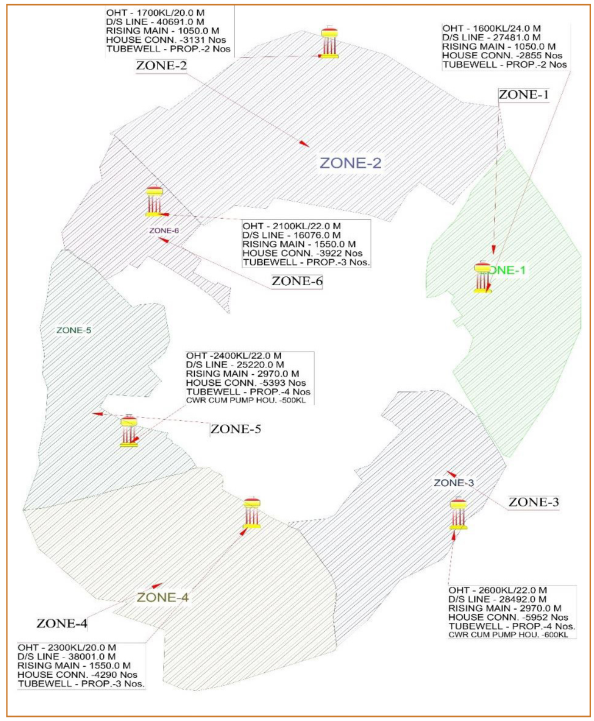
Source: Bijnor Water Supply Scheme DPR, 2022

Under construction overhead tank in Ward 6

The proposed scheme aims to serve 100 per cent of properties within the current municipal limits of Bijnor. As per the DPR, the project includes the development of six new water supply zones with Overhead Tanks (OHTs ranging from 1,600 KL to 2,400 KL), designed to ensure a uniform urban supply norm of 135 LPCD in the future. The total capital investment for the Bijnor City Water Supply Scheme is estimated at approximately Rs 9,191.80 lakh, targeting a design-year (2055) population of over 2.65 lakh in the expanded municipal area. The index plan map of Bijnor Water Supply Scheme is shown in the following map (see *Map 7*).

Map 7: Maps showing index plan for Bijnor water supply scheme





Source: DPR Water Supply scheme, Bijnor

Sanitation

Table 8: Comparison of wastewater and sanitation practices in urban BNPP and transitional villages

Indicator	BNPP (Core City)	Transitional Villages
Administrative Context	Established urban area under the BNPP	Former rural settlements incorporated into municipal limits in 2021
Sewerage Network Coverage	Approximately 80 km of sewer network serving the pre-2021 core city	Very limited sewer coverage; only Ladapura (Ward 32) partially covered
Household Sewer Connections	Largely absent; sewer network relies on interception of drains	Almost entirely absent
Wastewater Conveyance	Interception and diversion of open drains carrying mixed greywater and blackwater to STP	Wastewater primarily discharged into open drains or surrounding land
Dependence on On-Site Sanitation Systems (OSS)	Very high (over 95 per cent of households as per SFD 2020)	Nearly universal reliance on OSS
Dominant Containment Types	Septic tanks and fully lined tanks	Mix of septic tanks, fully lined tanks, semi-lined pits, and lined pits with open bottoms
Toilet Coverage	High household toilet coverage	Nearly universal household toilet coverage across surveyed wards
Effluent Discharge	Mostly into open drains connected to interception points	Mostly into open drains, open land, or low-lying areas

Indicator	BNPP (Core City)	Transitional Villages
Wastewater Flow Patterns	Gravity-based drainage facilitated by gentle slopes	Localized drainage patterns; railway line acts as physical barrier in several wards
Desludging Service Providers	Combination of municipal tanker and licensed private operators	Predominantly private desludging operators
Desludging Technology	Mechanical desludging through vacuum tankers	Mechanical desludging dominant (>80 per cent), but manual emptying persists
Desludging Frequency	Reactive; typically once every 3–10 years	Highly irregular; intervals range from 1–15 years
Accessibility Constraints	Moderate access for desludging vehicles	Narrow internal lanes restrict tanker access in many areas
Faecal Sludge Disposal	Directed to co-treatment unit at STP	Disposal pathways inconsistent; private operators sometimes bypass treatment facility
Treatment Infrastructure	24 MLD Sewage Treatment Plant with 20 KLD co-treatment unit for faecal sludge	Same facility serves peri-urban areas, but utilization remains limited
Treatment Capacity Utilization	STP operating near capacity due to intercepted drain flows	Co-treatment unit underutilized (~30 per cent capacity)
Institutional Oversight	Municipal oversight exists but operational gaps remain	Limited monitoring of private desludging and sludge disposal
Key Governance Challenges	Lack of household sewer connections, high reliance on OSS	Infrastructure gaps, groundwater-driven wastewater generation, and weak regulation of desludging services

Source: Compiled by CSE

The comparison between the core urban area and the Bijnor Extended Area (BEA) highlights major differences in wastewater management systems. In the core city under the BNPP, around 80 km of sewer network exists, but household sewer connections are largely absent, and wastewater is primarily conveyed through interception of open drains to the 24 MLD sewage treatment plant, which also includes a 20 KLD faecal sludge co-treatment unit. More than 95 per cent of households depend on on-site sanitation systems, mainly septic tanks and lined tanks, with desludging typically occurring every three to ten years through municipal and licensed private operators. In contrast, the transitional villages in the BEA have very limited sewer coverage, with only parts of Ladapura in Ward 32 connected, and nearly all households rely on on-site sanitation systems such as septic tanks and pits. Wastewater is mostly discharged into open drains, land, or low-lying areas, and desludging is carried out mainly by private operators with irregular intervals ranging from 1–15 years, often constrained by narrow lanes and limited monitoring. Although the same treatment facility serves both areas, the faecal sludge co-treatment unit operates at only about 30 per cent capacity, indicating gaps in sludge collection, regulation, and integration of peri-urban sanitation services into the city system.

Despite the presence of a functional STP and a co-treatment facility in Bijnor, the safe management of wastewater and faecal sludge in the newly added peri-urban wards is constrained by a combination of technical, geographic, and operational barriers. These barriers collectively limit the scalability of sewerage expansion, restrict mechanized faecal sludge management services, and perpetuate unsafe disposal practices.

- Limited physical access: Narrow internal lanes (often <2–2.5 m) in peri-urban wards restrict entry of mechanized desludging vehicles, leading to continued reliance on manual or informal emptying and inefficient service delivery.
- Incomplete drainage coverage: Slow and phased drain construction has resulted in wastewater discharge into open plots and low-lying areas, creating dispersed pollution hotspots that are difficult to regulate.
- Railway line as a barrier: The east–west railway line fragments sanitation infrastructure; complex approval processes and inadequate underpasses prevent seamless sewer and drain connectivity across wards.
- Adverse topography: Peri-urban areas east of the railway lie on a reverse slope, making gravity-based sewer extension technically complex and economically unviable, reinforcing dependence on on-site systems.
- Institutional and operational gaps: Weak FSM enforcement, unstructured desludging, informal dumping, and transitional planning challenges in newly added wards have led to fragmented and reactive sanitation interventions.

Stormwater management

Table 9: Comparison of stormwater management in urban BNPP and transitional villages

Indicator	BNPP (Core City)	Transitional Villages
Drainage Infrastructure	Partial drainage network with roadside drains in most built-up areas	No dedicated stormwater drainage system; reliance on open roadside drains
Stormwater–Wastewater Separation	Limited separation; drains often carry mixed wastewater	No separation; drains function as combined conduits for stormwater, greywater, and blackwater
Drain Coverage	Relatively high coverage in core city areas	Overall presence (66–100 per cent) but with localized gaps in peripheral pockets
Drain Design	Mostly open drains, some sections covered	Narrow, shallow, and discontinuous open drains
Drain Condition	Functional in central areas but deteriorating in older sections	Poorly graded, damaged, and frequently interrupted during utility works
Drain Outfalls	Some connectivity to major drains and interception systems	Often terminate in vacant plots, ponds, or agricultural fields due to absence of mapped outfalls
Greywater Discharge	Present but partially intercepted in sewered areas	Major component of drain flow across all wards

Indicator	BNPP (Core City)	Transitional Villages
Blackwater Presence	Limited but occurs through septic tank overflow and illegal connections	Significant in several wards, indicating direct toilet discharge or septic tank overflow
Stormwater-only Drains	Rare but present in some areas	Very limited (4–10 per cent of drains)
Drain Maintenance	Municipal cleaning and desilting conducted periodically	Maintenance largely reactive and occurs after flooding events
Solid Waste in Drains	Occasional blockage in dense areas	Widespread accumulation (45–72 per cent households reporting waste presence in different wards
Odour from Drains	Localized nuisance in older drainage sections	Wide range across wards (34–80 per cent households reporting foul smell)
Flooding and Waterlogging Risk	Moderate during heavy rainfall	High due to clogged drains, poor gradients, and mixed wastewater flows
Institutional Responsibility	Managed by the BNPP	Transitional governance; infrastructure inherited from rural systems
Key Governance Challenges	Aging infrastructure and inadequate separation of drainage and sewer systems	Lack of planned stormwater networks, infrastructure gaps, and weak operation and maintenance

Source: Compiled by CSE

Stormwater management represents the most visible and immediate service delivery failure in peri-urban Bijnor. None of the studied wards have a dedicated stormwater drainage network. Instead, open roadside drains act as combined conduits, carrying stormwater, greywater, and in many cases blackwater.

Drains are typically narrow, poorly graded, discontinuous, and frequently damaged during utility works. The absence of mapped outfalls causes drains to terminate in vacant plots, ponds, or agricultural land. Maintenance remains largely reactive, with desilting undertaken only after flooding events. This reflects weak operation and maintenance systems and limited budget prioritization.

The comparison of drainage conditions between the core city and the BEA reveals significant infrastructure and management gaps. In the core city under the BNPP, drainage coverage is relatively high, with roadside drains in most built-up areas, although separation between stormwater and wastewater remains limited and some older drains are deteriorating. In contrast, the transitional villages lack a dedicated stormwater drainage network and rely primarily on narrow open roadside drains, which often carry a mixture of stormwater, greywater, and blackwater. While overall drain presence is relatively high (66–100 per cent coverage), many drains are poorly graded, discontinuous, and frequently terminate in vacant plots, ponds, or agricultural fields due to the absence of planned outfalls. Greywater constitutes the majority of drain flow in these areas, while Blackwater presence indicates septic tank overflow or direct toilet discharge. Solid waste accumulation is widespread (45–72 per cent households reporting waste in drains), and 34–80 per cent households report foul odour, contributing to a high risk of waterlogging and flooding, particularly during heavy rainfall. These findings highlight the need for planned drainage systems, improved maintenance, and better integration of stormwater and wastewater management in the extended municipal area.

Cross-cutting issues impacting service delivery in peri-urban areas

Beyond ward-specific challenges, several systemic issues cut across peri-urban Bijnor and constrain effective service delivery.

First, there is a structural mismatch between infrastructure design and urban demand. Systems designed for rural densities and consumption levels are failing under rapidly rising household water use, commercial activity, and population growth.

Second, unregulated groundwater abstraction has become the backbone of water security. This distorts demand projections and overwhelms sanitation and drainage systems. Wastewater generation is no longer linked to municipal supply volumes, undermining sewage treatment plant capacity planning.

Third, geographic and infrastructural factors further shape Bijnor's peri-urban dynamics. The railway line running through the city acts as a physical barrier, influencing settlement growth, infrastructure connectivity, and wastewater conveyance. The railway line acts as a permanent hydraulic and institutional barrier. It prevents gravity-based sewerage expansion to eastern wards. Areas east of the railway, including several newly added wards, exhibit more pronounced service deficits and environmental stress, highlighting the uneven nature of peri-urban integration. Pumping solutions are technically feasible but financially and operationally unsustainable for low density peri-urban areas.

Fourth, institutional transition gaps persist following the shift from Gram Panchayat to the BNPP. Roles and responsibilities for operation and maintenance, asset ownership, monitoring, and financing remain unclear. Peri-urban wards compete with the core city for limited municipal resources, despite facing disproportionately higher infrastructure deficits.

Finally, data and planning deficits, including the absence of GIS based mapping of drains, on-site sanitation systems, wastewater flow paths, and water bodies, limit the BNPP's ability to prioritize investments. Without ward-level sanitation and drainage plans, interventions remain piecemeal and reactive.

5. Recommendations

5.1 Immediate measures (0–2 Years)

Immediate actions should focus on reducing untreated wastewater discharge and improving use of existing infrastructure.

Low-cost treatment and rejuvenation interventions should be implemented for the three heavily polluted ponds receiving domestic wastewater. Measures such as inlet screening, constructed wetlands or DWWTs, floating bio-remediation units, and controlled diversion of greywater can significantly reduce pollution loads without major civil works.

Faecal sludge management should be strengthened as the primary sanitation solution in peri-urban and fringe areas. Priority should be given to enabling safe transport of faecal sludge from dense and inaccessible settlements to the existing co-treatment facility, using smaller desludging vehicles and shared transfer points. Awareness programmes or sensitization about bye-laws can be rolled out in newly added peri-urban areas if not done previously to avoid improper disposal of untreated faecal sludge.

Routine desilting and repair of drains before monsoon seasons should be institutionalized, with a clear ward-level responsibility for maintenance. Preventing solid waste entry into drains through basic inlet covers and community monitoring can immediately reduce flooding and stagnation.

Simple ward-level mapping of drains, ponds, and on-site sanitation systems should be completed to support targeted interventions and avoid reactive responses.

5.2 Medium-term interventions (2–5 Years)

Medium-term actions should focus on system efficiency and local treatment, rather than expansion of large networks.

An integrated wastewater and stormwater management plan should be prepared specifically for peri-urban wards, focusing on separating wastewater from stormwater where feasible, protecting natural flow paths, and identifying priority interception points.

Decentralized wastewater treatment systems should be adopted selectively in settlements where wastewater already converges at ponds or drains. Small, community-level treatment units or in-situ nallah treatment including local reuse can reduce pollution loads and limit the volume of wastewater entering drains and the central STP.

Faecal sludge management services should be formalized through scheduled desludging in high-density areas and simple service contracts with private operators, supported by a transparent user fee structure.

Institutional clarity should be improved by formally transferring operation and maintenance responsibility of assets to the BNPP, supported by basic staff training and budget earmarking for peri-urban areas.

5.3 Long-term interventions (5–10 Years)

Long-term actions should prioritize incremental capacity enhancement and resource protection, avoiding high-cost, city-wide infrastructure where demand remains dispersed.

The existing sewage treatment plant should be optimized and expanded in phases only after decentralized and FSM-based solutions are stabilized. For areas across the railway line, a new Sewage Treatment Plant (STP) can be implemented.

Ponds, natural drains, and low-lying areas should be protected and restored as part of the drainage system, not treated as disposal sites. These assets can function as buffers for stormwater, groundwater recharge, and treated wastewater reuse.

Groundwater management should be strengthened through mandatory rainwater harvesting in new developments and institutional buildings, protection of recharge zones, and basic monitoring of abstraction trends.

Over time, sanitation and drainage planning should be integrated into routine municipal planning processes, supported by Management Information System (MIS) platforms. This will help in strengthening the monitoring protocols as well as serve as a guiding tool for need based interventions.

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Rapid urbanization is expanding Indian city limits, leaving newly added peripheral areas struggling to keep pace with basic infrastructure. Focusing on Bijnor, Uttar Pradesh, this report assesses the challenges and opportunities of water supply, wastewater and stormwater management in newly added peri-urban villages, and proposes inclusive and sustainable strategies for intervention.

The study highlights the service disparities between the urban core areas of Bijnor Nagar Palika and recently added peri-urban areas. It identifies core challenges—including dual-agency governance gaps, heavy reliance on unregulated groundwater, mismanagement of wastewater and faecal sludge and a lack of dedicated stormwater drainage. Complete with a time-bound roadmap of immediate and long-term recommendations, this report is an essential guide for municipal authorities, planners and policymakers working to bridge service delivery and governance gaps and build climate-resilient cities.

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