

Preventive Maintenance of Underground Sewerage Systems – Observation Note

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PREVENTIVE MAINTENANCE OF UNDERGROUND SEWERAGE SYSTEMS - OBSERVATION NOTE

November 2025

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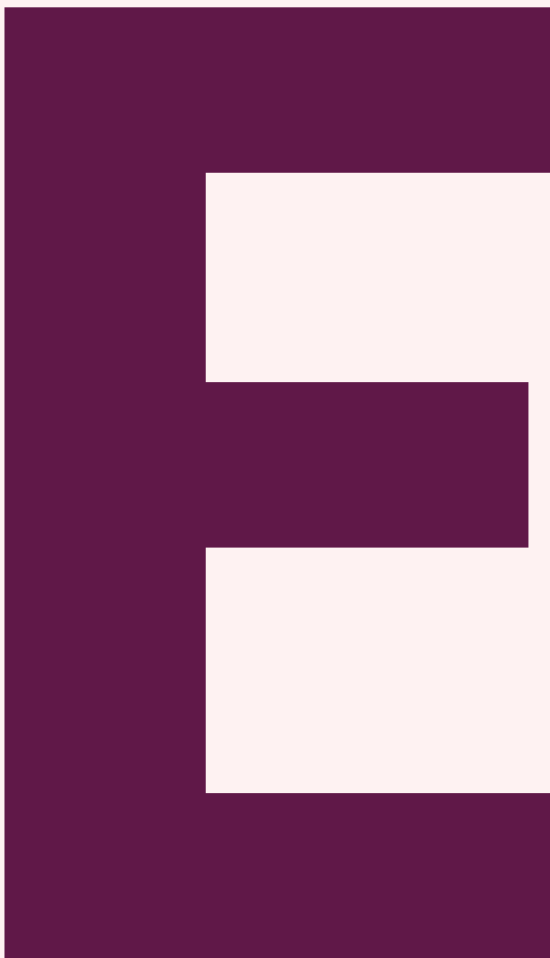
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Abbreviations

AEE	Assistant Executive Engineer
CPHEEO	Central Public Health and Environmental Engineering Organisation
CWIS	Citywide Inclusive Sanitation
JE	Junior Engineer
O&M	Operation and Maintenance
SWD	Stormwater Drain
TCC	Tiruchirappalli City Corporation
TNUSSP	Tamil Nadu Urban Sanitation Support Programme
UGSS	Underground Sewerage System

Executive Summary



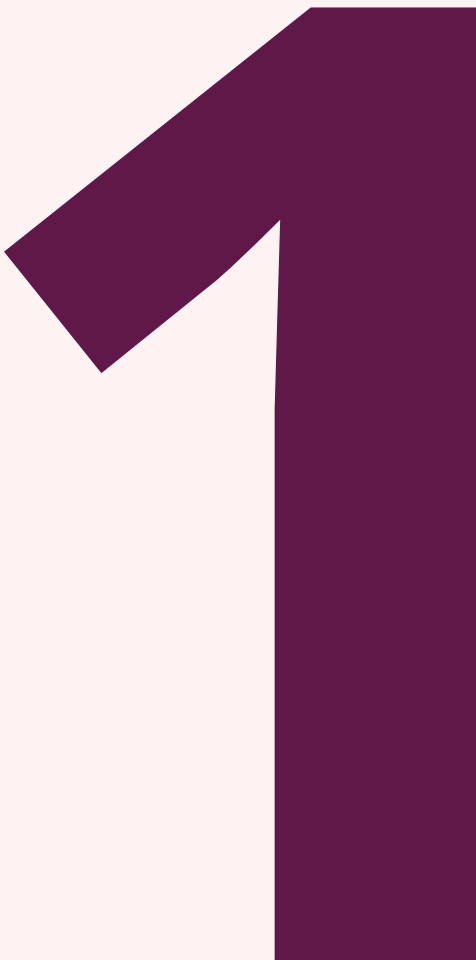
Executive Summary

Tiruchirappalli (Trichy), the fourth largest municipal corporation in Tamil Nadu, operates one of the extensive Underground Sewerage Systems (UGSS) in the state. UGSS currently covers 90 per cent of households within Tiruchirappalli City Corporation (TCC) limits. Despite near-universal coverage, the UGSS network and well-functioning grievance redressal system, the city continues to face blockages, particularly in dense urban settlements and near commercial establishments. As per TCC's request, the Citywide Inclusive Sanitation (CWIS) initiative of the Tamil Nadu Urban Sanitation Support Programme (TNUSSP), conducted a field-based assessment to understand the causes of frequent blockages and operational gaps, and propose preventive solutions.

The CWIS team conducted an assessment in two zones of the UGSS, which included interviews with TCC engineers, field inspections and analysis of complaints from TCC's four-channel grievance redressal system. The study found that most complaints of blockage came from areas where solid waste disposal into drains was common, and where unauthorised connections of Stormwater Drains (SWD) and sewer lines existed. A major finding of the study was related to diaphragm chambers which trap solids before wastewater enters the UGSS. Many chambers were poorly built or did not follow standard designs, leading to scum build-up. In commercial complexes, modifications to holding tanks that deviated from TCC-mandated structure added to the problem [2–4]. To reduce blockages and improve UGSS performance, the report recommends scaling up TCC's good practices across all wards with regular monitoring of high-risk areas. It calls for a survey of diaphragm chambers in apartment and commercial complexes to understand its performance efficiency. Preventive maintenance should include regular inspections, venting and retrofitting. Training for engineers and sanitation workers should be conducted periodically in addition to public awareness campaigns to discourage disposal of solid waste into UGSS.

Implementing these measures will help TCC improve the efficiency of the UGSS and minimise service disruptions. Promoting preventive maintenance and responsible user behaviour can make the system more resilient and serve as a model for other ULBs in the state.

Introduction



1. Introduction

Launched in 2016, the Citywide Inclusive Sanitation (CWIS) framework represented a fundamental shift in the way urban sanitation is conceived, planned, and delivered. Developed by a global coalition—including the Gates Foundation¹, World Bank, WaterAid, and Emory University—CWIS promotes equitable, safe, and sustainable sanitation for all urban residents, particularly the poor and marginalised. It advocates a systems approach that integrates sewered and non-sewered solutions, and addresses the entire sanitation chain—from containment to reuse or disposal.

In 2018, Tiruchirappalli (Trichy)—a city of over one million people in Tamil Nadu—was selected by the Gates Foundation as one of eight global cities to pilot the CWIS framework. This selection was built on Tamil Nadu's growing momentum in urban sanitation, shaped by the state's flagship mission, 'Muzhu Sugadhara Tamizhagam', and the work of the Tamil Nadu Urban Sanitation Support Programme (TNUSSP). From 2018 to 2024, the Indian Institute for Human Settlements (IIHS), in partnership with the Tiruchirappalli City Corporation (TCC) and a consortium of local partners, led the implementation of the CWIS Trichy Programme with the support of the Gates Foundation. The programme sought to demonstrate how inclusive, citywide sanitation could be delivered at scale through an integrated approach.

Its key objectives were to:

1. Ensure safe management of fecal sludge across the entire sanitation chain
2. Improve service delivery for the urban poor and other vulnerable populations
3. Strengthen the capacity of local governments and communities
4. Integrate gender equity across sanitation planning and service delivery
5. Enhance the well-being and dignity of sanitation workers
6. Position Trichy as a knowledge hub for inclusive sanitation

Collectively, these objectives reflect a commitment to system-wide transformation, bringing together infrastructure, governance, and community engagement to deliver inclusive and sustainable sanitation outcomes. This report is part of a broader series documenting the lessons, challenges, and insights from the CWIS Trichy experience.

At TCC's request, the CWIS team conducted a study of the Underground Sewerage System (UGSS) to assess current maintenance practices, identify causes of frequent blockages, and recommend measures to enhance efficiency and service delivery.

¹ The organisation was formerly known as Bill and Melinda Gates Foundation (BMGF).

Background of the study

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2. Background of the study

The UGSS in Trichy plays a critical role in managing wastewater and ensuring public health. Currently, UGSS coverage extends to 90 per cent (TCC, 2025) of the city's households, with ongoing efforts to expand its reach to unserved areas. Despite these efforts, the system faces frequent blockages, particularly in high-density urban settlements, due to improper disposal of solid waste, including plastics, sanitary waste, and construction debris. Additionally, operational inefficiencies, inconsistent maintenance schedules, and limited UGSS coverage in certain areas led to unauthorised sewage discharge into open drains and water bodies, further exacerbating sanitation challenges. Some UGSS components, such as diaphragm chambers in bulk waste-generating establishments, do not adhere to recommended guidelines, reducing their effectiveness.

To address these issues, TCC has taken several proactive measures, including the expansion of UGSS coverage, establishing complaint mechanisms and rapid response teams for blockage clearance, and conducting behaviour change campaigns to prevent solid waste disposal into the sewer system. One key intervention was the issuance of a directive mandating diaphragm chambers in bulk waste-generating establishments, along with technical support for individual households. However, despite these efforts, recurring blockages remain a significant concern, affecting UGSS efficiency and sanitation services.

Recognising the need for a detailed assessment, TCC requested the CWIS team to study the causes of frequent UGSS blockages, evaluate the effectiveness of existing maintenance practices, and assess the implementation of diaphragm chambers. This study aims to provide data-driven insights to strengthen UGSS maintenance strategies, optimise resource allocation, and enhance overall sanitation outcomes in Trichy.

2.1 Need for the Study

2.1.1 UGSS coverage and expansion efforts

According to the 2024-25 Administrative Report of TCC (2025), the implementation of UGSS in the city started in 1997 for the old city limits and was extended to uncovered areas within the old city limits and the areas under Ponmalai and Srirangam local bodies through the Trichy-Srirangam UGSS Scheme (2000 and 2018), under the National River Conservation Plan (2000). In Phases 2 and 3 of the initiative, 40 newly included wards were covered under the AMRUT scheme and with the funding from Asian Development Bank, leading to nearly 90 per cent UGSS coverage in the city. Currently, Phase 4 of UGSS expansion is underway under the AMRUT 2.0 scheme and the overall coverage is nearly 91 per cent.

2.1.2 Issues with existing UGSS connections

Despite the efforts to expand UGSS to the underserved areas, the network faces frequent blockages, particularly in urban poor settlements. Several key factors contribute to these issues:

- **Improper waste disposal:** Disposal of solid waste, including plastics, napkins, and oil waste from hotels into drainage systems has been a major cause of blockages.
- **Unauthorised connections:** The linking of Stormwater Drains (SWD) with UGSS has led to blockages and overflow issues.

- Diaphragm chamber compliance issues: Large residential apartments and commercial complexes often lack properly constructed diaphragm chambers, leading to increased solid waste accumulation in the UGSS [2, 3].

2.1.2.1 Measures taken by TCC

TCC has taken various steps to address these challenges, including:

1. **Complaint mechanisms:** A four-channel system (WhatsApp, direct complaints to Junior Engineers (JEs), ward office registration, and toll-free helplines) was established to facilitate timely response to UGSS issues.
2. **Rapid blockage clearance:** Blockage removal was carried out both manually and mechanically with jetting machines and de-sludging vehicles, when necessary.
3. **Preventive measures:**
 - Issuing notices to bulk liquid waste generators to construct diaphragm chambers before connecting to the UGSS network.
 - Enforcing proper construction standards, including the use of inspection chambers and appropriate pipeline slopes.
 - Promoting behaviour change through awareness campaigns discouraging solid waste disposal in drains.
4. **Monitoring and supervision:** Assistant Executive Engineers (AEEs) and JEs actively monitored and oversaw blockage removal efforts to ensure mechanical clearance methods are used instead of manual scavenging.

In addition, there were ongoing efforts to extend UGSS to uncovered areas. Key expansion efforts included:

- **Pipeline revamping and replacement:** Old pipelines in many parts of the city were upgraded to improve efficiency.
- **Household connectivity improvements:** TCC implemented measures such as laying shallow-depth connection pipes in dense urban areas like Srirangam, Vaikalmedu, and Palakarai.

2.1.3 Objectives of the study

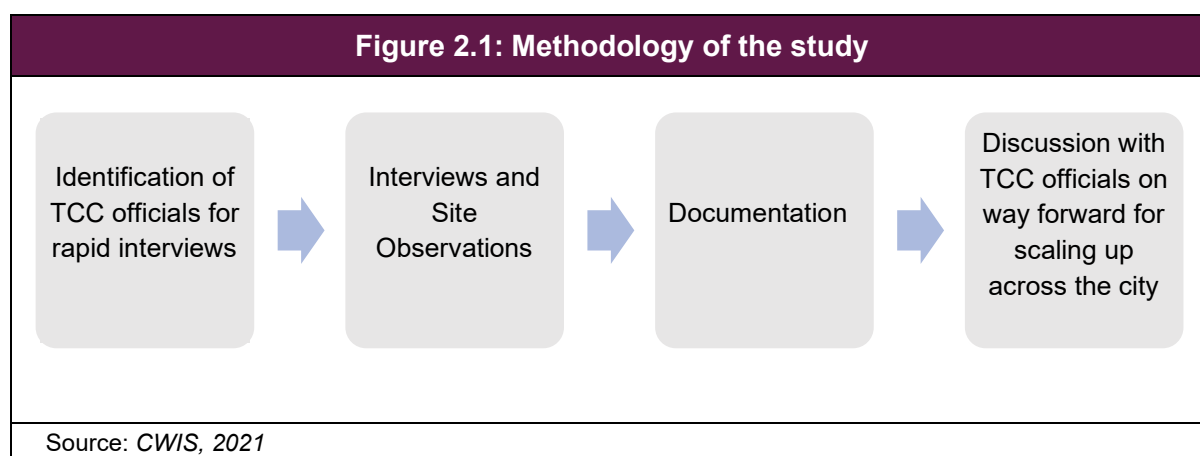
While TCC implemented multiple interventions, challenges persisted in preventing and efficiently managing blockages. This study was initiated to:

1. Assess the effectiveness of TCC's current UGSS preventive maintenance practices.
2. Evaluate the root causes of frequent UGSS blockages and propose strategies for long-term improvements.
3. Strengthen enforcement measures and identify additional technical and operational enhancements to improve UGSS efficiency.

2.2 Methodology

The CWIS team conducted rapid interviews and field assessments in November 2021. Interviews with four AEEs, one JE, and a sanitation worker were conducted. Conversations with the JE highlighted the

challenges and good practices followed in the preventive maintenance of UGSS. Site visits were undertaken to understand the ground conditions and effectiveness of preventive actions taken by TCC. Furthermore, second-level interviews with were conducted with the JE to verify the issues, as depicted in Figure 2.1.



2.3 Observations through Interviews

The summary of observations from the interviews are presented in Table 2.1.

Table 2.1: Observations from rapid interviews

Sl. No.	Description	Observation
1	Preventive maintenance	<ol style="list-style-type: none"> 1. Presently, no major preventive maintenance work has been carried out due to resource constraints. 2. Bulk liquid generators were given notices to construct diaphragm chambers or similar provisions before linking to the UGSS network. 3. Blockage removal was planned once every six months, which is not currently practised.
2	Reactive maintenance	Regular redressal of complaints was carried out by officers at the ward level.
3	Locations free of blockage	Blockages were found in all the areas while the frequency was higher in few locations.
4	Locations with frequent blockages	Most TCC officials were aware of the locations facing regular blockages to initiate focused preventive actions.
5	Steps taken to avoid blockage	<ol style="list-style-type: none"> 1. Insisting the public to not dispose of solid waste into the drainage system, especially in locations facing frequent blockages. 2. Enforcing diaphragm or inspection chambers for apartments and commercial complexes. TCC has directed the Slum Clearance Board to establish this system before linking a new connection (Annexure 1).

Table 2.1: Observations from rapid interviews

Sl. No.	Description	Observation
		3. Providing proper construction steps (manhole followed by pipeline) to maintain the slope.
6	Ways to improve the UGSS connection in uncovered areas	Laying of household connection pipes at shallow levels (commonly adopted across the city, for instance, at 6 feet Sandhu in Srirangam, Vaikalmedu, and Palakarai).
7	Strategy for early detections	There was no strategy followed for early detection, and blockages were identified only through visible overflow from manhole chambers (access opens).
8	Expenditure	Covered under general budget
9	Blockage removal techniques	Based on physical observation, manual removal with spade by labourers (contractors) was the first step, followed by mechanical removal.
10	Complaint mechanism	Complaint mechanism was functioning efficiently through four channels of raising complaints: <ol style="list-style-type: none"> 1. Through WhatsApp on the toll-free number, 1800-102-1994. 2. By informing JE on blockages. 3. By calling the Ward Office and registering complaints. 4. Directly reaching the Ward Office and entering the details in the complaint register.
11	Complaint received per ward	No. of complaints per ward: <ul style="list-style-type: none"> • Ariyamangalam zone, per day 6-8 blockages / 4 wards • K. Abhisekapuram zone, per day 4-6 blockages / 4 wards (Thillai Nagar ward office) • At AEE level, around 8 to 10 complaints on blockages depending on the zones
12	Insights about blockages from interviewees	<ol style="list-style-type: none"> 1. Diaphragm chambers were unavailable in large apartments. 2. Disposal of napkins, plastics, shampoo covers, hair and dumping of oil wastes from hotels into SWD or UGSS network were the main causes of blockages. 3. Rising usage of plastic over the past 10 years has led to increased blockages. 4. Unauthorised linking of SWD with UGSS also led to blockages. 5. Urban poor settlement areas such as Slum Clearance Board housing apartments, slums, junction areas and other densely populated areas were the major locations of frequent blockages.

Table 2.1: Observations from rapid interviews		
Sl. No.	Description	Observation
13	Cost incurred for blockage removal	TCC paid the charges to the contractor, who employed one labourer for small blockages and two for major blockages.
14	Usage of private de-sludging vehicles	For de-sludging, mostly TCC vehicles and occasionally private vehicles were used.
15	Challenges	<ol style="list-style-type: none"> 1. Enforcing restrictions on manual scavenging was difficult despite strict regulations on humans entering manholes (access opens). In case anyone is forced to enter, AEE had to be informed immediately. Moreover, AEEs and JEs frequently visited sites with major blockages during clearance work to ensure only mechanical scavenging was carried out. 2. Construction of diaphragm chambers in large-sized residential apartments was challenging.
Source: CWIS, 2022		

2.4 Observations from the Field

The measures taken to decrease blockages were evaluated on the field and observations are summarised below.

1. **Precaution during de-sludging:** Cover slab was kept open for 10 minutes to expel any gas present in the chamber.
2. **Solid removal:** For small manholes, spades were used to remove solids. In case of difficulty, mechanical blockage removal vehicles were used.
3. **Solid disposal:** Removed solids were retained at the site and later disposed of to the nearest micro compost centre.
4. **Blockage clearance:** The exact point of blockage was determined, and sludge was removed using a de-sludging vehicle. A jetting pipe was used to clear smaller blockages, whereas the line was cut and the sewage was diverted to nearest open drains in case of large blockage.
5. **Reasons for blockage:**
 - Hair, shampoo and plastic covers, clothes and other solid wastes
 - Thick layer of scum (sludge) in manhole (due to velocity issues)
 - Water usage pattern in slums
 - Connecting with SWD through bypassed arrangement
 - Silt settling in pipelines due to various reasons such as soil and silt in run-off water

6. **Pipeline construction:** Work on revamping and replacing old pipeline network in many parts of the city was observed.
7. **Continuous monitoring:** Due to the sensitive nature of blockage removal, major work was continuously monitored by AEE or JE. However, a thorough assessment is required to evaluate the frequency, causes, and overall effectiveness of the blockage clearance process. This includes identifying recurring issues, ensuring the practice of preventive measures, and assessing the deployment of adequate resources (Annexure 2) and strategies to ensure long-term resolution.

Studying Diaphragm Chambers

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3. Studying Diaphragm Chambers

Diaphragm chambers (Figure A1.2; Annexure 1) are specialised structures integrated into UGSS networks in residential areas to prevent clogging and improve wastewater flow efficiency. These chambers function by regulating the passage of solids and reducing the accumulation of debris that may obstruct pipelines. They typically use a flexible or perforated membrane to allow the passage of liquid while trapping solid waste, which can be periodically removed through maintenance access points

As TCC has passed orders to construct diaphragm chambers in bulk generators, and has recommended them for households as well, insights were obtained from AEEs to understand its design and construction.

3.1 Investment for Implementation

The TCC oversaw the construction of the system at the household level, while apartments and commercial complexes continued with their existing sanitation practices. Following the notification from TCC, **apartments in Trichy began the construction of diaphragm chambers.**

Table 3.1: Comparison between onsite sanitation system and diaphragm chamber		
Description	Onsite Sanitation System	Diaphragm chamber
Purpose	Primary digestion of wastewater	Settling of silt, floating materials, and oil traps
Frequency of cleaning or de-sludging	Once in 2 years or less	To be cleaned as frequently as daily or weekly
Risk of hazardous gas	High	Moderate
Design consideration	IS 2470-Part 1	No special design guidelines are followed. A simple septic tank structure irrespective of the number of users can be provided to trap the floating materials, grease and silt.
Source: CWIS, 2021		

3.2 Maintenance Processes and Cost

Regular UGSS maintenance involves scheduled removal of solids, with de-sludging every six months, costing approximately INR 3,000. TCC handled the maintenance for household units, while apartments and commercial complexes were responsible for their own upkeep.

3.3 Operation and Maintenance Challenges

Frequency of cleaning and de-sludging depends on the size, usage pattern and load of the diaphragm chamber. During the period of the study, diaphragm chambers faced O&M issues as they were not constructed as per the provided schematic diagrams [2, 3]. For example, one of the chambers in Slum

Board colony was constructed by TCC officials as per their need to retain floating materials. However, the chamber had accumulated scum and silt layers within four months of operation and the TCC had requested a Slum Board representative to clean the chamber, which was pending at the time of the study.

3.4 Comparison between Diaphragm Chambers and Onsite Sanitation Systems in terms of Operation and Maintenance

A comparison of the O&M of diaphragm chamber and onsite sanitation systems is provided in Table 3.2.

Table 3.2: Comparison of diaphragm chamber and onsite sanitation systems in terms of O&M		
Description	Diaphragm chamber	Onsite Sanitation Systems
Frequency of cleaning	Once a week or whenever blockage occurs	At least once in 2 years
Chances of gas accumulation	High as there might be some chances of gas accumulation due to 'reverse way' ² from the UGSS line	Low as it is an individual household
Disposal arrangement	Not required if maintained regularly since it is connected to the UGSS line	Required but difficult to meet the recommended guidelines by Central Public Health and Environmental Engineering Organisation (CPHEEO) due to ground water table and soil conditions
Operational cost	High since it requires routine cleaning arrangement until behavioural change of users	Low
Source: CWIS, 2021		

3.5 Observations from a Sample Diaphragm Chamber

A sample diaphragm chamber near Central Bus Stand was studied to assess the efficiency of the structure. The study aimed to determine the chamber's compliance with safety and engineering design standards, assess the operational performance, identify potential improvements, and provide recommendations for better functionality and enhanced sewage management. This included examining their capacity to regulate sewage flow, prevent blockages, and avoid gas accumulation, particularly reverse gas flow from UGSS systems. The evaluation also considered the installation and maintenance of chambers, and identified structural flaws, improper connections, and operational inefficiencies. (See Annexure 1)

² 'Reverse way' refers to the unintended backflow of gases from the UGD lines into the chamber due to pressure imbalances, improper venting, or inadequate design of the system.

3.6 Study Area

There were many hotels and commercial complexes in the city that did not provide proper diaphragm chambers. The study chose a hotel near Central Bus Stand with the support of the JE of the ward.

To facilitate the assessment, TCC provided support by deploying labourers to examine the tank. However, due to the workers' unfamiliarity with diaphragm chambers, their observations were limited to general aspects of the tank's physical condition rather than a thorough evaluation of its functionality. The workers had little knowledge about the purpose, location, and operational aspects of the diaphragm chamber,

This highlighted the need for targeted training and capacity building efforts to ensure that field staff and sanitation workers can effectively inspect, maintain, and manage diaphragm chambers as part of UGSS operations [6, 7]. This field visit facilitated the bridging of gap in knowledge regarding the intended function of the chamber in regulating sewage flow, preventing blockages, and minimising gas accumulation.

During the observations, it was found that the tank was not a diaphragm chamber but a holding tank for sullage (handwashing and kitchen wastewater). It was also noted that the toilets of the hotel (blackwater system) were connected to UGSS directly without passing through the tank, and house service connection chamber was absent.

3.7 Recommendations

To enhance the efficiency of UGSS maintenance and minimise blockages, the following actions have been recommended:

1. **Expansion of good practices** – TCC's effective practice of identifying blockage-prone locations and issuing notices to contributors should be expanded citywide.
2. **Survey and risk assessment** – Survey and risk assessment – A comprehensive survey of apartments and commercial complexes with diaphragm chambers should be conducted [7] to assess risks of gas accumulation, which may lead to toxic gas exposure or explosions. This will help identify design flaws, maintenance lapses, and operational inefficiencies while ensuring compliance with safety regulations.
3. **Preventive measures and maintenance** – Addressing issues like blockages and backflows require proactive measures such as regular inspections, proper venting, and retrofitting. Implementing these steps will enhance the safety, sustainability, and longevity of the UGSS while reducing repair costs and safeguarding public health.
4. **Pilot de-sludging and performance assessment** – To gain practical insights, diaphragm chambers at select locations should be de-sludged and monitored.
5. **Capacity building and training** – Enforcing restrictions on manual scavenging was difficult despite strict regulations [1], Workshops on preventing manual scavenging and capacity building sessions on blockage removal techniques should be conducted for TCC officials, leveraging external expertise where necessary.
6. **Targeted interventions in urban poor settlements** – A deeper analysis should be conducted to understand the high contribution of slums to sewer blockages, enabling focused solutions.

7. **Awareness and enforcement** – Awareness campaigns should promote adherence to proper diaphragm chamber construction among bulk waste generators to improve UGSS functionality and sustainability.

By implementing these recommendations, UGSS operations can be strengthened, ensuring a safer and more efficient urban sanitation system.

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Annexures

Annexure 1: Intimation for constructing diaphragm chamber A3

Annexure 2: Mechanical resources owned by TCC for sewerage maintenance A5

Annexure 3: Observations from site visit A6

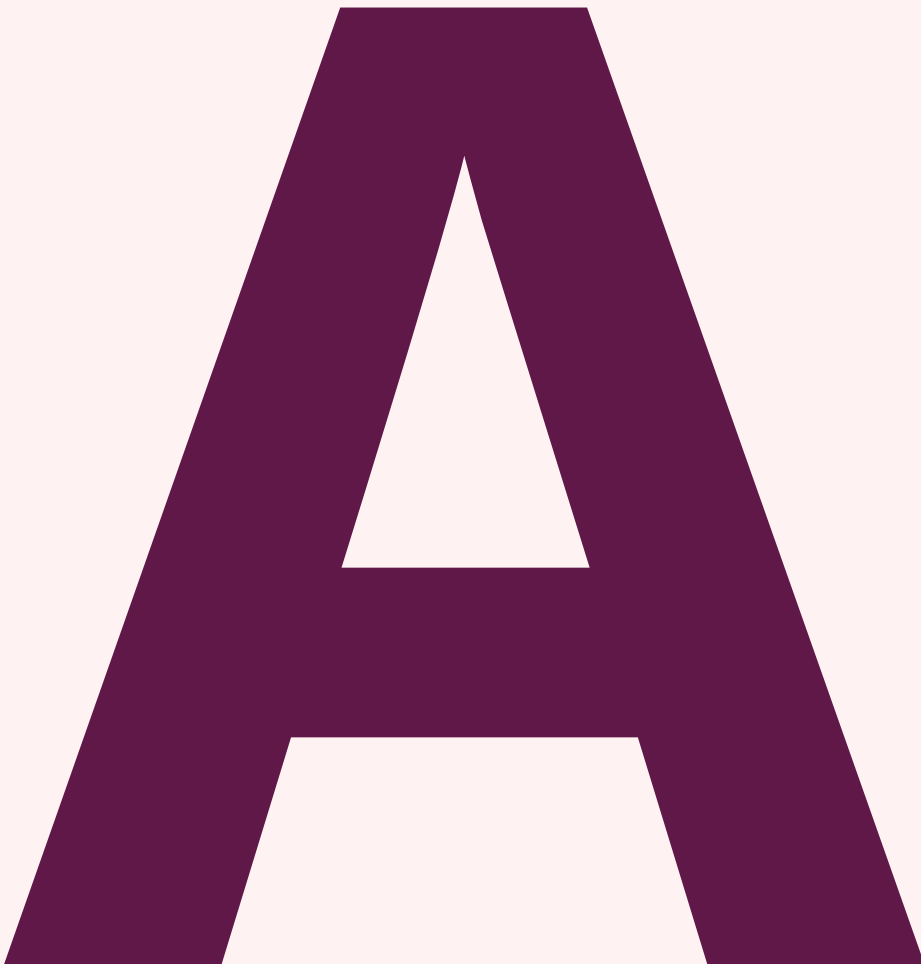
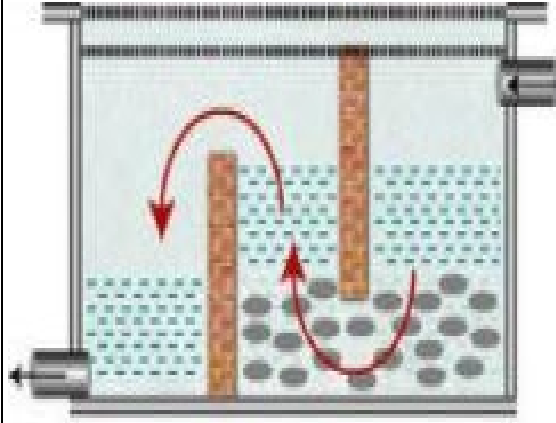
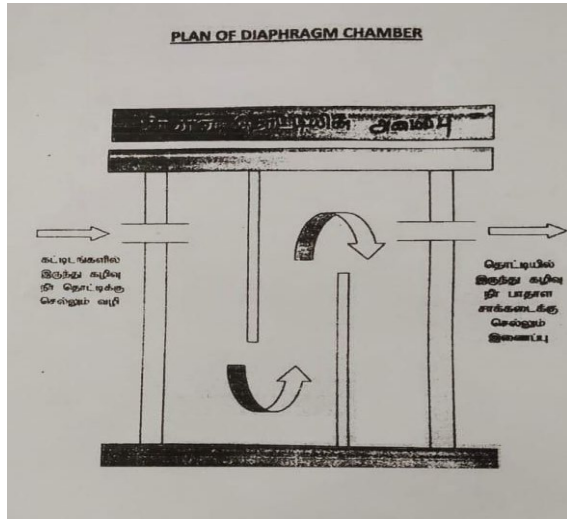





Figure A1.2: Schematic Diagram of Diaphragm Chamber



Source: TCC, 2021

Annexure 2: Mechanical resources owned by TCC for sewerage maintenance

Table A2.1: TCC mechanical resources for maintenance of underground sewerage system			
Sl. No.	Description	Number of vehicles	Image
1	De-sludging vehicles – 6KL	2	
2	Blockage removal vehicle - Jetting machine	4	
3	Small-sized grit or silt removal vehicle with cleaning arrangement	4	
Source: TCC, 2021			

Annexure 3: Observations from site visit



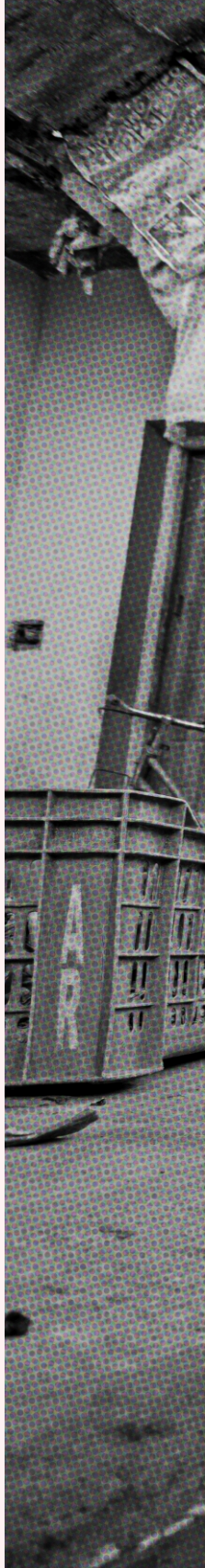
Figure A3.1: Observations from site visit	
Scum layer inside the underground drainage manhole	Open manhole (access open removed)
	
Progress of underground sewerage system revamping work	
	
Increase in the height of UGSS connection by shallow sewer connections (6 Feet Sandhu, Srirangam)	
	

Figure A3.1: Observations from site visit

<p>Removed solid wastes to be handed over to solid waste collection vehicle</p>	<p>Overflow pipe from access chamber connected to storm water drain</p>	
		
<p>Complaint Register and Job Sheet</p>		
		
<p>A diaphragm chamber constructed at a slum colony <i>(Since de-sludging was not completed, we were unable to find provisions and grit/ floating material accumulation in the diaphragm chamber)</i></p>		
		
<p>Source: CWIS, 2021</p>		



City-Wide Inclusive Sanitation programme, Tiruchirappalli (CWIS-Trichy), Tamil Nadu supports the Trichy City Corporation (TCC) to make the improvements along the full cycle of sanitation. In particular, this programme will enable inclusive sanitation by mainstreaming gender, seeking improvements in service for the urban poor, increasing occupational safety, welfare for the sanitary workers and improvements in infrastructure.



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