

Appendix 15

NRW Reduction Manual

NRW REDUCTION MANUAL

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JICA Expert Team (Water Sector)

The Project for
Comprehensive
Improvement of
Environmental
Sanitation in Varanasi
(CIESV)

FOREWARD

This manual is developed by JICA Expert Team¹, as one of the outputs from the JICA Technical Cooperation — the Project for Comprehensive Improvement of Environmental Sanitation in Varanasi (hereinafter referred to as “the Project”). The project started in July 2020 and completed in June 2024, during which JICA Expert Team worked together with Jal Kal, Varanasi Nagal Nigam (Jal Kal) and Uttar Pradesh Nagal Nigam (UPJN) to reduce Non-Revenue Water in Konia, a pilot project area in Varanasi.

This manual was developed to help Jal Kal and UPJN managers — such as Chief Engineers, General Managers, Project Managers, Superintendent Engineers, Executive engineers, Assistant engineers, and Junior engineers etc.— to continue Non-Revenue Water reduction in Varanasi by themselves after the Project finished. The Contents of this manual reflect the outcomes from the pilot project carried out in Konia Varanasi. Regarding the operational procedure of leak survey tools, only the essentials are described in this manual such as principle, intended purpose, how to use and point to note. For more details, especially how to operate the machine, please refer to the operation manual of each equipment, provided by the manufacturer.

In this manual, where the goal is to reduce Non-Revenue Water (NRW), “Leak Reduction and Prevention” account for the major part. It is because leakage is the main part of the NRW in Varanasi and the project put priority in reducing leakage (or “real loss” in terms of the definition of International Water Association). However, during the Project, some countermeasures are taken to reduce “Unbilled Authorized Consumption”, and illegal connection (or “Apparent Losses”). For more details, please see the Completion Report of the Project for Comprehensive Improvement of Environmental Sanitation in Varanasi.

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GLOSSARY AND ABBREVIATIONS

BFM	Bulk Flow Meter
CIESV	the Project for Comprehensive Improvement of Environmental Sanitation in Varanasi
HDPE	High density polyethylene
JICA	Japan International Cooperation Agency
Jal Kal	Jal Kal Vibhag Nagal Nigam
JET	JICA Expert Team
UPJN	Uttar Pradesh Nagal Nigam
OHT	Over-head Tank
PVC	Polyvinyl chorine
The Manager(s)	Manager of Jal Kal and UPJN, such as Chief Engineers, General Managers, Executive Engineers, Assistant Engineers, and Junior Engineers etc.
The Project	The Project for Comprehensive Improvement of Environmental Sanitation in Varanasi

1. Water Balance Analysis

1.1. Water Balance

Jal Kal and UPJN managers — such as Chief Engineers, General Managers, Project Managers, Superintendent Engineers, Executive engineers, Assistant engineers, and Junior engineers etc. (herein referred to as “the Managers”) — shall set their target of Non-Revenue Water reduction, taking into account of the resources and economics of the water authorities.

The first important step for the Managers to reduce NRW is to understand the water balance in their target area. Developing a Water Balance table is quite useful to understand the overall picture of water usage in the target area. Water Balance table helps utility managers to analyze the causes of NRW, and to consider countermeasures against the causes of NRW. The International Water Association (IWA) has developed a standard Water Balance table and terminology, which has been adopted by national associations in many countries across the world.

Table 1-1. Standard Water Balance (International Water Association)

System Input Volume	Authorized consumption	Billed Authorized Consumption	Billed Metered Consumption	Revenue Water
			Billed Unmetered Consumption	
		Unbilled Authorized Consumption	Unbilled Metered Consumption	Non-Revenue Water (NRW)
			Unbilled Unmetered Consumption:	
	Water Loses	Apparent Losses (or Commercial Losses)	Unauthorized Consumption	
			Customer Meter Inaccuracies and Data Handling Errors	
		Real Loss (or Physical Losses)	Leakage on Transmission and Distribution Mains	
			Leakage and Overflows from the Utilities Storage Tanks	
			Leakage on Service Connections up to the Customer Meter	

1.2. Method to Analyze Water Balance

Hereunder are the suggested steps to develop Water Balance Table in Varanasi.

- Step 1: Measure System Input Volume (by using bulk flow meter)
- Step 2: Measure Billed Authorized Consumption, or Revenue Water, by using customer meters installed
 - a) Billed Metered Consumption (measured by customer meters installed)
 - b) Billed Unmetered Consumption (calculated by estimation)
- Step 3: Calculate Non-Revenue Water by subtracting the Revenue Water from the System Input
- Step 4: Analyze Unbilled Authorized Consumption
 - a) Unbilled Metered Consumption (measured by customer meters installed)
 - b) Unbilled Unmetered Consumption (calculate by estimation)
 - c) Calculate Unbilled Authorized Consumption as a) plus b)
- Step 5: Calculate Authorized Consumption by adding Billed Authorized Consumption and Unbilled Authorized Consumption
- Step 6: Calculate Water Losses by subtracting Authorized Consumption from System Input Volume
- Step 7: Assess components of Unauthorized Consumption, and Metering Inaccuracies and Data Handling Errors by best means available through field verification and by estimation. Add Unauthorized Consumption and Metering Inaccuracies and Data Handling Errors to calculate Commercial Losses
- Step 8: Calculate Real Losses by subtracting the Apparent Losses from Water Loss
- Step 9: Assess components of Real Losses by best means available in the field and through desk studies.

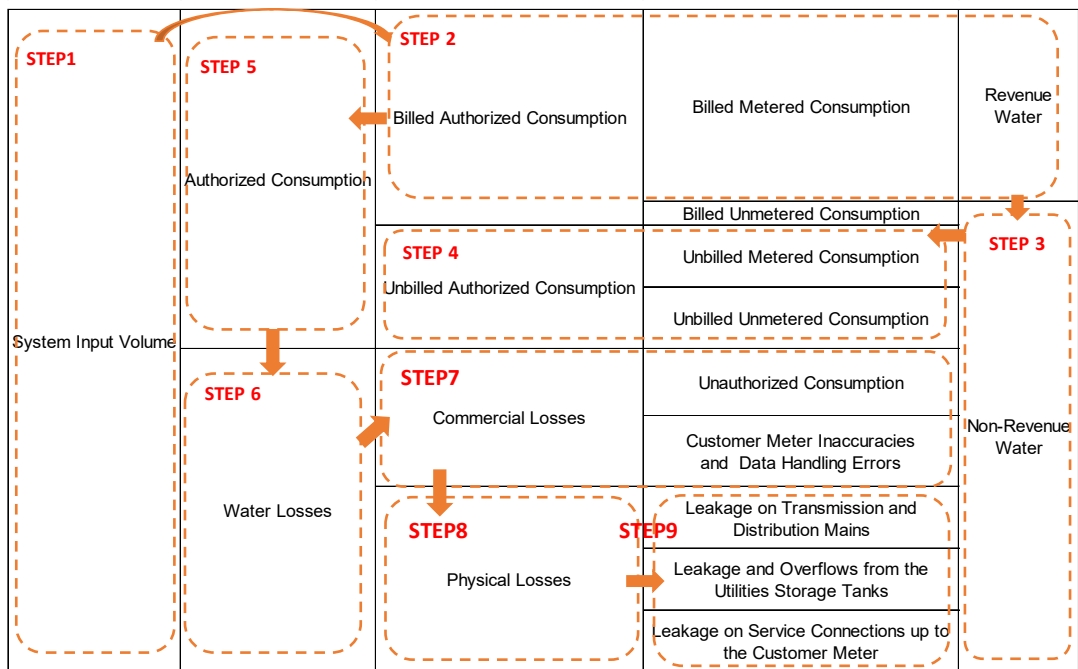


Figure 1-1. Steps for Calculating the Water Balance

2. District Metered Area (DMA)

2.1. DMA and NRW calculation

District Metered Area (DMA) is an area hydraulically isolated from the surrounding areas by sluice valves and flowmeters. DMA is commonly deployed in Pilot Project in many Technical Assistance programs because it can enable water authority managers to analyze NRW (including leakage), consider counter-measures against the cause of NRW, and monitor the impact of counter-measures upon NRW reduction.

In DMA, the volume of System Input (water inflow minus outflow) is measured by bulk flowmeters installed at the DMA boundaries. Also, the volume of Billed Authorized Consumption (or “Revenue Water”) is measured by customer meters (or domestic meters) installed at each water customers. By knowing the both the Manager can calculate the NRW as follows:

$\text{NRW} = \text{System Input} - \text{Billed Authorized Consumption (Revenue Water)}$

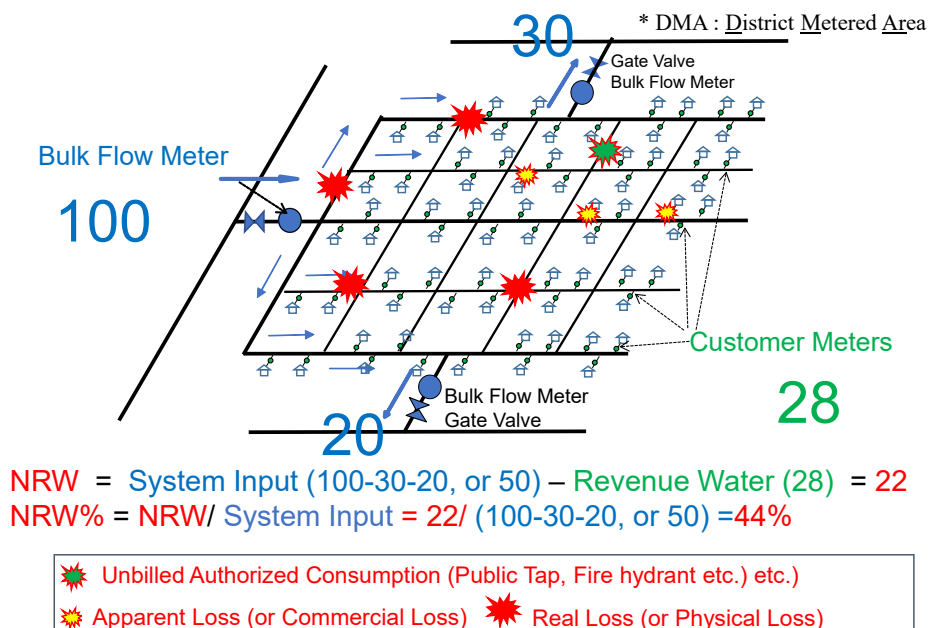


Figure 2-1. Conceptual Drawing of DMA

2.2. Selection Criteria of DMA

In general, hereunder are the set of criteria commonly used for DMA selection. In reality, however, selection of DMA out of all service areas, and designing the DMA is very much subjective to utility managers, and thus it is likely the different managers working for the same service area would come up with the different selection with different design of DMA.

- (a) **Availability of water:** In principle, water shall be available 24 hours a day, and 7 days a week. This is basic condition of accurate water balance analysis, leak survey and leak repair work.
- (b) **Availability of accurate pipeline drawings:** To design and establish DMA, the Managers shall have accurate pipe network drawings of the area. The Managers should check all inflow and outflow pipeline to and from the DMA, and shall install sluice valves and/or bulk flowmeter onto the lines for hydraulic isolation of the DMA.
- (c) **Size of DMA (number of service connections, area, geographical conditions):**
Depending on available resources, such as time, labor and budget, the Managers shall decide the size of DMA. Commonly used DMA size in pilot project is from 100 to 1000 connections, for it is somewhat “manageable” under limited resources.
- (d) **Number of valves:** To segregate the DMA hydraulically from the surrounding areas, the utility manager has to install valves (sluice valve, end cap etc.) on connecting line. In principle, the less sluice vales needed, the less cost incurs and easy to establish DMA.
- (e) **Number of bulk flow meters needed for inflows and outflows measurement:**
In principle, the less flow meters, the less cost incurs. Moreover, the less likely problems occur (such as submersion in rainy season, meter reading errors etc.) Practically speaking, several flow meters are manageable manually, but more than 10 flowmeters are less likely manageable by manually and need computer aided system, like Supervisory Control and Data Acquisition (SCADA)

2.3. About Konia

Konia is located in the central part of Varanasi, with a population of 17,985, according to the census in 2011. Located along the Varuna-river, the ward is naturally isolated from the other Northern wards. This area was selected as an area for the Pilot Project in November 2020, when the project was at the very initial phase.

At the beginning of the Project, due to travel restriction caused by COVID 19, JET had to call series of “on-line” meetings to explain about the project and discuss the Pilot Project area. Via the on-line meetings, pipe network seemed in Konia seemed much simpler than any other areas, which is one of the main reasons of choosing Konia as the Pilot Project area.

2.4. DMA Development

2.4.1. Installation of Bulk Flow Meter (BFM)

Bulk Flowmeter is the water flow meter installed to monitor the water flow on the line.

In case of Konia, one BFM, at the exit of Overhead tank (OHT), was installed to measure the “inflow” water flow volume to the DMA, and four (4) others were installed to measure the “outflow” water volume from the DMA to the downstream areas.

2.4.2. Flow meters to measure inflows

As for the inflow measurement, a bulk flow meter (BFM) was installed at the exit of overhead tank (OHT) at Konia. Before and after the bulk flowmeter installed were the sluice valves for a maintenance work of the BFM.

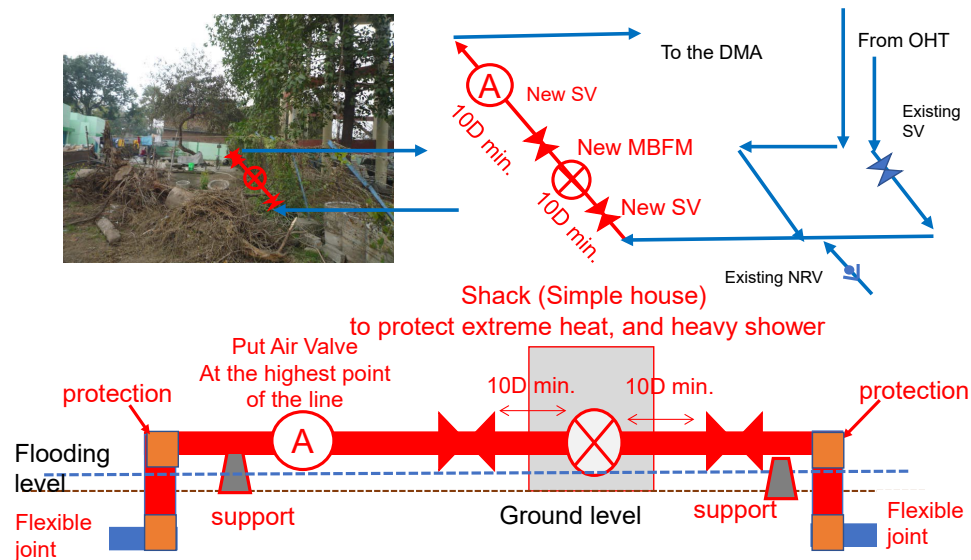


Figure 2-2. Installation of Bulk Flow Meters to measure the inflows to DMA

2.4.3. Flow meters to measure outflows

As for the outflow measurement, four (4) bulk flow meters are installed at the boundaries of DMA as shown in Figure below — point C, E, G and I respectively. Those Bulk Flow meters were installed together with sluice valves before and after the meters, for the maintenance and valve operation purpose

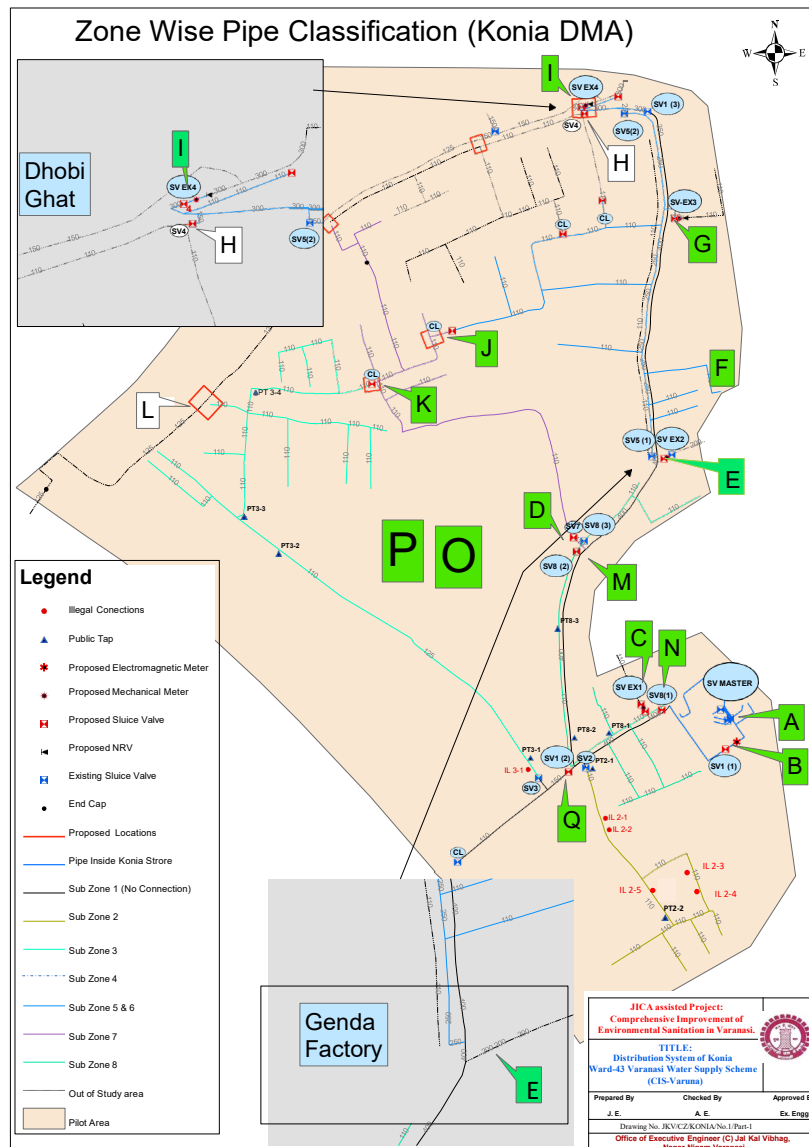


Figure 2-3. Installation point (C, E, G and I) of bulk flow meters (outflows).

2.4.4. Chambers for the Bulk Flowmeter:

Bulk flow meters shall be installed properly in “solid” and “water-tight” chambers to prevent the BFM from submergence by flooding and collapse by road traffic. Chamber shall be covered with water tight lid, and drainage shall be made properly by installing drainage pipe at the bottom of the chamber.

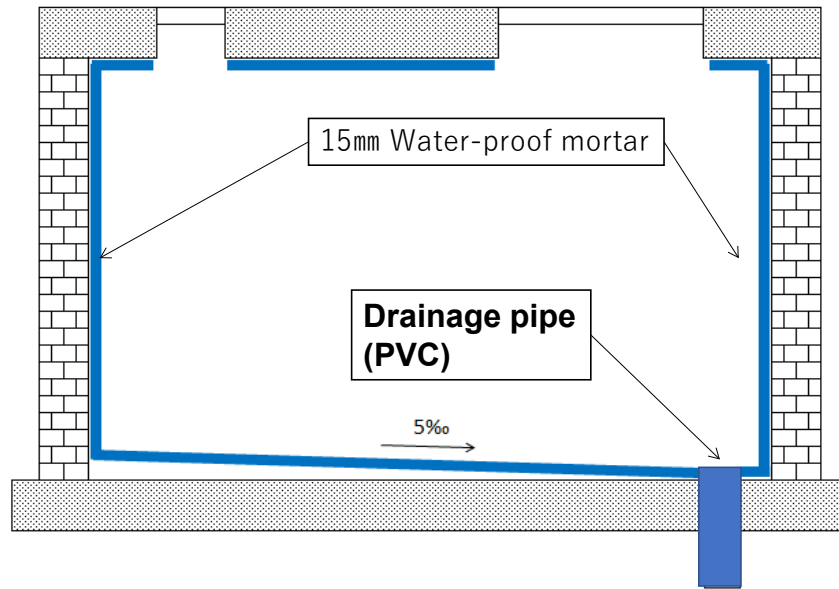


Figure 2-4. Example of Bulk flowmeter Chamber

2.4.5. Installation of customer-meters

In general, customer meters are not installed in Varanasi. Customers who have water pipe connection are charged “Water Charge,” based on the Assessed Annual Value of the Premises (or Annual Rental Value). Customers without service pipe connection but live within 100meter from water service pipe are charged “Water tax.”

To measure the volume of Revenue Water, customer meters were installed to each customer. In this project, Automatic Meter Reading (AMR) was proposed by the Indian side (namely Jal Kal and UPJN), in order to reduce heavy workload of meter-reading and to reduce human errors of meter-reading. In general, customer meters are installed along street, outside household, so that meter readers can access the meter without entering (or bothering) households. However, strongly suggested by the contractor who has other track records of AMR installation in other Indian cities, customer meters (AMR) are installed inside each house so that meters will not be stolen nor tampered by others.



Figure 2-5. Photos of Customer meters installed in DMA.

Due to public resentment, 299 customer meters, out of total 655 customers, were installed in DMA, between May 2022 and September 2022.

2.5. Dividing DMA into Sub-zones

Dividing DMA into several sub-zones is useful to find the most severely leaking area out of whole DMA. If some sub-zones have more NRW than any others, the Managers should put higher priority on locating leaks and leak repairs in the sub-areas than others. Also, if NRW is negligible in any sub-zones, utility managers can avoid further investigation in the area. As for the identification of severely leaking sub-zones, “Step Test” or “Minimum Night Flow” measurement is useful and commonly used. For more details, please see the Section 5.1 of this manual.

In case of DMA Konia, eight 8 sub-zones were developed by using 8 sluice valves — of which 5 are newly installed valves and 3 were existing ones.

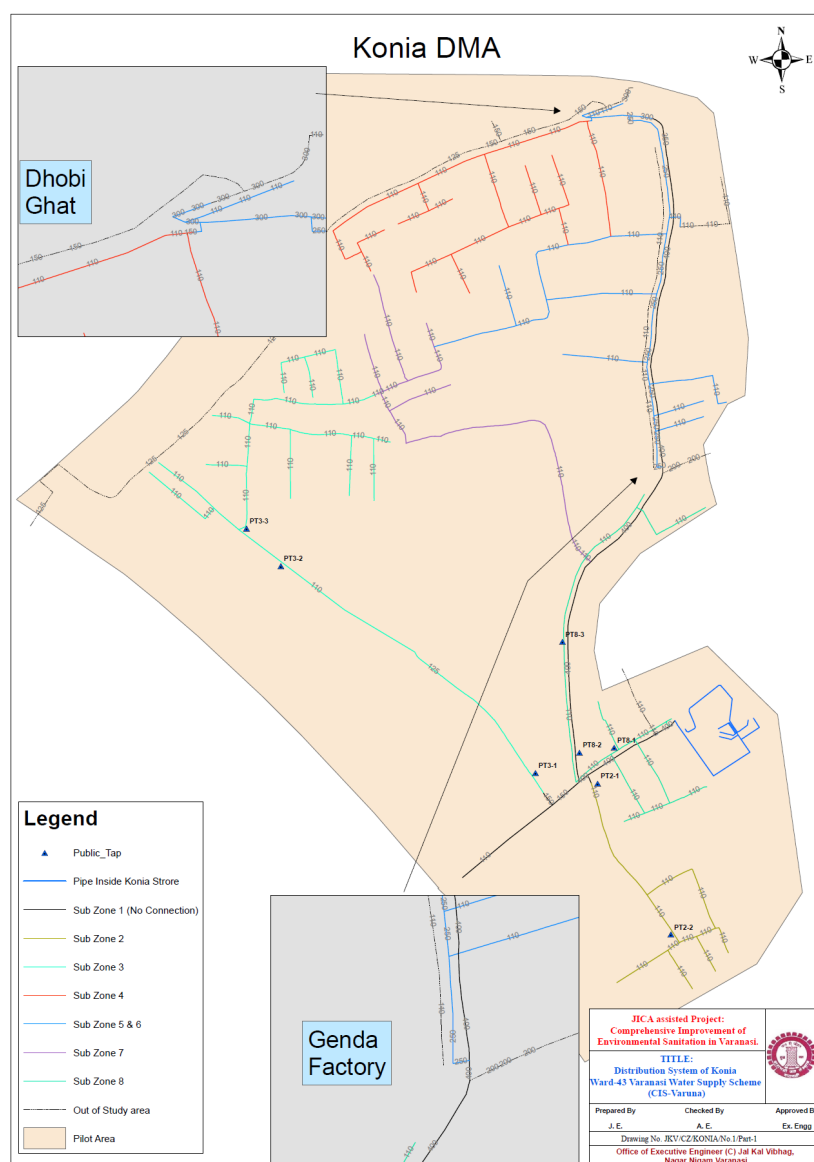


Figure 2-6. Sub-zoning of DMA

2.6. Result of Water Balance Analysis (Baseline)

Hereunder is the result of the Water Balance Analysis carried out during the Pilot Project. For more details, please see the Completion Report of The Project for Comprehensive Improvement of Environmental Sanitation in Varanasi (CIESV).

Table 2-1. Tentative Result of Water Balance Analysis (As of November 2022)

System Input Volume	Inflow	Authorized consumption	Billed Authorized Consumption	Billed Metered Consumption			Revenue Water (RW) 47%
				Billed Unmetered Consumption	541	46.8%	
	Outflow			Unbilled Authorized Consumption	Unbilled Metered Consumption		Non-Revenue Water (NRW) 53%
					Unbilled Unmetered Consumption:	8	
	The Balance (Inflow - Outflow)	Water Losses	Apparent Losses (or Commercial Losses)	Unauthorized Consumption (Illegal connection)	42	3.6%	
				Customer Meter Inaccuracies and Data Handling Errors			
			Real Loss (or Physical Losses)	Leakage on Transmission and Distribution Mains	565	48.9%	
				Leakage and Overflows from the Utilities Storage Tanks (OHT at Konia)			
	Leakage on Service Connections up to the Customer Meter						

3. Goal Setting and Action Planning

Based on the Water Balance Analysis, the Manager shall consider countermeasures against the NRW and shall set a “realistic” reduction goal (or milestone). To set a “realistic” goal, the Manager shall make a concrete action plan to reduce each component of NRW, by allocating reasonable budget and human resources.

Hereunder is the Tentative Action Plan suggested by JET against the Water Balance.

Table 3-1. Tentative Action Plan of NRW reduction in DMA1

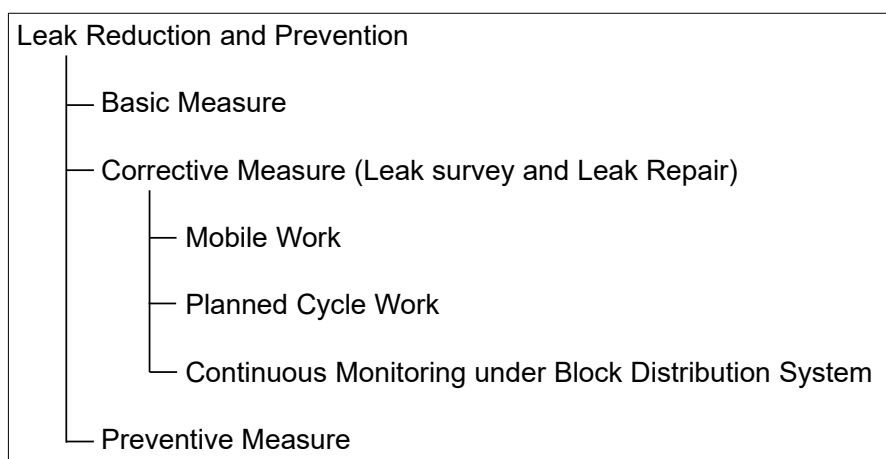
	Category	Measures to be taken
1	Reduction of Real Loss	i. Identify heavily leaking Sub-zones, by conducting Step Test of Minimum Night Flow (MNF) in Midnight ii. Conduct Leak Detection in the leaking Sub-zones, a. Stress Test (=find surface leak with expected “normal” pressure) b. Leak Detection by using Electro Leak Detector, Correlators under relatively high pressure iii. Repair Leaks a. Develop and Implement Standard Specs for the Repair Works, in order to increase the quality of repair work
2	Reduction of Apparent Loss	Provide Decent Stand-Pipe with proper Tap (made of metal)
3	Reduction of Auth. Unb. Con.	Provide Decent Stand-Pipe with proper Tap (made of metal)

4. Overview of Leakage Reduction and Prevention

4.1. Body of Theory about Leak Reduction and Leak Prevention

In general, Water leakage reduction and prevention measures can be classified into three categories² — **(1) Basic Measures, (2) Corrective Measures, and (3) Preventive Measures**. The Managers shall take Basis Measures all the times as the basis of non-revenue water reduction activities, and combine Corrective Measures and Preventive Measures with this, depending on the time and depending on the time and circumstances.

Table 4-1. Overview of Leak Detection and Prevention.



4.2. Basic Measures

4.2.1. Leakage Analysis and Monitoring

Leakage analysis is the classification of leaks (1) by facility (such as water transmission/distribution main/distribution branch pipes, water supply pipes, distribution ponds, etc.), (2) by cause (natural leakage, accidental damage), or (3) by region etc. It is important for the Managers in planning leakage reduction, because it provides an understanding of the leakage situation. Water Balance Analysis using the Water Balance Table is one of the useful methods of leakage analysis (please see the Chapter 2.)

In principle, the Manager can analyze the amount of water leakage by the following three methods:

a) Direct Measurement Method:

The Manager close all the inter-boundary valves of the target areas, and confirm that there is no inflow to or outflow from the target area. With all service connections valves closed, the Manager supply water from a certain point of the area (using fire-hydrant or water track for example), and measure the

² “The Guideline of Maintenance Management of Water Service (2016),” Japan Water Works Association, p469-474.

amount of water supplied into the area by using water flowmeter installed at the measuring point. There are two (2) ways for this direct method — (1) divide the target area into several sub-areas and measure the leakage volumes of all sub-areas (“circulation method”); and (2) choose one small sub-area and measures the leakage of the sub-area to represent whole target area (“sampling method”)

b) Indirect Measurement Method:

The Manager measure Minim Night Flow. This method is called Minimum Night Flow survey. The MNF measurement is a method to measure the amount of water leakage, based on the assumption that water is not used by anybody in the target area during midnight if selected properly.

c) Water Balance Analysis Method:

The Manager estimate amount of leakage by analyzing water balance. In brief, the amount of leakage is system input volume minus “effective” water volume in the area. Effective water is the billed or unbilled authorized and/or unauthorized water.

4.2.2. Internal Training

Technology and Knowledges of how to reduce leakage must be transferred from skilled engineers to others, one generation to others, since leakage reduction and prevention requires a lot of workforces and takes long time, like several decades. Internal training is very much important for such technology transfer within Jal Kal and UPJN. Trainings can be done in different manner — such as lecture in room, field training, and on-the-job training on the field, or mixture of these. The managers shall develop internal training programs and carry them out systematically to increase the human capacity of Jal Kal and UPJN, and improve quality of work.

4.3. Corrective Measures

Corrective Measures is the activities to reduce leakage by leak survey and leak repair. These measures can be divided into three categories — (1) **Mobile Work**, (2) **Planned Cycle Work**, and (3) **Continuous Monitoring under Distribution Block system**.

4.3.1. Mobile Work

This is the work to quickly investigate leakage (mostly for aboveground leakage), identify the point of leak, and repair the leakages (by pipe repair, rehabilitation or replacement etc.). In principle, Mobile Work is taken reactively, not preventively, in response to customer complaints or accidental damages caused by leakages.

This method is commonly used by water authority managers when required to identify leaks and to repair pipes urgently with limited human resources and budget. Usually, the areas of mobile work are decided reactively by the seriousness of leakage (a large volume of leakages, a large number of complaints from customers for no water, low water pressures, or dirty water etc.)

4.3.2. Planned Cycle work

The Manager divided a service area into segments appropriate for work efficiency, and conduct underground leak survey, and fix leaks systematically in a certain cycle (let's say every 2-5 years) by conducting (1) patrol (preliminary inspection), leak survey, and leak repair works in each segment. In general, this approach requires allocation of human resources and budget appropriately.

4.3.3. Continuous Monitoring under Distribution Block System

The Manager can monitor leakage by dividing the service area into small "Distribution Block Systems" and installing flow-meters into each block system.

4.3.4. Monitoring Leakage Recurrence

Leaks are caused by aging of the pipes, earthquakes, ground subsidence, corrosion, traffic loads, and nearby construction work by other utilities (sewerage, electricity, gas etc.). Even though leaking point is repaired, another new leak occurs near that repaired (or patched) point if the pipe material and the environment remain the same. This phenomenon is called "Leakage Recurrence." To monitor the leakage recurrence, the Managers should select a representative segment and conduct a follow-up survey every 1 to 2 years to estimate the amount.

4.4. Preventive Measures

This is the needful work to prevent “leakage recurrence (please see below)” and reduce leakages.

Preventive measures involve the followings.

- Replace or rehabilitate aged pipe.
- Improve Pipe (change material, layout, etc.)
- Control water pressure appropriately
- Take anti-corrosion measure against corrosive pile (such as mild steel)
- Measures for other utilities (electricity, gas, sewerage)

For more details about preventive measures, please see Section 8 (Preventive Measure)

5. Leak Survey

5.1. General Principle – 3 Step Investigation (Area-wise, Line-wise, and Point-wise)

To repair or replace leaking pipes, the Manager must find the leaking point on the pipeline. Otherwise, he/she has to replace all the doubtful pipelines. To find leaking points specifically from vast pipe network require skills and strategy. To narrow down leaking points from a network of pipelines, the Manager can take the following three (3) steps;

- (a) **Area Investigation**: The first step (or method) is used to find small sub-zone (or segment) which has more leakages than other sub-zones in the target area, by investigating leakage volume of each sub-zones. “Area-wise step of Minimum Night Flow by using electromagnetic flowmeter (or portable ultrasonic flow meter)” can be used in this step.
- (b) **Line Investigation**: The second step is to identify lines with relatively higher leakage volume than other lines. To this end, (a) Step Test with ultrasonic flow meter, (b) Electronic listening stick is commonly used.
- (c) **Point Investigation**: The third step is to locate the points of leakage from the area narrowed down by the previous steps. During this step, (a) Electric Leak Detector, (b) Leak Noise Correlator, and (c) Listening Stick are commonly used to identify the leaking point.

Ideally, the Manager can take each step one-by-one — from Area investigation (step 1) to Line investigation (step 2), and to point investigation (step3). In reality, however, it may not be the case sometime, with limited human resources, budget, and time etc. Instead of step (a) and (b), the Manager can use the below mentioned “Indirect Diagnosis Method” to narrow down the leaking lines.

5.1.1. “Indirect Investigation Method”

“Indirect Diagnostic Method” is the way to find the area or lines which needs repair or replacement by using existing data and information accumulated through day-to-day operation and maintenance activities. Hereunder are the indirect method commonly used by water authority managers.

- Ages of the pipe
- Number of complaints of the pipe (or area), such as no water, low pressure, low water quality etc.).
- Number of leaks identified on the pipe (or the area)
- Serious accident caused by natural disaster (flooding, earthquake etc.)

With the above-mentioned principle in mind, the Manager shall consider how to narrow down the leaking points effectively. Details of each leak survey method in each step are described in the following sections.

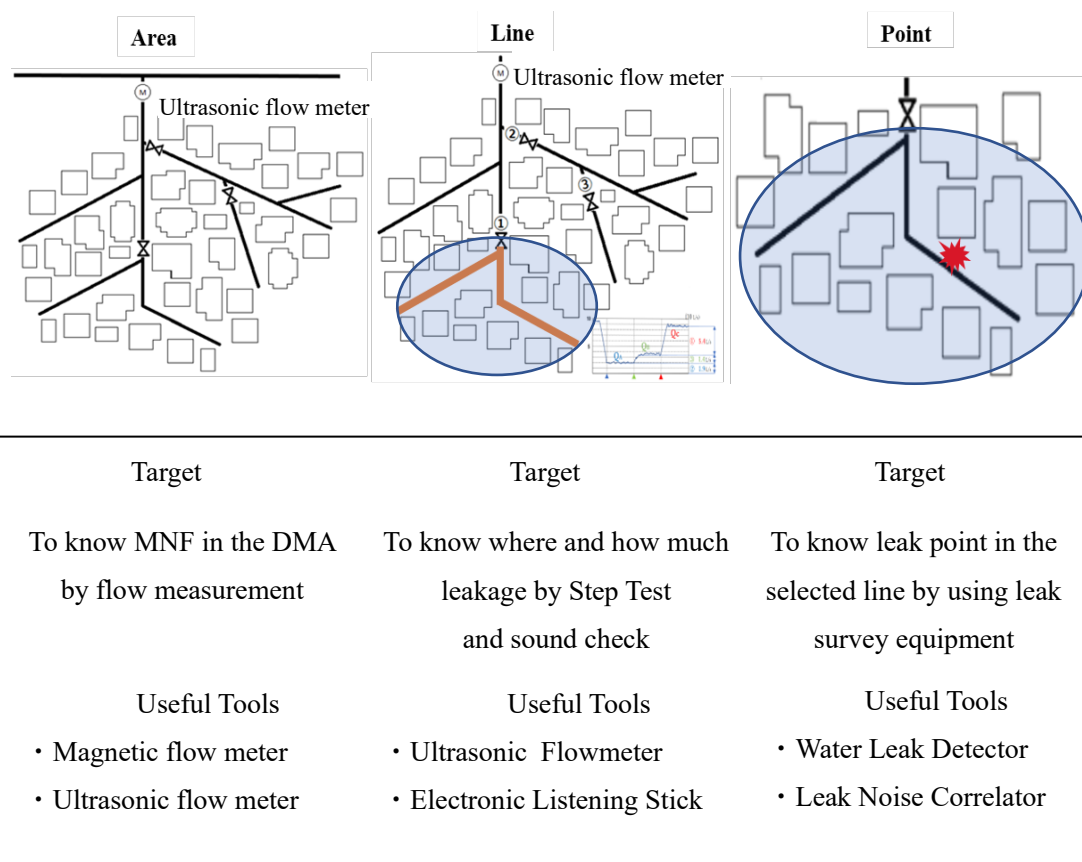


Figure 5-1. Narrowing Down Method and Tools

5.2. Minimum Night Flow (MNF)

Knowing existing leak volume in the target area is important for the Managers before conducting detailed leak surveys. Hereunder is useful technique to estimate the leakage volume in a target area or target line.

In general, water usage decreases after peak-hour in the evening (let's say from 5 pm to 8 pm in case of Konia), and water flow in distribution pipe comes down to minimum during midnight. This minimum flow during midnight is called "Minimum Night Flow (MNF)." In general, MNF comes from (a) water usage by customers and (b) the leakage from pipe in the area.

In many cases, MNF is the flow rate measured between 2:00 am to 5:00 am. The image of water usage trend in a day and the MNF are illustrated in the graph below.

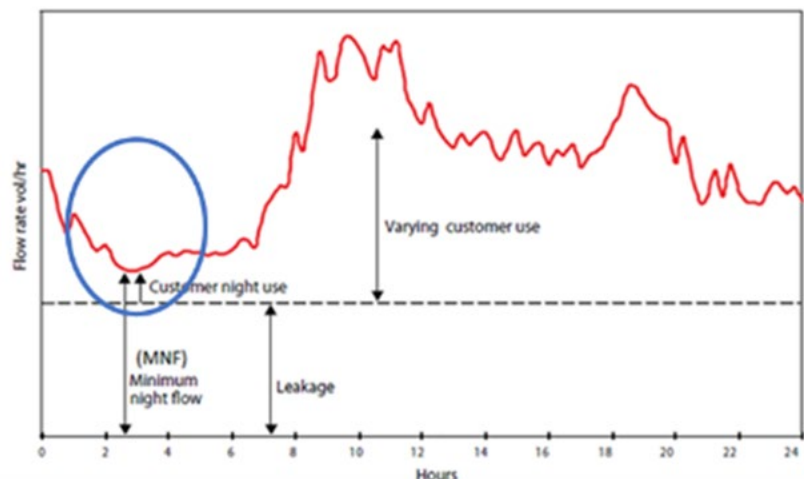


Figure 5-2. Image of Daily Water Usage and of MNF

MNF can be measured by the bulk flow meter (electromagnetic flowmeter) installed at the outlet of OHT or portable ultrasonic flow meter temporarily installed on the distribution mains of the sub-zone. The image of the latter case, MNF measurement using an ultrasonic flow meter, is shown below.

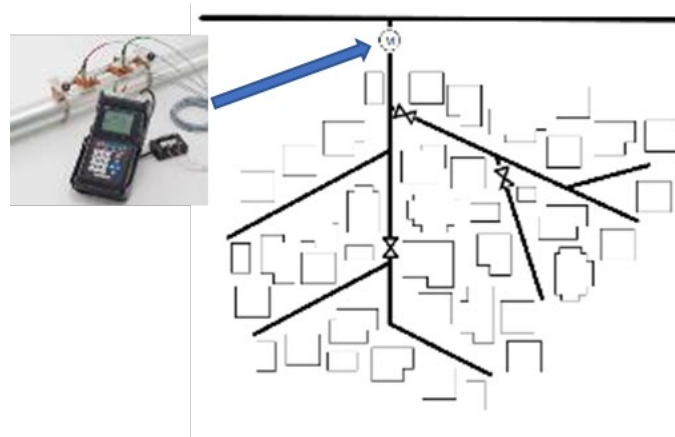


Figure 5-3. Image of MNF survey using an ultrasonic flow meter

To measure the leakage volume accurately in the target area by excluding water usage from the MNF, the Manager shall close all the service connection valves in the area during the survey. However, closing all the valves takes time. Moreover, survey members may not know all the valve location. With limited staff less familiar with the valve locations, the Managers may need to conduct MNF survey without closing service connection valves. In such case, the Manager must know that MNF includes both leakages and household usage of the time.

According to the experience of Tokyo Metropolitan Government, if the target area has 500-1000 service connections, they can find a time slot of a few minutes during midnight when nobody use water. The time slot is called “Unoccupied Time” (or “*akijikan*” in Japanese). The volume of MNF during the Unoccupied Time is regarded as the leakage volume of the survey area in Tokyo.

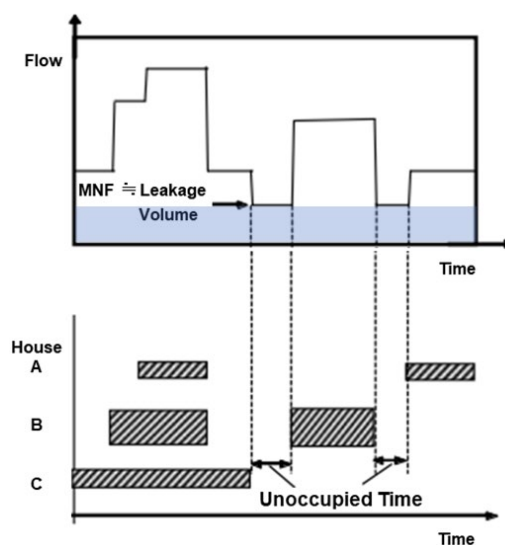


Figure 5-4. Image of Unoccupied Time during Midnight

However, in some areas like Konia, Varanasi where water is not supplied 24 hours a day, many residents have water tanks in their residence, with water taps not closed all day. In such circumstances, the Managers may not be able to find Unoccupied Time during midnight. MNF accounts leakage and water usage which includes water flow to the household tanks in survey area.

“Step Test” is a method to measure MNFs of some areas or lines step-by-step. During the step test, the Managers tentatively isolate each area (or line) by closing inlet valve of the area (or the line).

*Note: At the beginning, the DMA was divided into 8 sub-zones, but sub-zone 4 was excluded from the DMA because it was found that the area is supplied water from out of DMA boundary (Dhobi Gat Tube well).

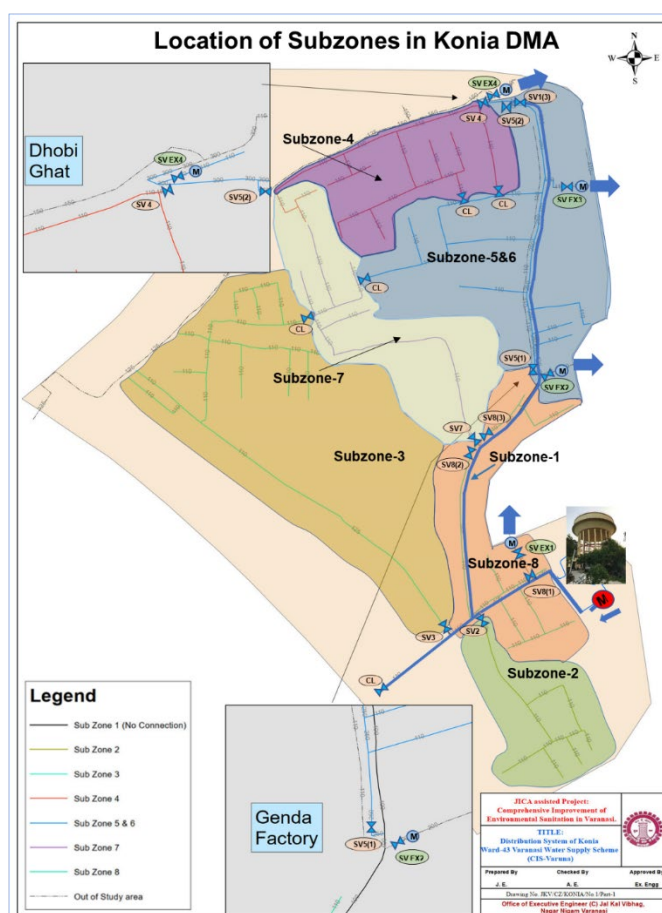


Figure 5-5. Eight (8) Sub-zones in the DMA, Konia, Varanasi

5.3.1. Area-by-area Step-test by using Electronic Magnetic Flowmeter installed at OHT

The step test usually needs several members with two or three workers in each team, for opening/closing chamber covers and sluice valves. Before starting step test, the Manager shall prepare operational timeline and valve location map, and share (or discuss) the operational timeline with survey members.

Hereunder is the sample of the timeline format used during pilot project in DMA Konia, which includes team members name, responsibility of each team, contact method and numbers (mobile phones, groupware etc.), and the operation procedure. Each team shall conduct its task according to the operational timeline, communicating with each other (by using mobile phone or groupware, like WhatsApp) during the step test.

Table 5-1. Sample of operational timeline sheet for the step test

Operational Timeline			
Team	Team-1	Team-2	Team-3
Role	Master valve Operation	SV operation	SV operation
Member	Mr.A	Mr.B	Mr.C
Operator	Mr.D,E	Mr.F,G	Mr.H,I
Tools	Master SV Wrench	SV Key	SV Key
Phone			
Operation Time			
23:00	All member gather at OHT		
23:30	Meeting about today's work		
Close SVs			
0:00	Open the Master SV		
0:10		Step:1 Close SV-EX4	
0:20		Step:2 Close SV-EX3	
0:30		Step:3 Close SV-EX2	
0:40			Step:4 Close SV-EX1
0:50		Step:5 Close SV8(3)&(2)	
1:00		Step:6 Close SV7	
1:10		Step:7 Close SV5(2)	
1:20			Step:8 Close SV3
1:30			Step:9 Close SV2
Open SVs			
1:50			Step:10 Open SV2
1:55			Step:11 Open SV3
2:00			
↓			
End	All member gather at OHT		

During the Step Test, survey members close the sluice valves installed at the entrance of each sub-zone step-by-step. The Manager can measure the MNF of the entire DMA and each subzone by using an electronic magnetic flowmeter installed at the exit of OHT.

The Manager can use the data logger (Fuji Tecom DLS-HS) to record the change of MNF during survey (the data logger can log MNF data every 15 second).



Figure 5-6. Portable Data Logger installed to the Electronic Magnetic Flowmeter at OHT

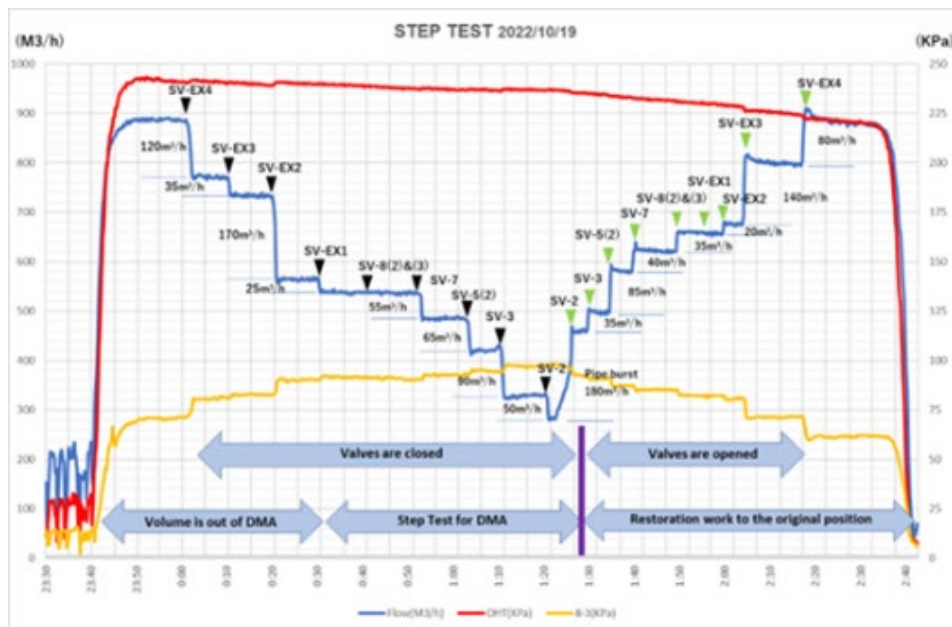


Figure 5-7. Sample of the Step Test result

The manager can find the priority area simply choosing the subzone which has the largest MNF among others, or by calculating per unit MNF of each area (such as per pipe length or per customer connections MNF).

5.3.2. Line-by-line Step Test by using Portable Ultrasonic Flow Meter

Another method of MNF measurement is to conduct line-by-line Step Test. In most cases, the Manager find no existing bulk flowmeters on the target lines. In such case, portable ultrasonic flowmeter is useful, for the Manager can install (or mount) the meter on pipe at the inlet of the distribution main. This test requires survey members to close all the service connection valves along the lines. While closing existing sluice valves sequentially, the Managers can know the leakage flow of each line from the flow rate change of the ultrasonic flow meters.

The following is an example of Step Test from step1 to step3.

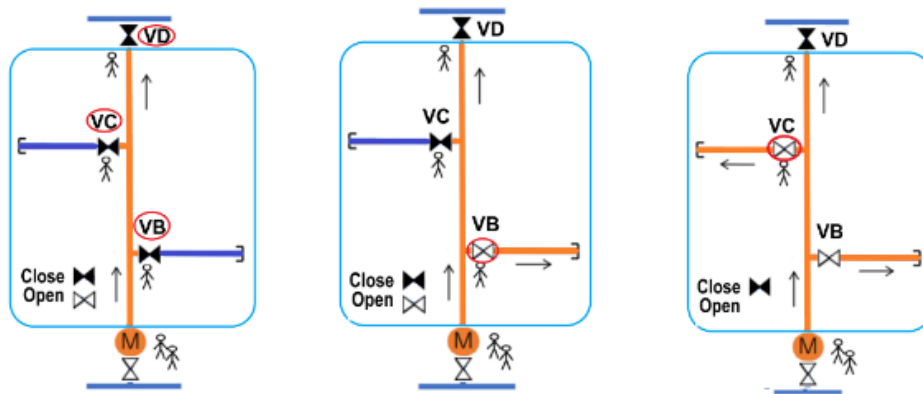


Figure 5-8. Image of Line-wise Step Test

Procedure of valve operation during the Step Test

Step1 (Left): Close VD, VC, and VB valves; and read a flow rate (Q_A) by using the Ultrasonic Flowmeter (indicated as “M” in the figure).

Step2(Center): Open the VB valve; and check if the flow rate (Q_B) increases from Q_A or not. If the flow rate (Q_B) increases from the previous reading (Q_A), it means that the difference ($Q_B - Q_A$) is caused by the leakage on VB line. If the flow rate (Q_B) doesn't increase from the previous reading (Q_A), it means that there is no leakage on the VB line.

Step3(Right): Open the VC valve; and check if the Flow rate (Q_C) increases from the previous reading (Q_B) or not. If the flow rate (Q_C) increases from the previous reading (Q_B), it means that the difference ($Q_C - Q_B$) is caused by the leakage on VC line. If the flow rate (Q_C) doesn't increase from the previous reading (Q_C), it means that there is no leakage on the VC line.

If a leak does not exist on a line, the flow rate will not change after the relevant valves are opened. However, if a leak exists on some lines, the flow rate will increase as the relevant valves are opened. The image of the Step Test Result is shown below.

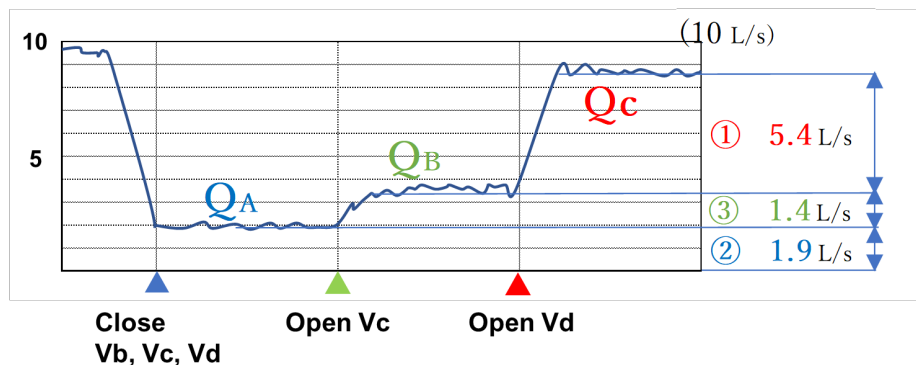


Figure 5-9. Image of Step Test graph

5.4. Stress Test for Point Investigation

“Stress Test” is one of the point investigation methods used during the pilot project in DMA Konia. This method is to visualize “invisible” underground leakage by providing relatively high but still normal water pressure on relevant pipelines.

This method is not commonly used for leak detection in countries where water pressure is appropriate (say 150 Kpa or more) and metal pipes are used. However, it is considered to be effective in the DMA Konia, where point investigation by using the conventional leak survey tools is difficult. Hereunder is the reason: In general, most leak detectors use conventional leak survey tools —such as Listening Stick, Leak Detecort, and Correlative Leak Detector etc.— to catch leaking sound from the leaking pipes to identify leaking point. However, in Konia, leak sound is very difficult to be caught by the commonly used tools because most pipelines are made of PVC and laid under stone-paved street, by which water leaking sound does not propagate well on the pipes and the roads. Hereunder are the details of Stress Test, as an alternative.

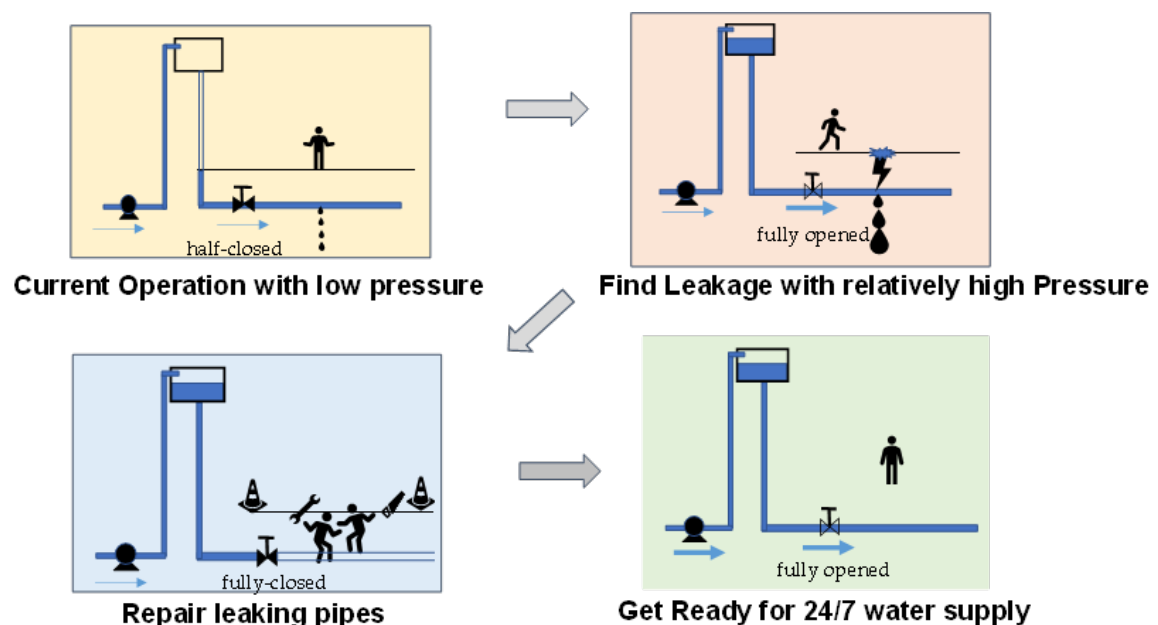


Figure 5-10. Image of Stress Test used for the Pilot Project

The Managers shall carry out this Stress Test during midnight, because it requires the valve operation (which may cause water stoppage) and less traffic on the target area.

Firstly, as shown in the figure below, leak survey team close all the inlet valves of areas B, C, D, E, and F, and ensure that the water level of OHT is maintained to keep the pressure in the main A route

200 KPa (20m H₂O) and more. Closing the customer's taps in advance ensures higher water pressure in the target lines.

Secondly, a survey member opens the inlet valve of area B carefully (or slowly for not to cause water hammer in the relevant line). Then check if the leaked water come aboveground along the relevant pipeline.

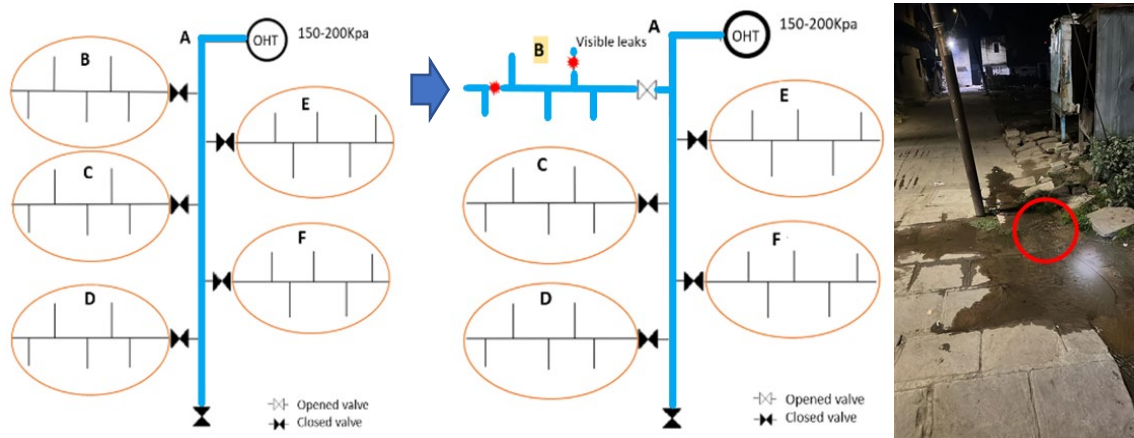


Figure 5-11. Image of the Stress Test using Step Test method

Thirdly, survey members return the valve in area B to original position, and move on to the next area (such as C, D, E, and F) to carry out the same survey. When the survey team finds surface or underground leaks, they take note of the location on a map and mark it with the color splay on the road. The mark on the road is useful for pipe repair work.

Lastly, if time allows, survey members can check underground leaks by using Electric Leak Detector from the road surface. After finishing all surveys in the target area, survey members should make sure that all sluice valves operated during the survey are returned to their original position.

6. Instrument for Leak Survey

This section provides the quick overview of leak detection instrument to the Managers — such as (a)Intended use, (b) Principle of detectors, (c)how to use the instrument, and (d) the point to note for the usage. However, this manual is not a user manual of each instrument. For more details about how to operate each machine, please refer to the user manual of each instrument.

6.1. Instrument for Area investigation

6.1.1. Ultrasonic Flow Meter (Model: Tokyo Keiki UFP-20)



Figure 6-1. External Appearance and Component of Ultrasonic flow meter

a) Principle of Measurement

Ultrasonic wave signals are emitted by a sensor (a or b) installed on a pipe and received by a second sensor (a or b). These signals are emitted alternately in the direction of flow and against it. Due to the medium that is flowing, the transit time of the sound propagating in the direction of flow are shorter than the transit time of the sound propagating against the direction of flow.

The transit-time difference ΔT is measured and allows the determination of the average flow velocity along the path of acoustic propagation. A profile correction is then performed at the main computing unit to obtain the average flow velocity over the cross-sectional area of the pipe, which is proportional to the volumetric flow rate.

Ultrasonic waves are transmitted and received inside the pipe from a sensor attached to the outside of the pipe.

Since the received time is different depending on the speed of the water in the pipe, the flow velocity is measured, and the flow rate is calculated from the cross-sectional area of the pipe.

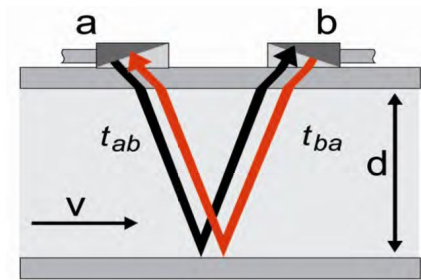


Illustration 1: Clamp-on ultrasonic flowmeter configuration

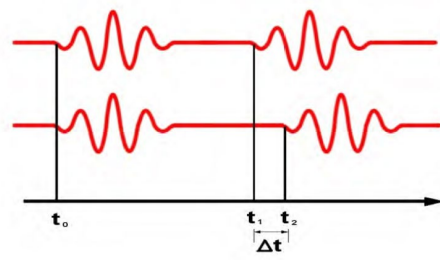


Illustration 2: Transit-time measuring principle

Figure 6-2. Principle of Ultrasonic flow meter

An increased number of transits means increased accuracy of the measurement. However, the increased transit distance leads to a higher attenuation of the signal. The reflections on the opposite pipe wall and deposits on the inner pipe wall cause additional amplitude losses of the sound signal. If the signal is attenuated strongly by the medium, the pipe, deposits, etc., the number of sound-paths needs be set to 1.

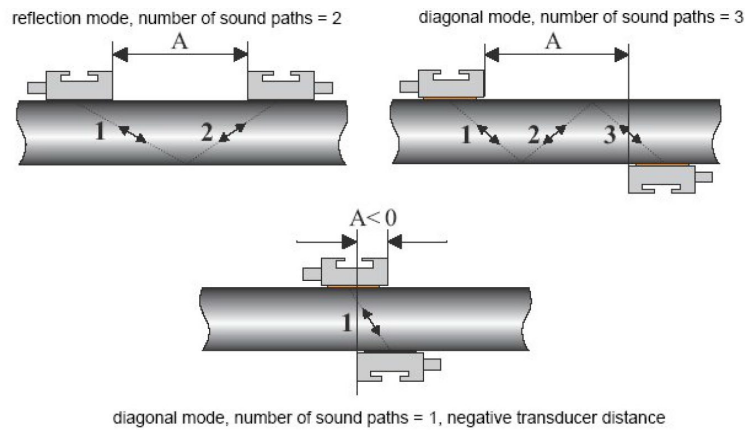


Figure 6-3. Sensor mounting type

b) Intended Purpose

The Manager can use ultrasonic flow meter to measure MNF during area investigation and line investigation. By using this instrument, the managers can measure the “instant” water flow in the target pipeline without cutting the pipe for meter installation. The sensor can be installed (or mounted) on an exposed pipe as shown below.

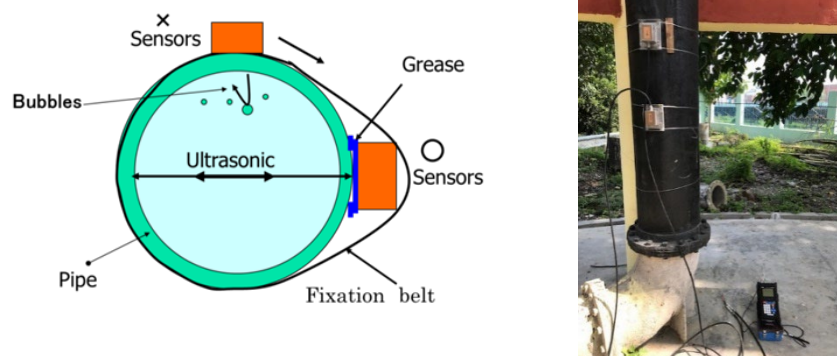


Figure 6-4. Image of sensor installation

c) How to use

Calculation of Sensor distance

First, input a file name, using cursor keys and press the enter key at the end. Secondly, input an outer diameter by using numeric keys. Thirdly, Input pipe information —such as material, thickness, lining material, type of liquid, type of sensor, and installation method (Z, V, W). After all required information is entered, the suggested distance of the two sensors will be shown on the display.

Sensor Installation

Applicable pipe diameter for the medium sensor, the one JET procured, for the Model UFP-20 of Tokyo Keiki, is from 65mm to 500mm. Optionally, two other sensors are available — small sensor (for 13mm-50 mm pipe) and large sensor (for 300mm-5000mm diameter pipe).

The sensor mounting distance is the distance between the two sensors. To ensure that the sensor surface and the pipe wall are in close contact, the surface of the pipe wall should be cleaned and polished with sandpaper. To avoid the influence of turbulence in the pipe, the sensors should be installed at a distance of 10D (ten times the pipe diameter) from the 90-degree bend or any valves. Pipe sensors should be installed on the side of the pipe to avoid the influence of air in the pipe. The manager shall install the sensors firmly by using wires so that they will not move during the survey.

Once the sensor is mounted on pipe wall, and the sensor cables are connected to the main unit, flow rate is displayed automatically.

Reception status

Check the following items if ultrasonic sound reception is poor and flow rates are not displayed.

- Check that there are no errors in the input parameters.
- Check if the sensor spacing is correct.

- Check the reception status, a peak wave shape with a more than 60% reception rate in the Echo-form Viewer.
- If the input items and sensor distance are correct, but the reception status is poor, then try another sensor mounting position (Z, V, W) and retry the measurement.

Operation procedure

Operation procedure is shown below.

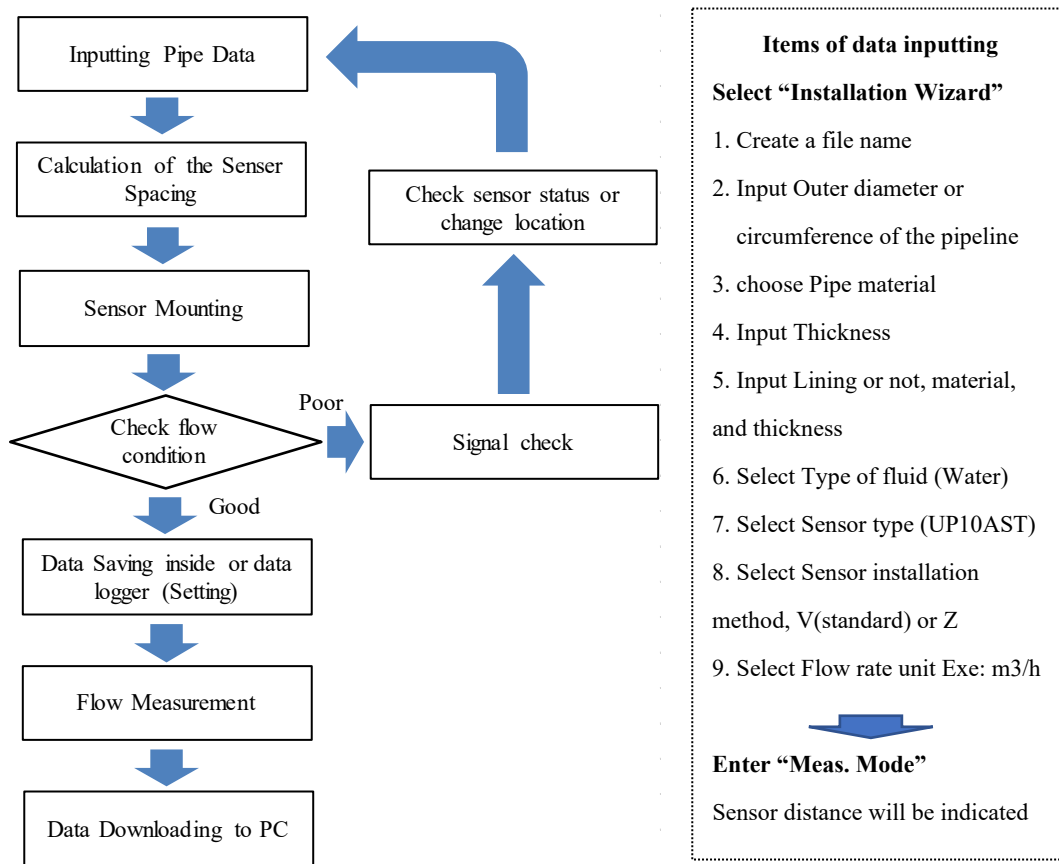


Figure 6-5. Operation procedure of the Ultrasonic flowmeter

d) Point to note

The Manager shall check the status of battery charge before any use. UFP-20 can be used for 8 hours consecutively when the battery is fully charged.

For more detailed operating procedures, please refer to the operation manual.

6.2. Instrument for Line investigation

6.2.1. Listening Stick

a) Principle of Listing stick

Listening stick is a very simple device, consisting of the head with a vibration plate and a metal stick as shown in the Figure below. Leak sound is propagated through pipeline from leaking point to a nearby water meter or a sluice valve. Listening stick is used to amplify the leak sound via the vibration plate. With this simpleness requiring no electricity nor any set-up, the Managers can use this device at any time during any step (from step 1 to step 3) of leak survey.

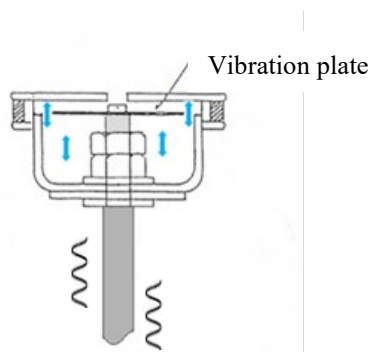


Figure 6-6. Structure of Listening stick

b) Intended purpose

There are three ways to use this device for leak detection.

- Listen to a leak sound by attaching the metal stick to water meters or valves on the pipeline.
- Listen to a leak sound by inserting the metal stick into the ground nearby
- Check the soil condition of the suspicious leaking point by inserting the metal stick into the ground. If the metal stick turns wet, it means water is there.



Figure 6-7. Photo of Listening Stick (Fuji Tecom, LSP1.5)

c) How to use the Instrument

- Attach metal stick to the glass surface or metallic part of a water meter, valves, and other

fittings.

- Put an ear to the vibration plate of listening stick to listen to leak noise carefully.
- Cover the other side of the ear when the surrounding environment is noisy
- Close the stop valve of service connection if the water meter is moving and recheck the leak sound

d) Points to note

- Do not swing around the listening stick to avoid injury.
- Do not bend the stick strongly
- Do not apply strong force to the head when pull the metal stick from ground
- Do not hold the stick with a hand when listen to leak sound. Otherwise, sound will be attenuated.

6.2.2. Electronic Listening Stick

a) Principle of Measurement

Electronic listening Stick has same principle as that of (mechanical) Listening Stick. However, this tool has processor and display (LCD) attached to the head of the stick, where analog sound is amplified and converted to digital data. Because sound level is displayed on the LCD, this tool is more user-friendly, requiring users less experience and skills.

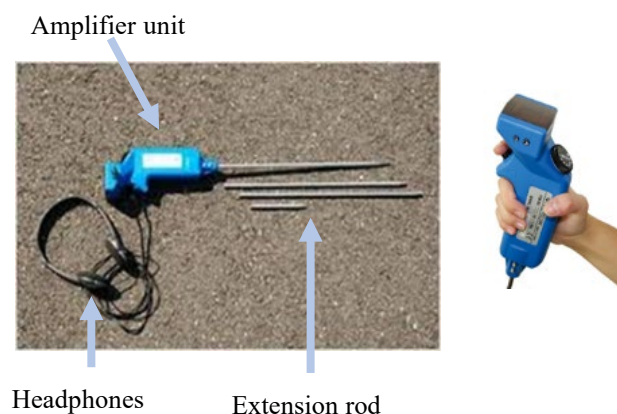


Figure 6-8. Photo of Electronic Listening Stick (Fuji Tecom, FSB-8D)

b) Intended Use

The Manager can use electronic listening stick to check the level of leak sound by contacting its metal stick part to water meter or valve. This tool can be used for not only metal pipes, but also non-metal pipes such as PVC and HDPE.

c) How to Use the Instrument

- Adjust the sound level with the volume control if the sound is too loud before survey.
- Attach the tip of contact bar to a water meter, a water tap, or other fittings, and then press the switch button.
- Sound level is displayed on the LCD. The sound can be heard through the headphones.



Figure 6-9. Overview of Electric listening stick

d) d)Points to note

- Contact the bar to the pipe, adjust the volume, then turn on the switch. Otherwise, the contact will make a loud noise, which will be harmful to ears.
- Since the main unit has an electric amplifier, do not apply strong impact.

6.3. Instrument for Point investigation

6.3.1. Electric Leak Detector

a) Principle of Measurement

Electric Leak Detector consists of sensor (or ground microphone) with handset, amplifier (or main processor) and headphone. The sensor (or ground microphone) is used to catch underground leak sound. The leak sound is amplified at the amplifier (or main processor unit), then be audible via the headphone.

Water pressure increases during midnight as water consumption decreases. Leak sound also increases as the friction noise of water leak becomes larger with increased pressure. Importantly, surrounding noise on street goes down as traffic becomes less during mid night. So, it is recommended to use this instrument during midnight, the quietest time of day.

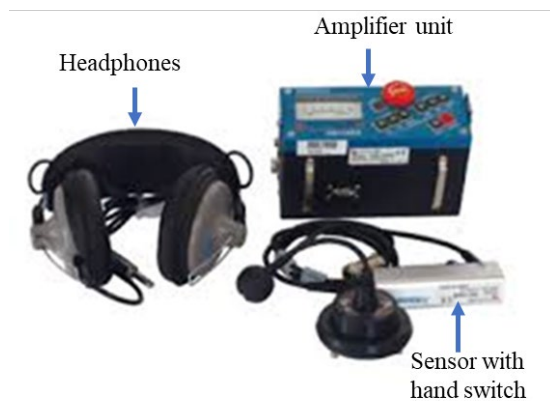


Figure 6-10. Photo of Electric Leak Detector (Fuji Tecom HG-10A II)

b) Intended Use

Users can identify the leak point by listening to the loudest sound from the road surface with an Electric Leak Detector.

Slowly place the sensor on the road surface where the buried pipe and press the switch to hear the sound.

Place the sensor at intervals of 40-50cm each distance.

When find a strange sound, move the sensor rightward, leftward, forward, and backward, moving in the direction of the loudest sound.

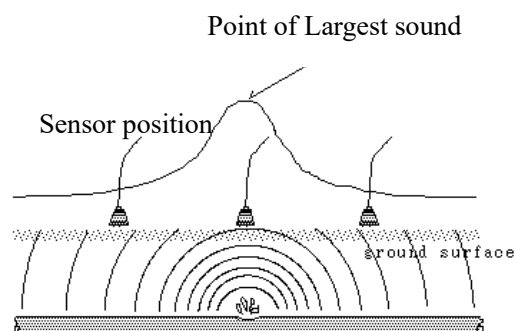


Figure 6-11. Principle of Electric Leak Detector

c) How to Use the Instrument

- Turn on the switch on amplifier (or the main unit), and check the battery level before using it on filed.

- Hold the handset with the ground microphone (or sensor), and make small sounds near the sensor with your foot to check the listening volume condition. Then, adjust the volume to a suitable level with the control knob.
- If necessary, adjust the filter frequency to pipe material. The commonly used filter position that covers all materials is 400Hz to 1.2MHz. Please refer the operation manual for the combination of filter frequency bands if needed.
- The person who uses this instrument shall keep two (2) meters away from the other person to avoiding noise from their feet. The user shall gently place the sensor on ground approximately every 30 cm to 50 cm. Then, the move the sensor back and forth, left and right, to catch a leak sound, and trace the sound until he/she can get the largest sound.
- When reaches a suspicious point of leak, he should mark the point on a survey map and the surface of the load Pointe to be noted

d) Point to Note

- Remove the headphones plug from the main unit while it is not in use. Otherwise, battery will be run out of electricity.
- Do not drop the sensor to the ground from a high position. Otherwise, the element plate will be broken, causing serious damage to the equipment. Element plate is a small plate installed in a sensor, which covert sound vibration into electric signal.
- Do not put the sensor in water or soak it with rain because the sensor is not waterproof.

6.3.2. Leak Noise Correlator

a) Principle

This instrument consists of Prime Touch (Main unit), two transmitters with internal accelerometer(sensor). Two internal accelerometers are to be mounted on the valve, and transmitter are used to transmit signal to the Prim Touch by using radio wave.

When leak is located just at the center of two internal accelerometers, leak sound reaches both sensors simultaneously at same time and same distance.

However, if leak point is close to one of the sensors (for example, sensor A), the leak sound reaches faster to the closer sensor (sensor A) than to the further one (sensor B).

The leak noise correlator measures the time delay between two points, and the leak position is calculated from the pipe propagation speed by pipe material and diameter and time delay.

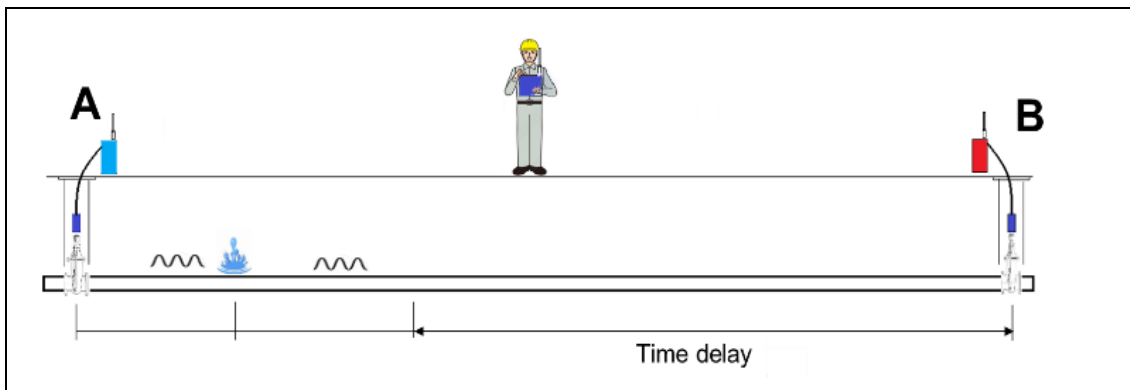


Figure 6-12. Principle of Measurement

b) Intended purpose

The Manager can use this instrument to identify the leak point on distribution mains. Leak noise correlator is effective in identifying leaks which are located at deep underground or located at noisy areas – such as heavy traffic road where leak sound is difficult to detect by the Electric Leak Detector.

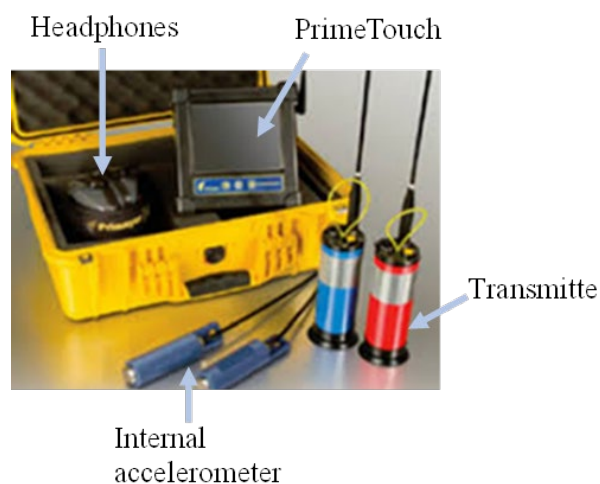


Figure 6-13. Photo of Leak Noise Correlator (Primayer Eureka 3)

c) How to Use

Prerequisites for use

- Leak noise reaches two measurement points at which sensors are mounted.
- Input data such as material, diameter, and distance between two sensors are known.
- If any of these conditions is missing or wrong, the leak position cannot be detected, or an error in the result occurs.

Preparation

Put the sensors on the top of the pipe or valve, and check the signal after turning on the Prime Touch

switch. If a receiving signal is weak, the operator moves the position of the Prime Touch to get a strong one. The operator can listen to the sound through the headphones. Flow chart of operation is shown below.

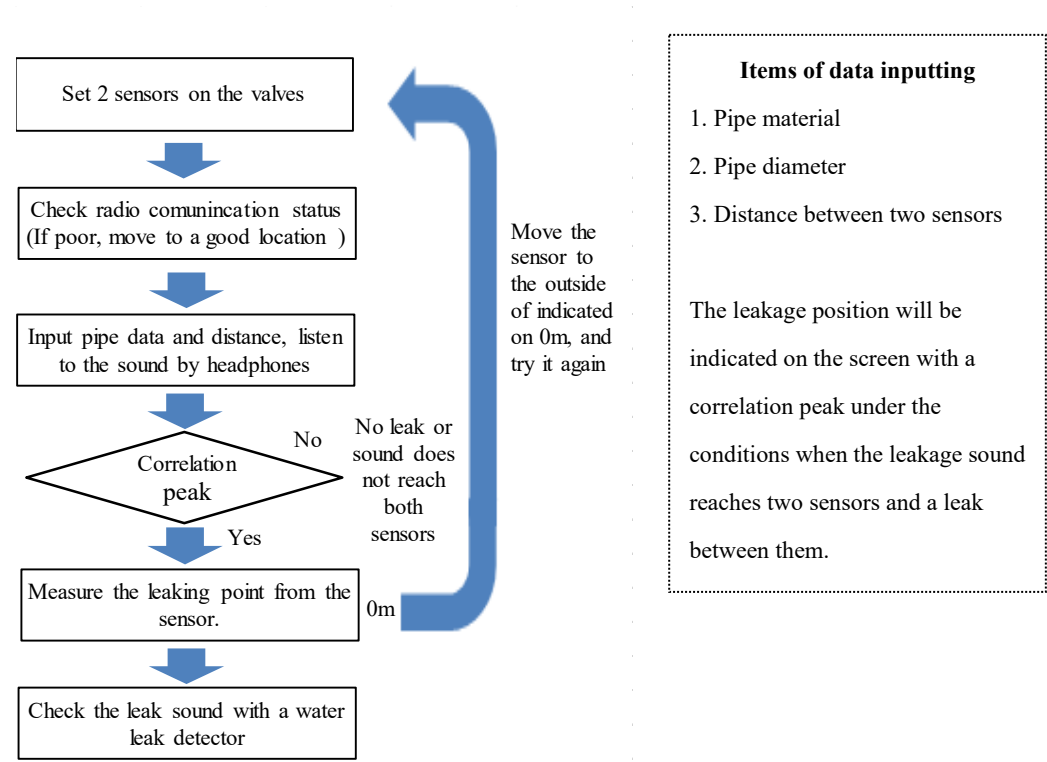


Figure 6-14. Operation procedure of the Leak Noise Correlator

Correlation peak

When leak noise reaches the two sensors and leak point is between them, a correlation peak will appear on the screen with the distance from the leak position.

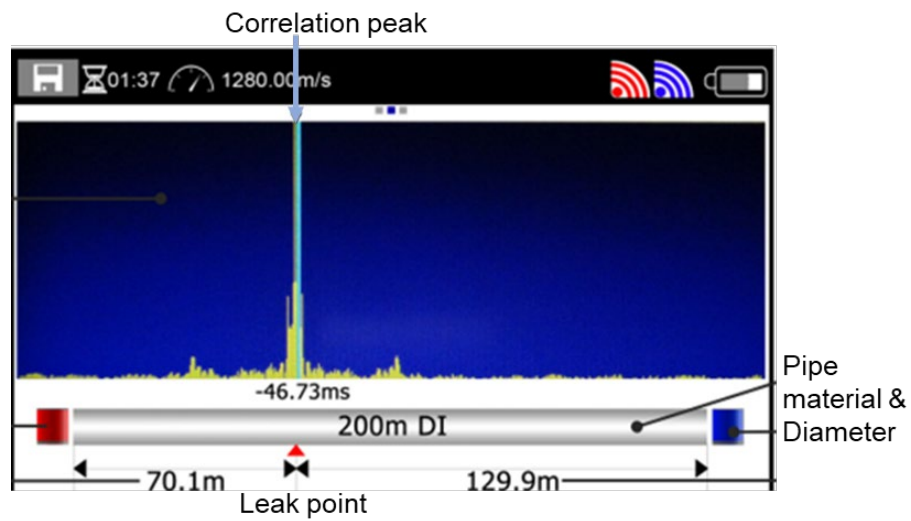


Figure 6-15. Correlation peak with distance from sensors

Indicated as Zero (0) meter or Negative meter

There are two possibilities if the distance from a leak is 0m or negative on one side of the sensors. Firstly, the leak point is very close to the sensor. Secondly, the leak point is outside of the two sensors.

In case negative distance is indicated, the Manager should move the sensor and try again, as shown below.

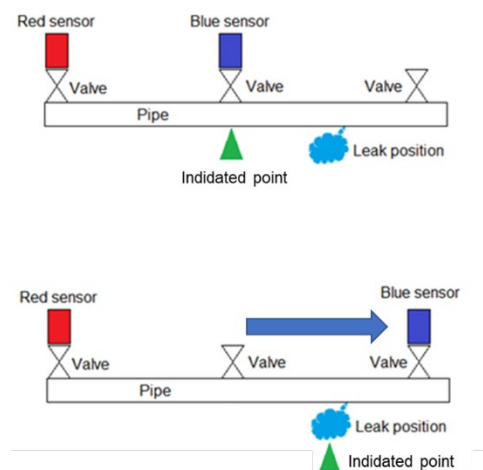


Figure 6-4. Move the sensor outside the valve from indicated 0m

- Indicated leak point should be confirmed by using Listening stick.

d) Points to note

- The face of sensor touch with the contacted part of the valve should be kept clean; otherwise, make an error in distance.
- Check the battery before use. A full battery charge for the main unit needs approximately 4 hours and can operate for 8 hours under normal operating conditions.

6.4. Confirmation Method of Suspected Leak

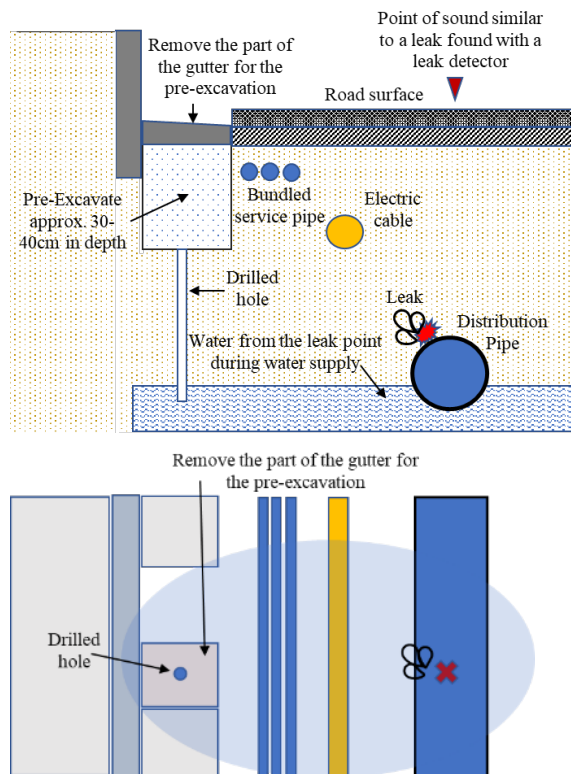
Confirmation survey is a survey for the Manager to confirm whether leak actually exists at the suspected point identified by leak survey instrument, such as Electric Leak Detector and Leak Noise Correlator.

If a drainage basin is near the suspicious point, the manager shall open the basin cover and check inside to see whether the water flows into the drainage. If the manager finds it difficult to check whether the leaked water is tapped water or wastewater (or rain water), he/she shall take a sample and check its residual chlorine. In general, tap water contains residual chlorine while wastewater (or rain water) does not.

Then, the Manager shall drill a hole by using Hammer Drill as shown in the figure, use a Boring Bar to insert a Listening Stick, and finally insert a Listening Stick to check the leakage sound and wet/dry condition of the soil.

Before drilling a hole, the Manager shall measure the depth of pipe by checking a near-by sluice valve chamber, to estimate the depth of the leaking pipe. Also, the Manager shall ensure that there is no electric cable, gas pipe, or other water service pipes buried at the drilling point to prevent accidents.

Image of conformation survey to identify the leak position as shown below.



Step-1
Remove a piece of gutter



Step-2
Excavate there approx.40cm to check if there are other pipes and electric cables.



Step-3
Insert the boring bar carefully to nearby buried pipe in order to check if there is any leaked water.

Figure 6-5. Image of confirmation survey

If the above-mentioned survey is difficult to conduct, then the Manager shall drill a hole slowly and carefully at the suspected leak point to prevent any accidents.

7. Leak Repair (Corrective Measure)

Leakage from water pipes does not only waste valuable water resources, but also causes flooding and traffic accident. By reducing water leakage, the Managers can save water resources, increase water supply, and reduce cost of worker, electricity, chemicals etc. required for water supply. In order to reduce water leakage, the Managers shall renew old pipes systematically.

7.1. Cause of water leakage

Most of the water leakage are caused by poor construction or insufficient leak repair. To prevent water leakage, Jal Kal should supervise the contractor.



Figure 7-1. Leakage point

7.2. Temporary Method of Leak Repair

7.2.1. Rubber & Clamps for Temporal Repair Work

The Manager can use rubber tape and hose clamp to repair small leakage temporarily. However, this repair method can be used only tentatively in case of emergency, and other permanent method shall be implemented accordingly —such as pipe renewal or pipe replacement.

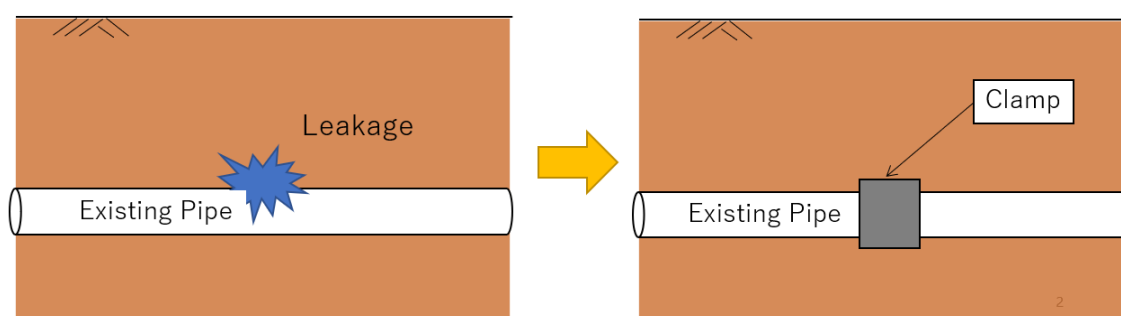


Figure 7-2. Clamp

As for this temporal method, the Manager can wrap around leakage with rubber sheet, put hose-clamp on the rubber sheet, then tighten the hose clamp to stop leakage. Just binding rubber band with plastic strip as shown in the photo below is not appropriate, and the Manager shall stop this kind of practice instantly.



Figure 7-3. Inappropriate water stoppage method

7.2.2. Wooden Plug

The wooden plug can be used as a temporary method to stop leakage, in a situation where there is no sluice valve to stop the water in the event of sudden water leakage. In this method, a peg-shaped (pencil like) plug is made from wood that matches the diameter and shape of the hole, and the plug is hammered in temporarily to stop the leakage. After installing this wooden plug, cut the top of the plug and attach a clamp to complete the water stoppage work.

These works require highly skilled plumbers.

If the water pressure is high, or if there are holes in the sides or bottom of the tube, it may not be possible to drive the wooden plug.



Figure 7-4. Wood plug

In the case of steel pipes, a steel plate of an appropriate size is applied, and the perimeter of the steel plate is welded to perform the main waterproofing work. If these methods do not stop the water completely, replace and repair the pipe.

7.2.3. Glass Fiber Wrap

There are two types of fiberglass wrap solutions.

The first solution is to use fiberglass resin tape. Fiberglass resin tape hardens as it gets wet and stops leakage. Though fiberglass tape can stop leakage for a while, it is still a temporary solution.



Figure 7-5. Glass fiber band

When the Manager use fiberglass resin tape, he/she shall clean pipe with a rag. While the pipe is still wet, wrap the fiberglass tape around the damaged area and wait for 15 minutes until the resin hardened.

The second solution is to use fiberglass resin cloth. Fiberglass resin cloth can be applicable for longer period than fiberglass resin tape, but it is still a temporal one. Before using the fiberglass cloth, the Manager shall clean the pipe with a wet rag, then file the pipe surface smooth. Sanding the surface lightly will make the pipe surface smooth. Then, fiberglass resin cloth can be placed over the leak. Finally, shine a UV light directly onto the pipe, which will begin the curing process of fiberglass. In about 15 minutes, the curing process will be completed. The Manager can start supplying water accordingly.

7.3. Permanent Method of Leak Repair

7.3.1. Pipe replacement (Straight)

Pipe replacement is the most commonly used repair method, in which plumbers cut and remove the existing pipe at the leaking point and replaces it with a new pipe. Plumbers shall joint new pipes and existing pipes with clamps as shown below.

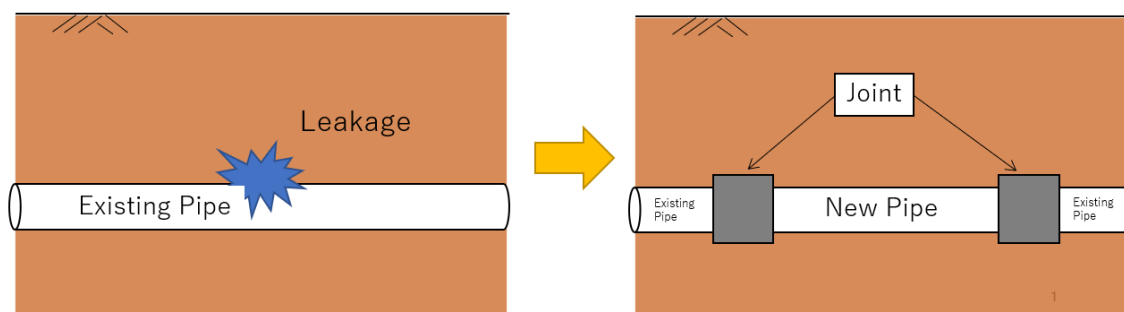


Figure 7-6. Pipe replacement

7.3.2. Concrete protection

a) Curved pipe (Elbow)

If there is leakage from the PVC curved pipe (elbow) part, replace the pipe as a general rule.

After replacing the pipe, apply concrete protection as shown below.

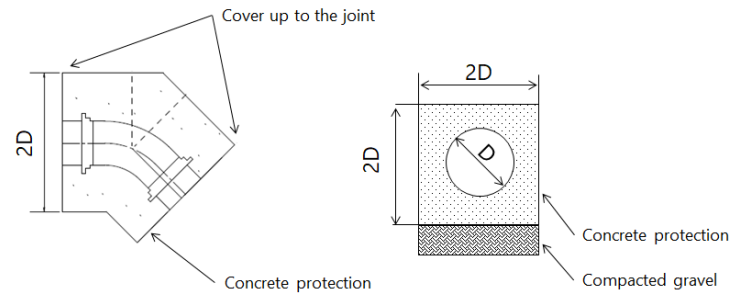


Figure 7-7. Concrete protection (Curved pipe)

b) T-joint pipe

If there is leakage from the PVC T-joint pipe, replace the pipe as a general rule. After replacing the pipe, apply concrete protection as shown below.

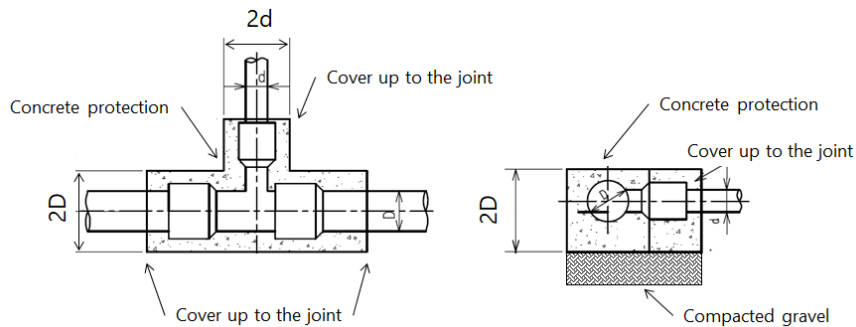


Figure 7-8. Concrete protection (T-joint)

7.4. Water leakage inspection after completion

After pipe work is completed by contractors, the repaired pipe shall not be backfilled without the permission of water authority managers. Authority managers shall go to the field and investigate the quality of work and check if the repair work is completed properly, confirming that the leakage is fixed completely.



Figure 7-9. Completion inspection

7.5. Backfill

After confirming that there are no leaks, use good quality sand and soil to firmly compact and backfill. Proper backfilling protects repaired water pipes and prevents roads from sinking

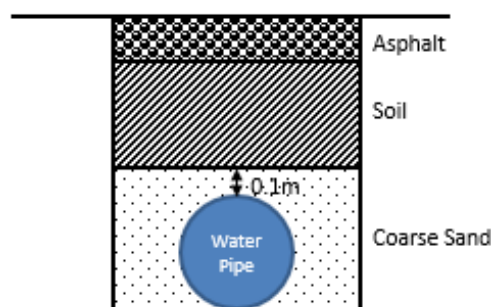


Figure 7-10. Cross-sectional view of backfill (example)

8. Preventive Measure

8.1. General Principle

To reduce and prevent leakage, the Manager shall replace (or renew) aged pipes strategically. Pipe replacement (or renewal) shall be carried out by water authorities for the following reasons;

- To prevent pipe burst of aged pipe
- To prevent dirty water (rusty water by corrosion, dusty water from pipe crack and joint detachment, permeation of sewerage)
- To improve water supply service with good water pressure and water quality

In addition, from the view point of improving customer service, pipe replacement is being carried out for the following purpose in Japan;

- To improve earthquake resistance
- To reduce educe residual chlorine
- To increase direct water supply (by reducing customer booster pump and water tank)

8.1.1. Basic Survey

To make basic plan, the manager need the following data and information as much as possible.

- Pipe Information (installation year, material, diameter, thickness, length)
- Pipe Laying Information (laying depth, road condition, land owner)
- Hydraulic and Water Quality Information (direction of flow, water flow rate, water pressure, and water quality)
- Accident Data (date, causes, place, contents of accident etc.)
- Customer Complaint Data (date, place, reason of complaint, measures taken)
- Social background Information (such as number of connections, supply volume, traffic information, critical user information, hospital, evacuation center)

8.1.2. Basic Planning

Based on the information acquired through the basic survey, the Manager shall decide the priority (area or line) of pipe replacement. In case of Japan, functionality of pipe (transmission, distribution, and service connection) and impact of accident are evaluated. Other factors considered in many cases are upper-level policy and plan (if any relevant), target, budget constraint, physical (geological) constraint for pipe replacement. In case of Japan, the most frequently prioritized pipe for replacement is (a) asbestos-pipe, (b) lead pipe, and (c) any pipe older than their service life (for example, 40 years old or more for Ductile Iron pipe).

8.1.3. Detailed Planning

Selection of method (pipe replacement of rehabilitation),

In principle, pipes are replaced by “open cut method,” by which pipe under the ground is exposed, replaced, and finally refilled by surface material. However, if it is difficult for managers to apply open cut method (because of heavy traffic, unremovable structures etc.), the manager shall choose “non-open cut method.”

8.1.4. Execution of Detailed Plan

The Manager shall carry out the detailed plan accordingly. Hereunder are some important points to note, in general.

8.1.5. Explanation to the nearby resident:

8.1.6. Consultation with other utility manager:

8.1.7. Creation of “Standard Drawing”

In order to improve and standardize construction quality, it is necessary to create a **“Standard Drawing”** with specifications, such as size materials, etc. of Jal Kal's general water facilities and equipment.

The construction contractor carries out construction based on the standard drawing, so uniform and constant quality is maintained.

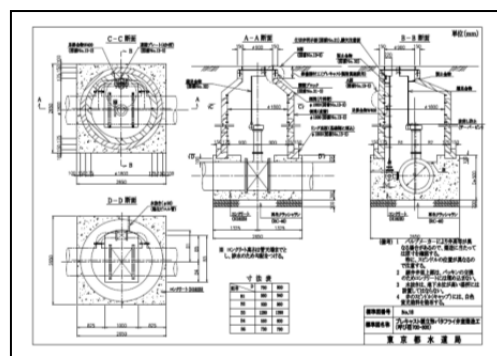


Figure 8-1. Standard drawing

8.1.8. Updating the pipe database:

Updating database and pipe diagram is very much important for maintenance work afterward. Recently, many water authorities keep digital data, using Graphical Information System. Once pipe replacement is completed, the Manager shall update the digital data.

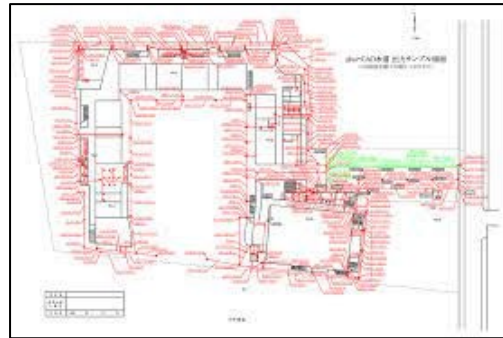


Figure 8-2. Pipe database (Mapping)

8.2. Change pipe materials

PVC pipes, which are mainly used for small-diameter pipes, are relatively inexpensive, easy to handle, and easy to install, but they are vulnerable to material deterioration and external damage.

Therefore, the adoption of thick-walled PVC pipes for water supply, polyethylene pipes, and ductile cast iron pipes based on the standards of the Indian Water Works Association should be considered.



Figure 8-3. Damaged existing pipe

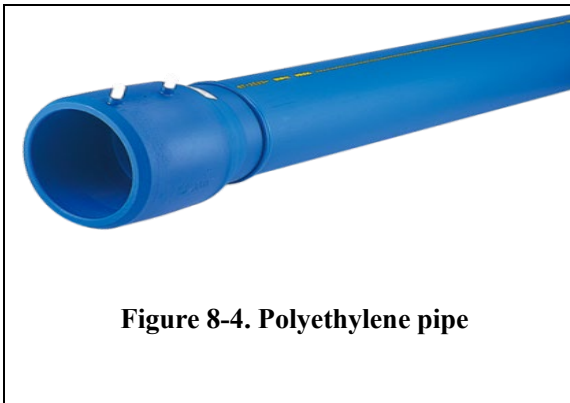


Figure 8-4. Polyethylene pipe



Figure 8-5. Ductile iron pipe

8.3. Improvement of Piping Method

In some cases, 90-degree elbows are used for bends; if bends are made by 90 degrees, high stress is applied there, and the pipe joint tends to come out. Therefore, the Managers shall try to make bends as gentle as possible, by using 45-degree elbows.

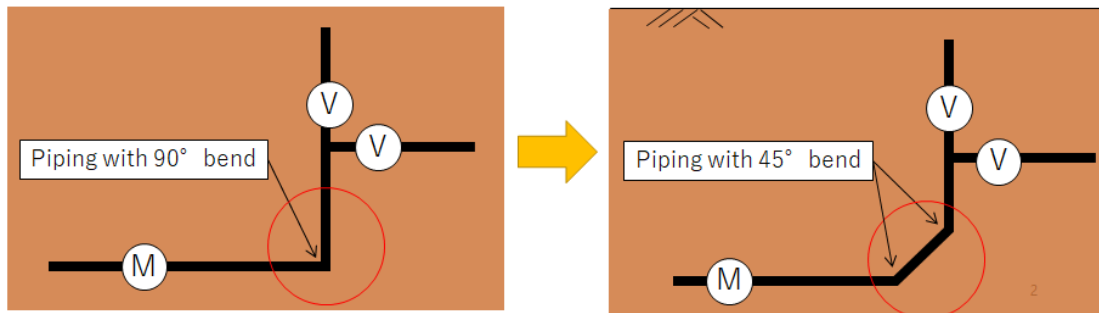


Figure 8-6. Example of piping method

8.4. Use Pipe Alert Sheet

When performing pipe renewal work, etc. before backfilling, by laying the “Pipe Alert Sheet”, Jal Kal can alert other utilities (for example Electricity, Gas, Telephone etc.) for their construction work. By protecting water pipes from damage for construction work, water leakage can be prevented.



Figure 8-7. Pipe alert sheet

8.5. Improvement of service pipe

Long service pipes, sometimes called “spaghetti” piping, are one of the main causes of water leakage. Water authority manager shall avoid connecting many long service pipes at the same point, as shown in the left side figure below. The managers shall lay new distribution pipes and make service pipe shorter as shown in the right-side figure below. By doing so, water leakage can be greatly reduced.

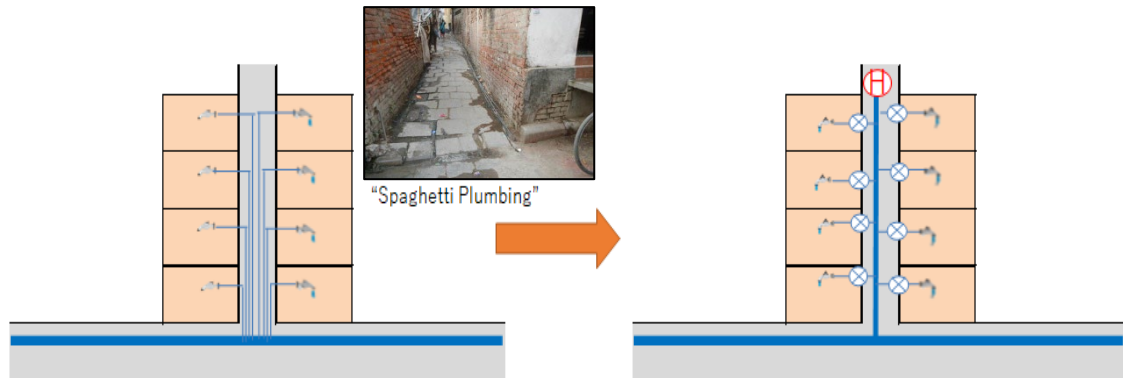


Figure 8-8. Improvement of long service pipes

8.6. License system of contractors

All the piping and repair work shall be done by the contractors certified by Jal Kal for service pipe installation and pipe repair work. In addition, when contractors approved by Jal Kal carry out piping and repair work, water authority manager shall always inspect the quality of work before they start backfilling.

Appendix 16

NRW Reduction Manual (Summary)

The Project for Comprehensive Improvement of Environmental Sanitation in Varanasi (CIESV)



Summary of NRW Reduction Manual

7th June, 2023

JICA Expert Team
(Toshiyuki Hattori, Akihiko Okazaki, Hiroshi Kojima)

Summary of NRW Reduction Manual (Draft)

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Summary of NRW Reduction Manual (Draft)

2

Part I

1. Water Balance Analysis

2. District Metered Area (DMA)

3. Goal Setting and Action Planning

4. Overview of Leakage Reduction and Prevention

1.1. Water Balance Analysis

The first important step for the Managers to reduce NRW is to understand the water balance in their target area. Developing a Water Balance table is quite useful to understand the overall picture of water usage in the target area. Water Balance table helps utility managers to analyze the causes of NRW, and to consider countermeasures against the causes of NRW.

Table 1-1. Standard Water Balance (International Water Association)

System Input Volume	Authorized consumption	Billed Authorized Consumption	Billed Metered Consumption	Revenue Water
			Billed Unmetered Consumption	
		Unbilled Authorized Consumption	Unbilled Metered Consumption	Non-Revenue Water (NRW)
			Unbilled Unmetered Consumption:	
	Water Losses	Apparent Losses (or Commercial Losses)	Unauthorized Consumption	
			Customer Meter Inaccuracies and Data Handling Errors	
		Real Loss (or Physical Losses)	Leakage on Transmission and Distribution Mains	
			Leakage and Overflows from the Utilities Storage Tanks	
			Leakage on Service Connections up to the Customer Meter	

1.2. Method to Analyze Water Balance

Hereunder are the suggested steps to develop Water Balance Table in Varanasi.

- Step 1: Measure System Input Volume (by using bulk flow meter)
- Step 2: Measure Billed Authorized Consumption, or Revenue Water, by using customer meters installed
 - a) Billed Metered Consumption (measured by customer meters installed)
 - b) Billed Unmetered Consumption (calculated by estimation)
- Step 3: Calculate Non-Revenue Water by subtracting the Revenue Water from the System Input
- Step 4: Analyze Unbilled Authorized Consumption
 - a) Unbilled Metered Consumption (measured by customer meters installed)
 - b) Unbilled Unmetered Consumption (calculate by estimation)
 - c) Calculate Unbilled Authorized Consumption as a) plus b)
- Step 5: Calculate Authorized Consumption by adding Billed Authorized Consumption and Unbilled Authorized Consumption
- Step 6: Calculate Water Losses by subtracting Authorized Consumption from System Input Volume
- Step 7: Assess components of Unauthorized Consumption, and Metering Inaccuracies and Data Handling Errors by best means available through field verification and by estimation. Add Unauthorized Consumption and Metering Inaccuracies and Data Handling Errors to calculate Commercial Losses
- Step 8: Calculate Real Losses by subtracting the Apparent Losses from Water Losses
- Step 9: Assess components of Real Losses by best means available in the field and through desk studies.

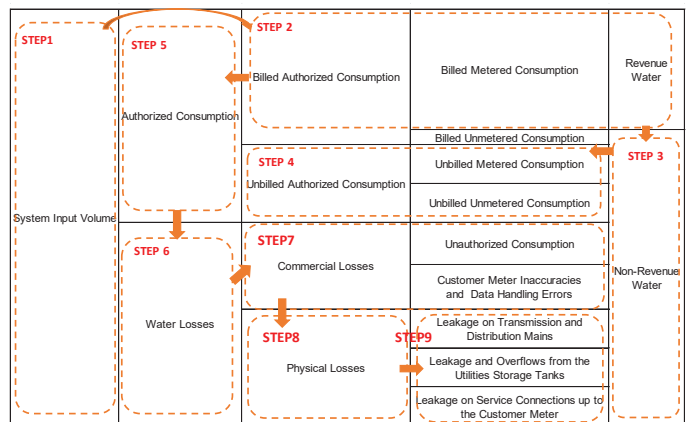


Figure 1-1. Steps for Calculating the Water Balance

2. District Metered Area (DMA)

“District Metered Area (DMA)” is an area hydraulically isolated from the surrounding areas by sluice valves and flowmeters. DMA is commonly deployed in Pilot Project in many Technical Assistance programs because it can enable water authority managers to analyze NRW (including leakage), consider counter-measures against the cause of NRW, and monitor the impact of counter-measures upon NRW reduction.

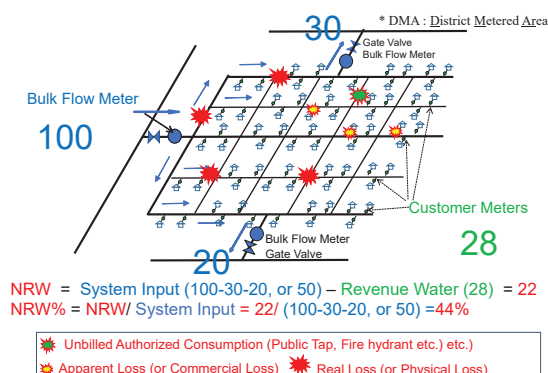


Figure 2-1. Conceptual Drawing of DMA

Selection Criteria of DMA

- (a) **Availability of water (24/7)**
- (b) Availability of accurate pipeline drawings
- (c) Size of DMA (number of service connections, area, geographical conditions)
- (d) Number of sluice valves
- (e) Number of bulk flow meters needed for inflows and outflows measurement

Point is to make it “manageable”

2.4 DMA Development

Installation of Bulk Flow Meter (BFM)

Bulk Flowmeter is the water flow meter installed to monitor the water flow on the line.

In case of Konia, one BFM, at the exit of Overhead tank (OHT), was installed to measure the “inflow” water flow volume to the DMA, and four (4) others were installed to measure the “outflow” water volume from the DMA to the downstream areas.

Installation of customer-meters

To measure the volume of Revenue Water, customer meters need to be installed to each customer. In this project, Automatic Meter Reading (AMR) was proposed by the Indian side (namely Jal Kal and UPJN), in order to reduce heavy workload of meter-reading and to reduce human errors of meter-reading. In general, customer meters are installed along street, outside household, so that meter readers can access the meter without entering (or bothering) households. However, strongly suggested by the contractor, R.G. Industries Inc., who has other track records of AMR installation in other Indian cities, customer meters (AMR) are installed inside each house so that meters will not be stolen nor tampered by others.

Others (Installation of Sluice Valves, Improvement of pipelines, Repair of malfunctioned facilities etc.)

To segregate a DMA “hydraulically” from its surrounding areas and to streamline water flow, inserting sluice valves, and changing pipelines, repairing malfunctioned facilities are also suggested.

Summary of NRW Reduction Manual (Draft)

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3. Goal Setting and Action Planning

Based on the Water Balance Analysis, the Manager shall consider countermeasures against the NRW and shall set a “realistic” reduction goal (or milestone). To set a “realistic” goal, the Manager shall make a concrete action plan to reduce each component of NRW, by allocating reasonable budget and human resources.

Hereunder is the Action Plan suggested by JET based on the Water Balance Analysis in DMA

Water Balance “tentatively estimated” in Oct 2022

System Input Volume	Inflow	Authorized consumption	Billed Authorized Consumption	Billed Metered Consumption	541	46.8%	Revenue Water (RW)	46.8%
	2,310		Unbilled Authorized Consumption	Unbilled Metered Consumption	8	0.7%		
			Unbilled Unauthorized Consumption	Unauthorized Consumption (Illegal connection)	42	3.6%		
	Outflow		Apparent Losses (or Commercial Losses)	Customer Meter Inaccuracies and Data Handling Errors				
	1,155		Water Losses	Leakage on Transmission and Distribution Mains				
			Real Loss (or Physical Losses)	Leakage and Overflows from the Utilities Storage Tanks (OHT at Konia)	565	48.9%		
				Leakage on Service Connections up to the Customer Meter				
	The Balance (Inflow - Outflow)						Non-Revenue Water (NRW)	53.2%
	1,155							
Unit	[m ³ /day]				[m ³ /day]	[%]		



Action Plan Suggest in November 2022

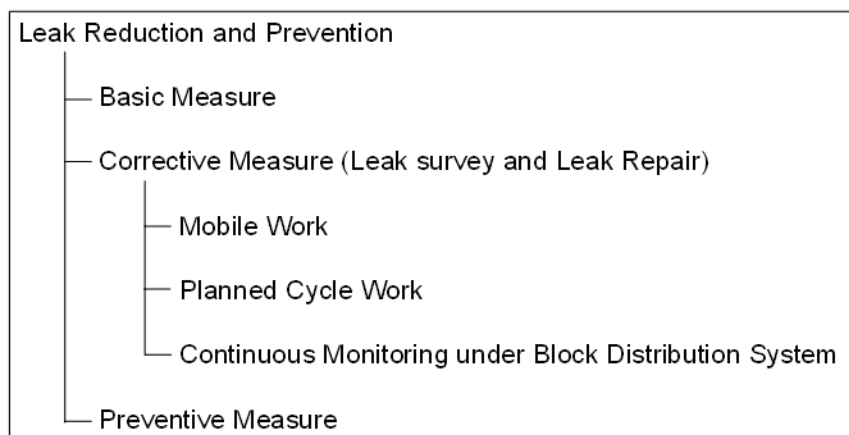
Category	Measures to be taken
1 Reduction of Real Loss	i. Identify heavily leaking Sub-zones, by conducting Step Test of Minimum Night Flow (MNF) in Midnight ii. Conduct Leak Detection in the leaking Sub-zones, a. Stress Test (=find surface leak with expected “normal” pressure) b. Leak Detection by using Electro Leak Detector, Correlators under relatively high pressure iii. Repair Leaks a. Develop and Implement Standard Specs for the Repair Works, in order to increase the quality of repair work
2 Reduction of Apparent Loss	Provide Decent Stand-Pipe with proper Tap (made of metal)
3 Reduction of Auth. Unb. Con.	Provide Decent Stand-Pipe with proper Tap (made of metal)

Summary of NRW Reduction Manual (Draft)

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4. Overview of Leakage Reduction and Prevention

In general, Water leakage reduction and prevention measures can be classified into three categories — **(1) Basic Measures, (2) Corrective Measures, and (3) Preventive Measures.**



4.2 Basic Measures

1. Leakage Analysis and Monitoring

Leakage analysis is the classification of leaks (1) by facility (such as water transmission/distribution main/distribution branch pipes, water supply pipes, distribution ponds, etc.), (2) by cause (natural leakage, accidental damage), or (3) by region etc. It is important for the Managers in planning leakage reduction, because it provides an understanding of the leakage situation. Water Balance Analysis using the Water Balance Table is one of the useful methods of leakage analysis

In principle, the Manager can analyze the amount of water leakage by the following three methods:

- a) **Direct Measurement Method**
- b) **Indirect Measurement Method (Minimum Night Flow survey)**
- c) **Water Balance Analysis Method:**

2. Internal Training

Technology and Knowledges of how to reduce leakage must be transferred from skilled engineers to others, or one generation to others, since leakage reduction and prevention requires a lot of workforces and takes long time. Internal training is very much important for such technology transfer within JalKal and UPJN. Trainings can be done in different manner — such as lecture in room, field training, and on-the-job training on the field, or mixture of these.

4.3. Corrective Measure

Corrective Measures is the activities to reduce leakage by **Leak Survey** and **Leak Repair**. These measurers can be divided into three categories — (1) **Mobile Work**, (2) **Planned Cycle Work**, and (3) **Continuous Monitoring under Distribution Block system**.

Mobile Work

This is the work to quickly investigate leakage (mostly for aboveground leakage), identify the point of leak, and repair the leakages (by pipe repair, rehabilitation or replacement etc.). In principle, Mobile Work is taken reactively, not preventively, in response to customer complaints or accidental damages caused by leakages.

Planned Cycle work

The Manager can divided his/her service area into several areas, and conduct leak survey, and fix leaks systematically in a certain cycle (let's say every 2-5 years) by conducting (1) patrol (preliminary inspection), leak survey, and leak repair works in each segment. In general, this approach requires allocation of human resources and budget appropriately.

Continuous Monitoring under Distribution Block System

The Manager can monitor leakage by dividing the service area into small "Distribution Block Systems" and installing flow-meters into each block system. When required, The Manager can conduct repair works whenever necessary (such as sudden increase of leakage drop of pressure in some blocks.).

4.4 Preventive Measures

This is the needful work to prevent "leakage recurrence (please see below)" and reduce leakages. Preventive measures involve the followings.

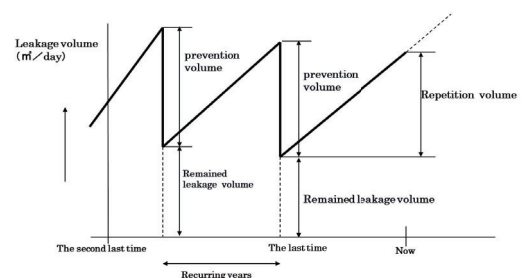
- Replace or rehabilitate aged pipe.
- Improve Pipe (change material, layout, etc.)
- Control water pressure appropriately
- Take anti-corrosion measure against corrosive pile (such as mild steel)
- Measures for other utilities (electricity, gas, sewerage)

Fore more details about preventive measures, please see Section 8 (Preventive Measure)

Leakage Recurrence

In general, leaks are caused by aging of the pipes, earthquakes, ground subsidence, corrosion, traffic loads, and nearby construction work by other utilities (sewerage, electricity, gas etc.). Even though leaking point is repaired, new leak occurs near the repaired (or patched) point if the pipe material and the environment remain the same.

This phenomenon is called "Leakage Recurrence." To monitor the leakage recurrence, the Managers should select a representative segment and conduct a follow-up survey every 1 to 2 years to estimate the amount of leakage recurrence.



Images of Leakage Recurrence

Part II

5. Leak Survey

6. Instrument for Leak Survey

5. Leak Survey

Concept of leak survey

The concept of leak survey is to identify the leak point narrowing down from a large area to point.
DMA(Whole area) → Subzone(Small sized area) → Leakage lines → Leak points

1. Area method

To know leakage area with volume in the DMA by the **Step test** using flow meter

Equipment

- Ultrasonic flow meter
- Magnetic flow meter

2. Line method

To know leakage line in the selected small area by **Sound-check or Step test**.

Equipment

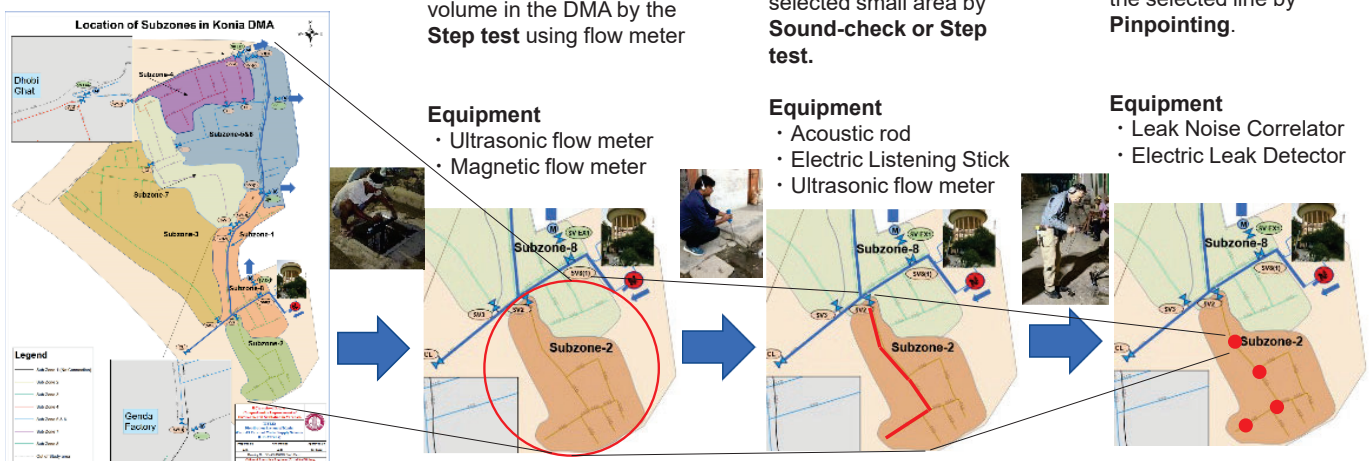
- Acoustic rod
- Electric Listening Stick
- Ultrasonic flow meter

3. Point method

To know leakage point in the selected line by **Pinpointing**.

Equipment

- Leak Noise Correlator
- Electric Leak Detector



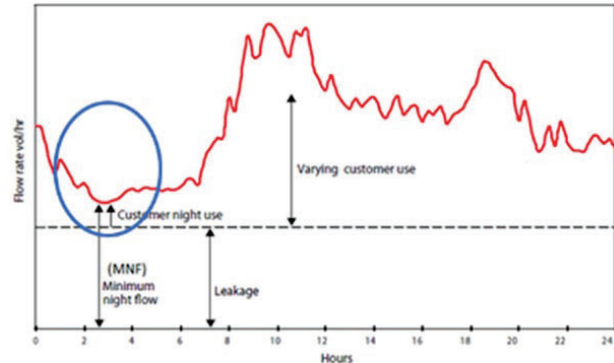
5.2. Minimum Night Flow (MNF)

Minimum night flow is minimum flow in a day.

Usually, Minimum flow in a residential area is recorded at midnight because most people sleep and do not use water much.

However, some people use water. MNF includes a little water usage in it.

Therefore, MNF is close to the leakage volume in the area.



Sample of flow pattern in a day and MNF

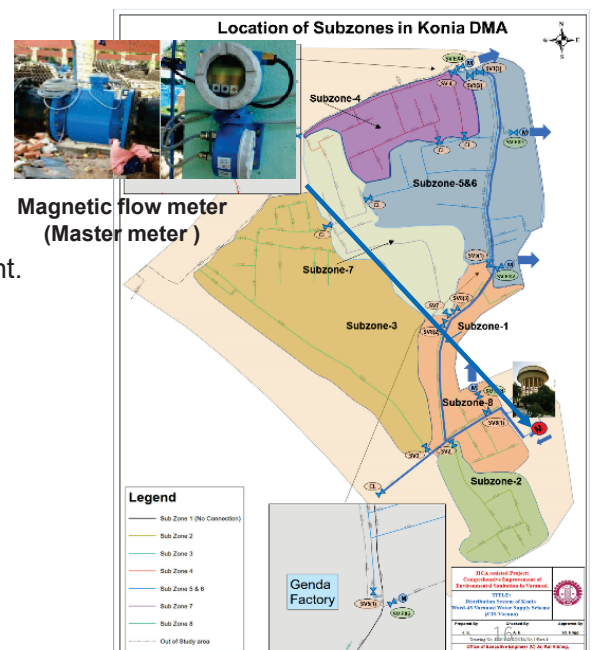
Prioritization of the leak detection by the step test as the Area method

Step Test

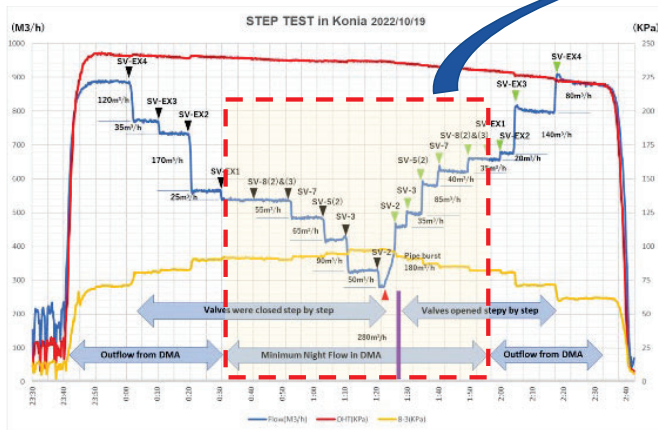
The step test is to know where and how much leakage volume in the subzone and whole DMA by valve operation works.

How to measure

1. Measure the minimum night flow (leakage volume) in the DMA by the master meter at the outlet of the OHT at midnight.
2. Close the sluice valves at the inlet of sub-zones one by one at 5 to 10 minutes intervals and open them with the same procedures.
3. Measure the changed volume each section during valve operations.



Result of Step Test



Graph of Step Test

Subzone information		Pipe Length [m]	Number of Customer Connection	Step Test 19-20th Oct		Average		MNF/Pipe Length [L/m/hr]	MNF/Connection [L/hr/connection]	Unit Leakage (Priority)
				MNF Open→Close [m3/hr]	MNF Close→Open [m3/hr]	MNF [m3/hr]	MNF [%]			
Out of DMA	SV-EX4 300PVC			120	80	100	13%			
	SV-EX3 110PVC			35	-	35	4%			
	SV-EX2 200PVC			170	140	155	15%			
	SV-EX1 110PVC			25	20	22	2%			
SZ_8	SV8(3) 110PVC						1%			
	SV8(2) 110PVC					10	0%			
	SV8(1) 110PVC									
SZ_7	SV7 110PVC	582	0.118	104						
	SV7 110PVC	506	10%	80	55	35	45	5%		
SZ_5+6	SV5(2)* 250PVC	941	19%	164	65	40	53	6%		
	SV5(1) 250PVC	755	15%	182	-					
SZ_4	SV4 110PVC	1044	21%	184	90	85	87	10%		
SZ_3	SV3 110PVC	380	8%	66	50	35	42	5%		
SZ_2	SV2 110PVC									
SZ_1	SV1(3) 350AC									
	SV1(2) 150DI									
	SV1(1) 400AC									
	Remaining (SZ1)	712	14%	0	280	280	337	39%		
Pipe Burst						180				
Total		4920		780	890	880	866	100%		

Calculation and prioritization of leakage detection

We prioritize a high number of MNF volume per length and per number of connections as a leak detection survey area from subzones.

6. Instruments of Leak Survey

6.1.1. Ultrasonic flow meter

6.2.1. Listening Stick (Sound check)

6.2.2 .Electric Listening Stick

6.3.1. Electric Leak Detector

6.3.2. Leak Noise Correlator

The manual shows a)Principle , b)Intended use, c)How to use, and d)Points to note in that order at each equipment.

6.1.1 Ultrasonic flow meter Model: Tokyo keiki UFP-20



Sensors with mounting fixture
Connecting cables
Flow meter

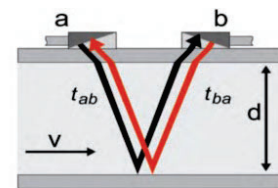


Illustration 1: Clamp-on ultrasonic flowmeter configuration

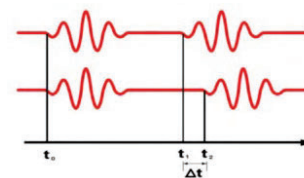


Illustration 2: Transit-time measuring principle

Principle

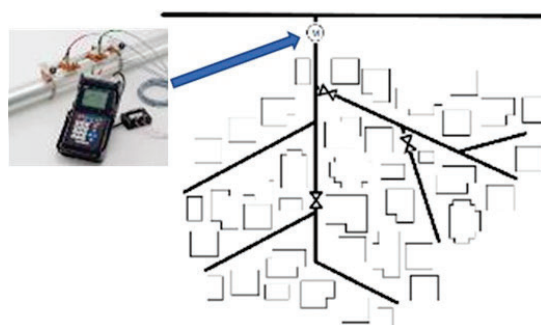
Ultrasonic waves are transmitted and received inside the pipe from a sensor attached to the outside of the pipe.

Since the received time is different depending on the speed of the water in the pipe, the flow velocity is measured, and the flow rate is calculated from the cross-sectional area of the pipe.

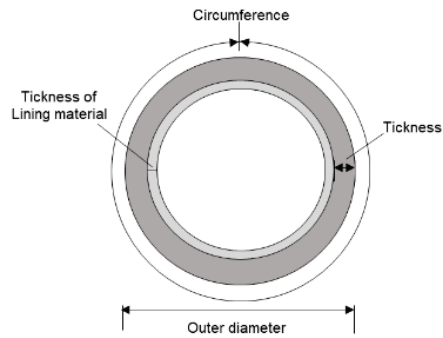
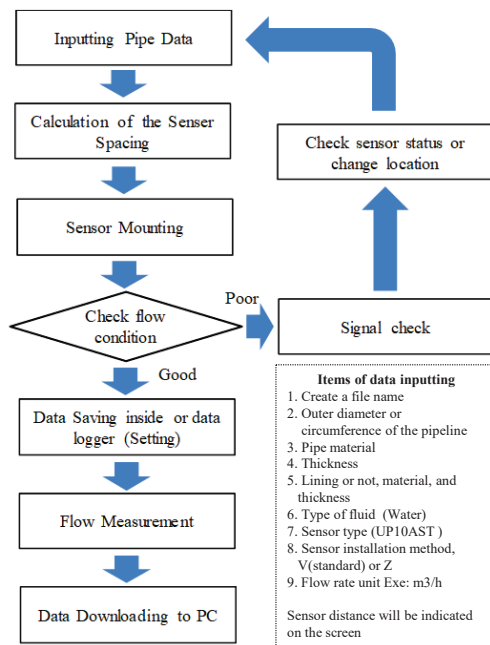
Intended Use

It does not stop the water or cut the pipe, and the flow rate can be measured by installing the sensor outside the water pipe.

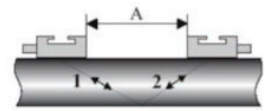
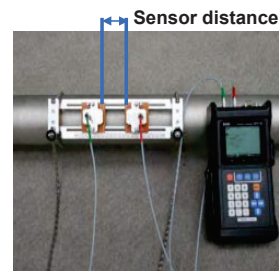
The ultrasonic flow meter is used in the DMA step test and measurement of MNF.



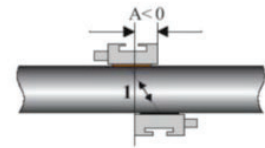
Procedure for entering information of water pipe



Name of parts of pipe



V method (Standard)



Z method

(When the straight pipe section is not enough or when dose not get a signal in V method)

Sensor installation type

Summary of NRW Reduction Manual (Draft)

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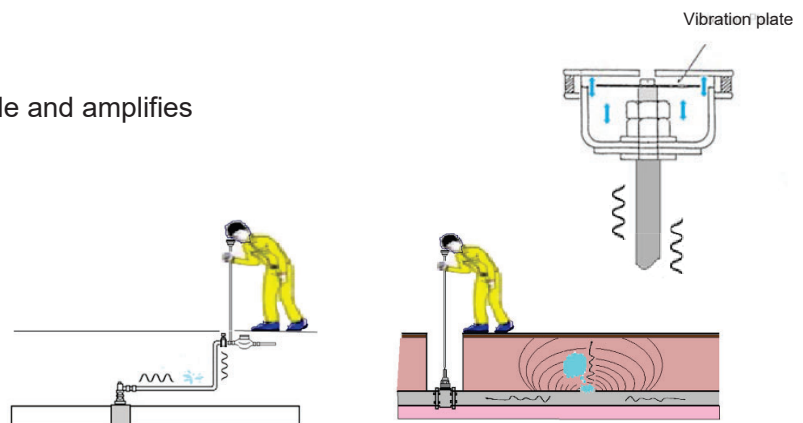
6.2.1 Listening stick

Principle

Listening stick has a vibration plate inside and amplifies the sound transmission.

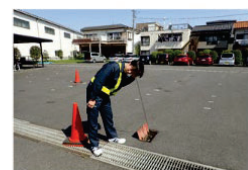
Intended use

Sound check with a acoustic rod at water meter (Service pipe)



How to Use

Contact bar to the water meter and listen to sound.



6.2.2. Electric listening stick Model: Fujitecom FSB-8D



Principle & Indented use

It has amplifier unit inside, and amplify sound more.

It is suitable for listening sound on PVC pipe.

How to use

The rod contacts a water meter or exposed pipe and listens to a sound through the headphones.

6.3. Electric Leak Detector Model: Fujitecom HG-10A II

Principle

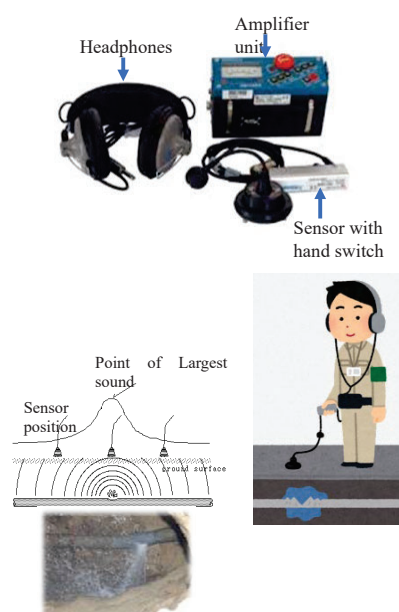
When the sensor captures a sound, it is amplified and listened to through headphones.

Intend use

The leak detector is used to distinguish the leak sound where or not from a road surface.

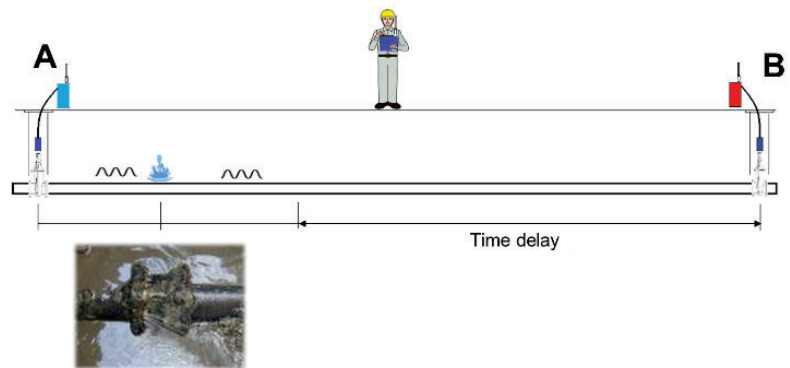
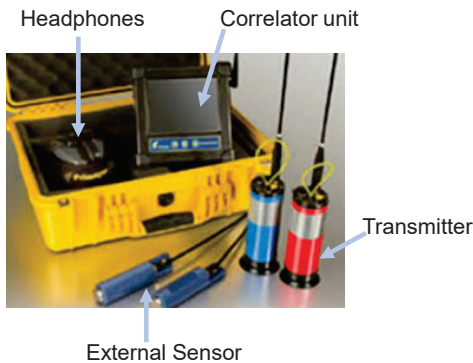
How to Use

- Slowly place the sensor on the road where the pipe is buried and press the switch to hear the sound.
- Place the sensor at intervals of 40-50cm.
- Detect the location of the loudest point.



6.4. Leak Noise Correlator Model: Primayer Eurika3

Components of Leak noise correlator



Principle

- When leak point is close to A side, leak sound reaches B side with a time delay.
- Correlator measures the time delay between two sensors and calculates distance the leak point from A and B.

Measurement Conditions

The measurement requires the following three conditions

1. The sound of the leak reaches A and B.
2. The leakage point must be between A and B.
3. Information on the pipe must be known.

Good Working Conditions

- In general, leakage sound propagates better in metal pipe than non-metal pipe.
- High pressure condition is better than low pressure.

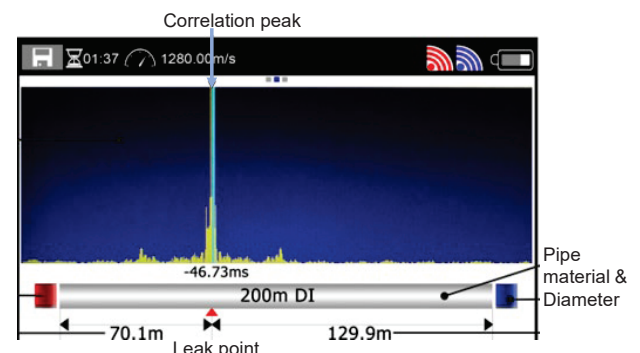


It is desirable to conduct the leak detection at nighttime when it is quiet, and water pressure is sufficient.

How to Use

Place the external sensor on the valve. Enter the following three conditions.

1. Pipe material
2. Pipe diameter
3. Distance between two points (A and B)



Monitor of Correlator

Part III

7. Leak Repair (Corrective Measure)

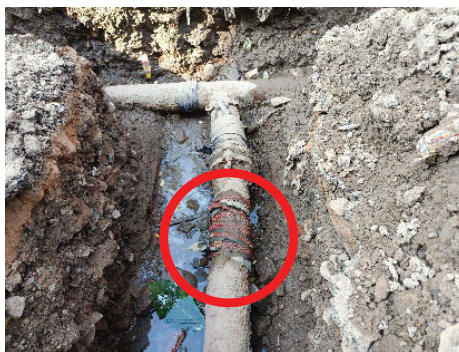
8. Preventive Measure

7.1. Cause of Water Leakage

- ✓ Most of the water leakage are caused by poor construction or insufficient leak repair
- ✓ In addition, there were many cases of water leakage because the traces where the water supply pipes were connected were not properly shut off
- ✓ To prevent water leakage, Jal Kal should supervise all construction work and contractors



Point 1-6



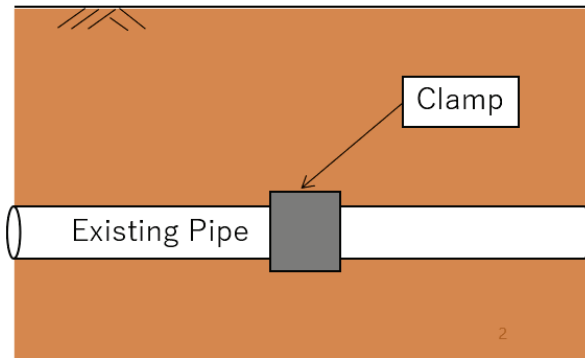
Point 8-2



Point 8-3

7.2. Temporary Method of Leak Repair

- ✓ Effective as an emergency repair
- ✓ Temporary and eventually requires permanent repair



Clamps



Summary of NRW Reduction Manual (Draft)

Wooden Plugs



Glass Fiber Band

7.2. Temporary Method of Leak Repair

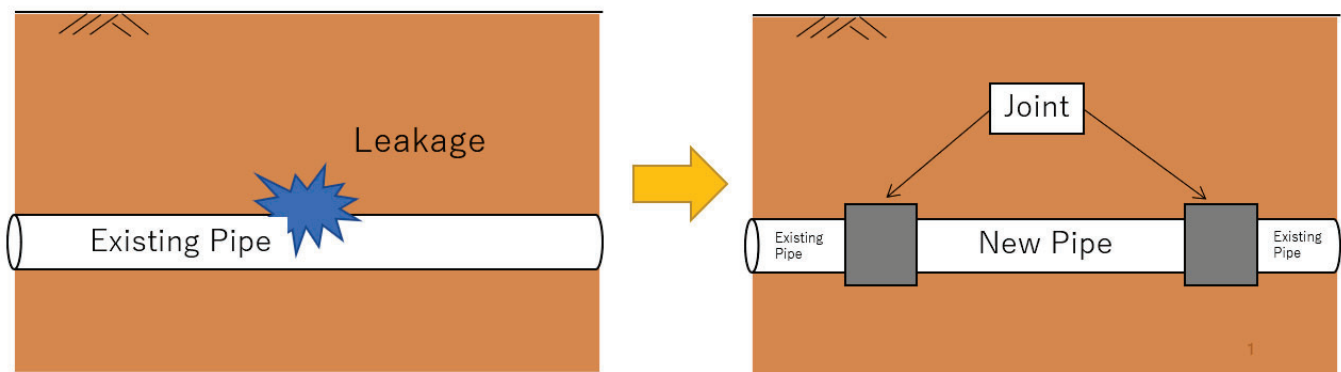
- ✓ Wrong repairs won't stop the leak
- ✓ If the pipe is severely damaged, replace the pipe



7.3. Permanent Method of Leak Repair

7.3.1. Pipe replacement (Straight)

- ✓ Most common method
- ✓ Secure connection with existing pipes
- ✓ Use the correct fittings for the pipe material



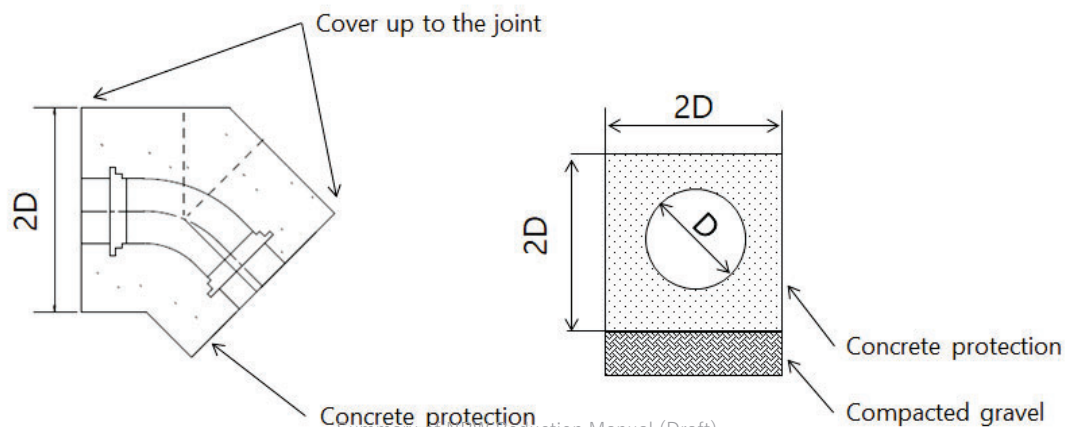
Summary of NRW Reduction Manual (Draft)

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7.3. Permanent Method of Leak Repair

7.3.2. Pipe replacement (Curved (Elbow))

- ✓ Strong water pressure is applied to the part where the curved pipe (elbow).
- ✓ Concrete protection is effective to prevent pipes from coming off due to water pressure



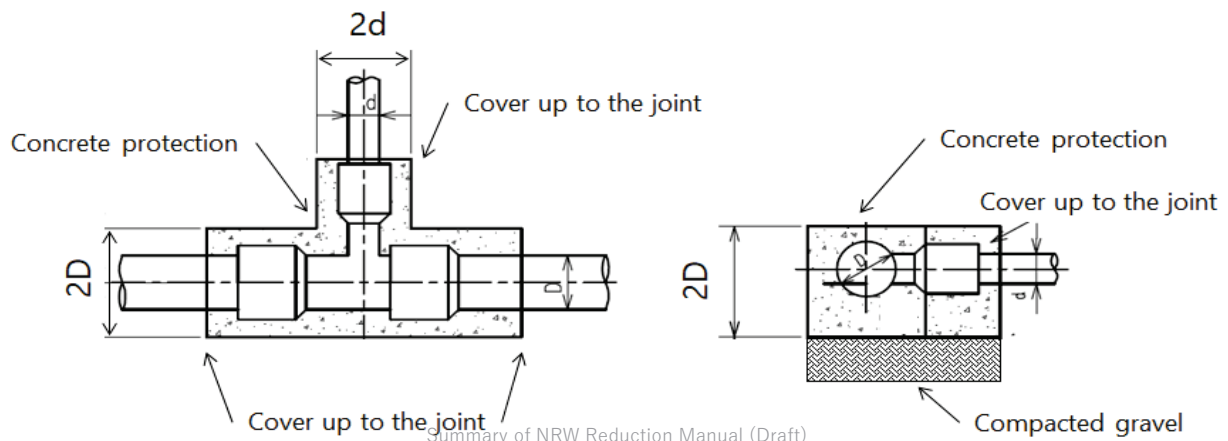
Summary of NRW Reduction Manual (Draft)

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7.3. Permanent Method of Leak Repair

7.3.2. Pipe replacement (T-joint)

- ✓ A tee is similar to a bend.
- ✓ Strong water pressure is applied to the T part
- ✓ Concrete protection is effective to prevent pipes from coming off due to water pressure



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7.4. Water leakage inspection after completion

- ✓ After completing the piping, be sure to visually check for leaks before backfilling



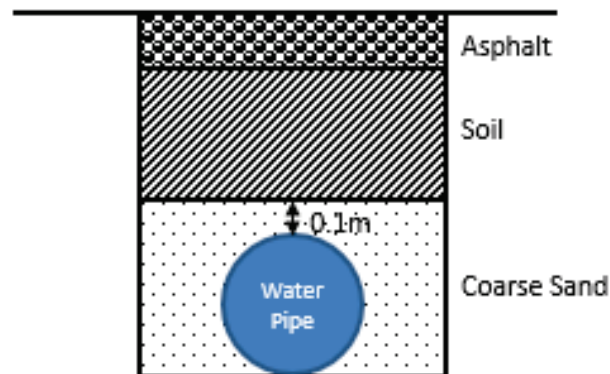
Summary of NRW Reduction Manual (Draft)



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7.5. Backfill

- ✓ Be sure to backfill after checking the laying of piping
- ✓ Use good quality sand and soil
- ✓ Protect the pipe by compacting the road and prevent the road from sinking

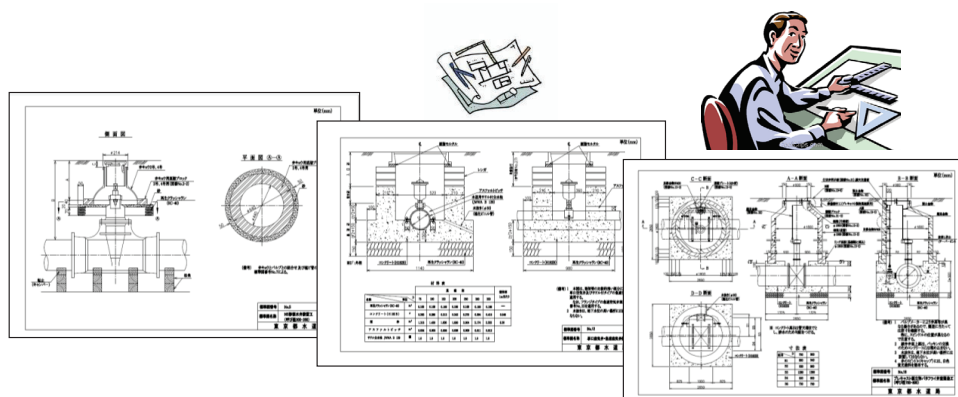


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8. Preventive Measure

8.1.7. Creation of “Standard Drawing”

- ✓ To ensure that construction quality and design do not differ regardless of who makes it
- ✓ To prevent the orderer's intention from being mistakenly conveyed to the contractor

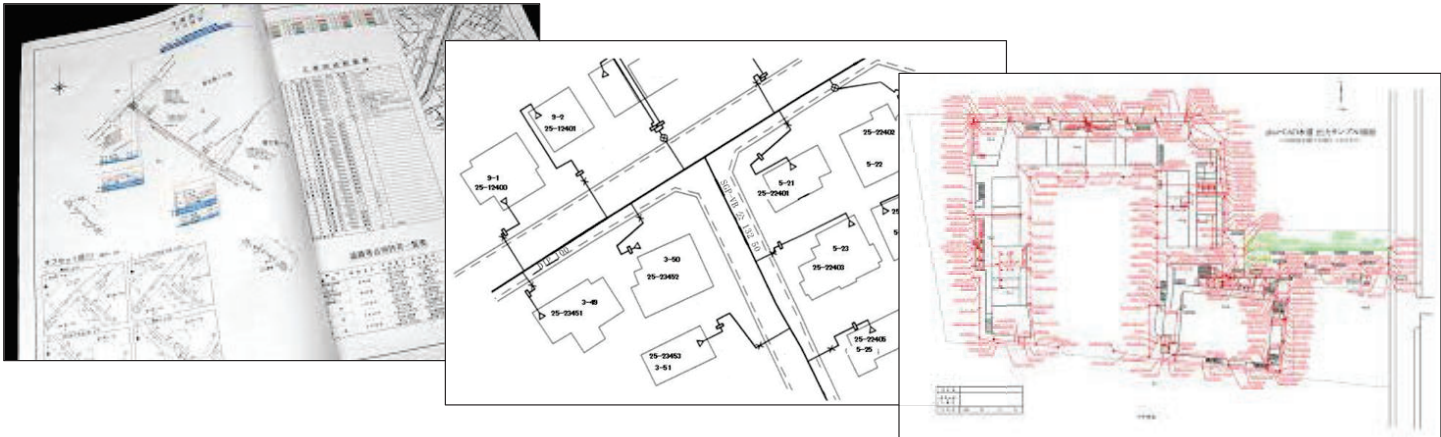


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8. Preventive Measure

8.1.8. Updating the pipe database

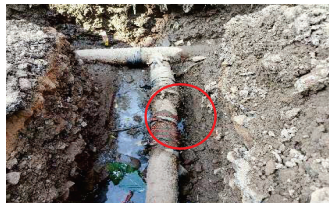
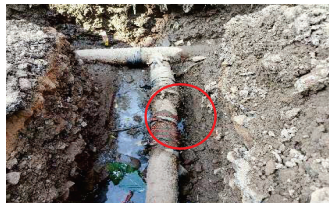
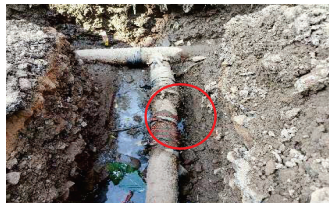
- ✓ Accurately record construction details
- ✓ Based on this information, it is possible to analyze the cause of the failure and use it for future update plans.



8. Preventive Measure

8.1.8. Updating the pipe database

- ✓ Record repair history (when, who, material, size, repair method, etc.)

Pipe Repair Record Sheet																																							
No.	Location	Date	Type	Depth	Diameter	Material	Position	who discovered	Person in charge	Traditional repair method	JET suggestion																												
1	1-6		Distribution pipe	0.5m	110mm	PVC ==> MS	Straight	Jal Kal & JET	Ashtosh Tripati, Jal Kal	damp	Work Record Photo <table><tr><td>Location</td><td>Point 8-2</td><td>Date</td><td>6-Dec-22</td></tr><tr><td>Type</td><td>Distribution</td><td>Depth</td><td>0.6m</td></tr><tr><td>Diameter</td><td>110</td><td>Position</td><td>Tee</td></tr><tr><td>Material</td><td>MS ==> MS</td><td>Person in charge</td><td>Mr. Ashtosh, Jal Kal</td></tr><tr><td>Photo</td><td colspan="3"></td></tr><tr><td colspan="4"> Before </td></tr><tr><td colspan="4"> After </td></tr></table>	Location	Point 8-2	Date	6-Dec-22	Type	Distribution	Depth	0.6m	Diameter	110	Position	Tee	Material	MS ==> MS	Person in charge	Mr. Ashtosh, Jal Kal	Photo				Before 				After 			
Location	Point 8-2	Date	6-Dec-22																																				
Type	Distribution	Depth	0.6m																																				
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Material	MS ==> MS	Person in charge	Mr. Ashtosh, Jal Kal																																				
Photo																																							
Before 																																							
After 																																							
2	8-2	6-Dec-22	Distribution pipe	0.6m	110mm	MS ==> MS	Tee	Jal Kal & JET	Ashtosh Tripati, Jal Kal	Rubbe																													
3	8-3	6-Dec-22	Distribution pipe	0.6m	110mm	PVC ==> MS	Straight	Jal Kal & JET	Ashtosh Tripati, Jal Kal	Rubbe																													
4	3-7		Service pipe					Jal Kal & JET																															
5	3-8		Service pipe					Jal Kal & JET																															
6																																							
7																																							
8																																							
9																																							
10																																							

Summary of NRW Reduction Manual (Draft)

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8. Preventive Measure

8.2. Change pipe materials

- ✓ Consider new materials

➤ In Japan, these generally have a legal useful life of 40 years



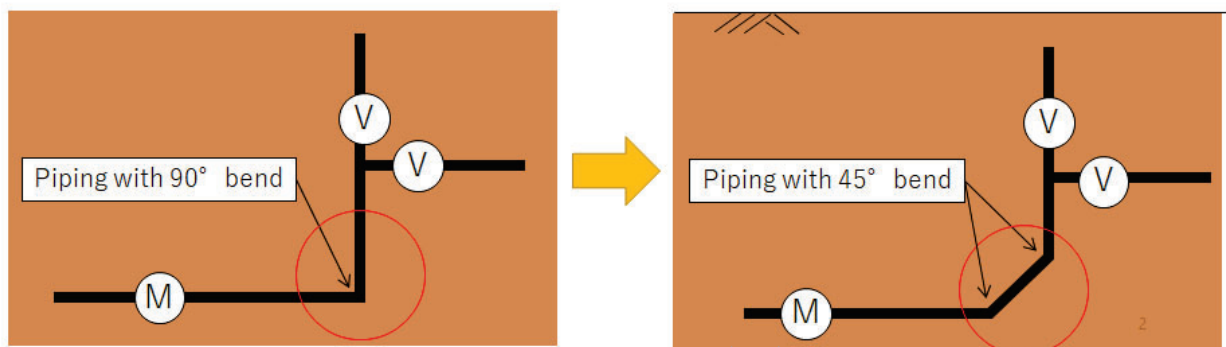
Summary of NRW Reduction Manual (Draft)

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8. Preventive Measure

8.3. Improvement of piping method

- ✓ If you bend the water pipe at 90 degrees, high water pressure will be applied there.
- ✓ By bending the water pipe with two pipes at 45°, it prevents the pipe from coming off.



Summary of NRW Reduction Manual (Draft)

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8. Preventive Measure

8.4. Pipe alert sheet

- ✓ Various structures are buried underground (for example Electricity, Gas, Telephone etc.)
- ✓ Protects water distribution pipes from external damage
- ✓ This sheet informs others of the presence of water pipes



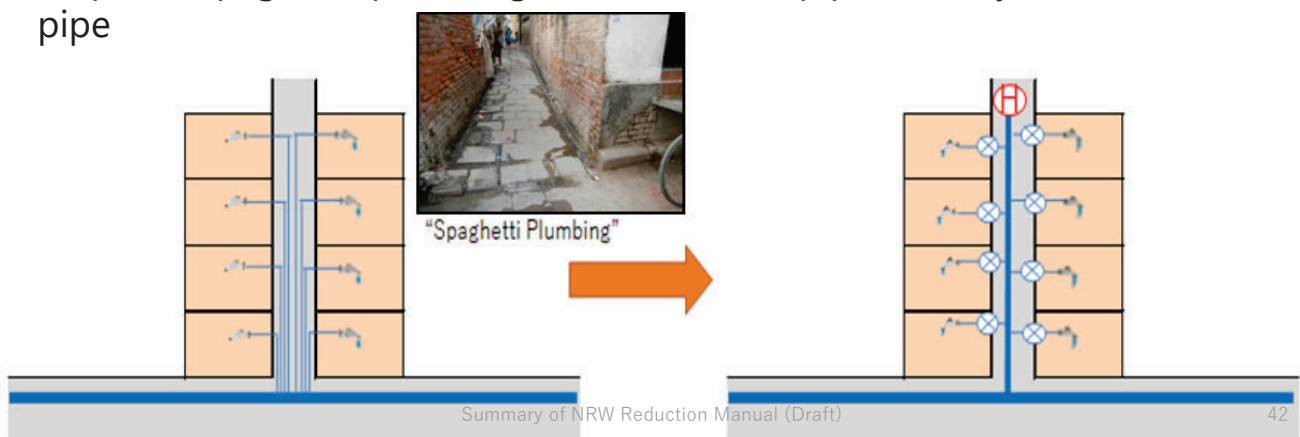
Summary of NRW Reduction Manual (Draft)

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8. Preventive Measure

8.5. Improvement of service pipes

- ✓ Service pipes are vulnerable to damage
- ✓ Do not expose the service pipe on the road
- ✓ By connecting many water service pipes to the same place of the distribution pipe, it leads to deterioration of the distribution pipe
- ✓ Stop the spaghetti plumbing of the service pipe and lay the distribution pipe



Summary of NRW Reduction Manual (Draft)

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Appendix 17

Citywide Rollout Plan for NRW Reduction in Varanasi

**The Project for Comprehensive Improvement of
Environmental Sanitation in Varanasi (CIESV)**



**Citywide Rollout Plan
for NRW Reduction in Varanasi**

April, 2024

JICA Expert Team

Contents

1. Background
 2. NRW reduction in Varanasi
 3. Creating Dedicated Team for NRW Reduction
 4. Job Description of NRW Team
 5. Suggest Structure of NRW Team
 6. Phase I : Pilot Project
 7. Phase II: Trial Phase for Citywide roll-out
 8. Phase III: Citywide deployment
 9. Expected Schedule
- Attachment
1. Sample Specification of Bulk meter and customer meters
 2. Sample Cost of Investment for the Pilot Project

Background(1)- Water Supply by Jal Kal

- In Varanasi, Jal Kal produces 330 MLD* (million liter /day) of water for customers, of which 205 MLD* comes from ground water and 125 MLD* from surface water from Ganga river.
- Revenue Water account for 65%* of the produced water, while Non Revenue Water account for the remaining 35%* .
- In most parts of Varanasi, water is supplied intermittently (3-4 hours/day) because the capacity of water treatment plant and tubewell pumps, as well as pipe network are not enough to supply 24hours/day.

* The numbers above are excerpted from Jal Kal web site.
https://www.JalKalvaranasi.org/webpages.php?tag=Water_Supply

Background(2)- Financial position of Jal Kal

- In general, water utilities in developed country are operated under a “self-supporting accounting system,” where all expenses are covered by the incomes from water supply.
- However, according to the financial statements (or “*Balance Sheet*”) audited by P.K. Sharma & Co, chartered accountant of Jal Kal VNN, it can be said that Jal Kal is far from self-supporting, with its Balance Sheet relying on grant in aid, and leaving large amount of outstanding liabilities for purchases & expenses. Details are as follows:
 - Jal Kal’s net loss for the year 2021-22 was approximately 1.04 Billion INR, with the total income of 442 million INR and the total expense of 1,478 million INR respectively.
 - Jal Kal’s deficit (or Accumulated Loss) is 8.68 billion INR as of 31st Mar. 2022, which is approximately 20 times larger than the annual revenue of Jal Kal.*

* 8.67 billion INR / 442 million INR =19.6 [-]

Reduction of Non-Revenue Water(NRW)

- “Non-Revenue Water(NRW)” is the water produced and distributed to users, but not produced any revenue to Jal Kal. In fact, it is causing only expenditures to Jal Kal.
- Hence, the reduction of NRW is one of the priorities Jal Kal shall address, to improve its financial performance.
- To reduce NRW, Jal Kal & UPJN need to address the followings;
 - Conduct Water Balance Analysis;
 - Carry out leak survey and leak repair; and
 - Monitor NRW (volume and ratio)

Basic Idea of City-wide Rollout plan

- During CIESV, Pilot Project was carried out in Konia under the initiative and management of JICA Expert Team. Jal Kal and UPJN received a variety of trainings provided by JET and acquired basic knowledge of NRW reduction.
- To reduce NRW throughout Varanasi, Jal Kal and/or UPJN shall test the acquired knowledge on the fields and produce actual results step-by-step, while developing enough human resources to carry out NRW reduction through out the city.
- Importantly, basic facilities -- such as customer meters (for each household) and Bulk flow meters to monitor the volume of production and distribution -- shall be installed before full implementation of NRW reduction. Without the facilities, Jal Kal and UPJN cannot measure the performance of NRW reduction.
- Suggested steps are as follows;
 - Phase 1: Self managed Pilot Project, under the condition of 24/7 water supply and needful customer and bulk flow meters installed.
 - Phase 2: Trial Phase of City Wide Rollout Plan
 - Phase 3: Full execution of City Wide Rollout Plan

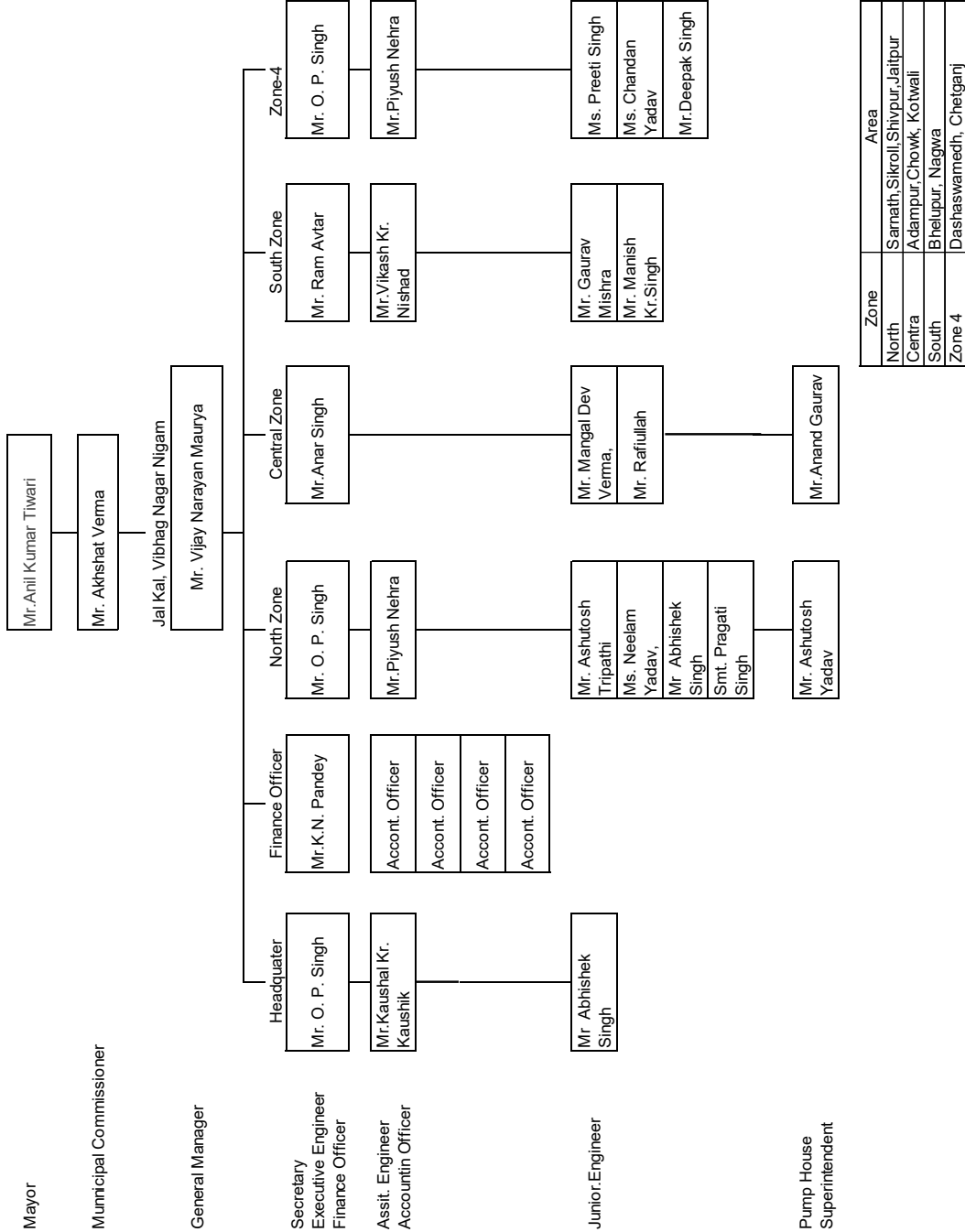
Creating Dedicated Team for NRW Reduction

- In near future, before the Phase 2 of the rollout plan, Jal Kal shall create a dedicated team for NRW Reduction (NRW Team) to supervise and enhance NRW reduction throughout Jal Kal.
- The member of dedicated team shall be as follows to start with, taking into consideration of the limited human resources.;
 - Executive Engineer (1)
 - Assistance Engineer (1)
 - Junior Engineer (1)
 - Hump House Superintendent (1)

Job description of NRW Team

1. Develop a detailed NRW Reduction Plan to reduce NRW in each zone and throughout Varanasi
2. Create budget proposal for NRW Reduction Plan
3. Execute the NRW Reduction Plan together with each zonal team
4. Provide technical assistance to each zone team and coordinate activities among zone teams. This includes development and implementation of training program related to NRW reduction.
5. Monitor activities in each zone and collect NRW data.

Current Organizational Structure of Jal Kal



Mayor

Municipal Commissioner

General Manager

**Secretary
Executive Engineer
Finance Officer**

**Assit. Engineer
Accountin Officer**

Junior Engineer

**Pump House
Superintendent**

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graph TD
    Mayor[Mayor] --- MC[Municipal Commissioner]
    MC --- GM[General Manager]
    GM --- Sec[Secretary  
Executive Engineer  
Finance Officer]
    GM --- AsstEng[Assit. Engineer  
Accountin Officer]
    GM --- JE[Junior Engineer]
    GM --- PHS[Pump House  
Superintendent]

    Sec --- HQ[Headquarter]
    Sec --- FO[Finance Officer]
    Sec --- NZ[North Zone]
    Sec --- CZ[Central Zone]
    Sec --- SZ[South Zone]
    Sec --- Z4[Zone-4]

    HQ --- MrOPS[Mr. O. P. Singh]
    HQ --- MrK[Mr. Kaushal Kr. Kaushik]
    HQ --- MrA[Mr. Abhishek Singh]

    FO --- MrKNP[Mr.K.N. Pandey]
    FO --- AO[Accont. Officer]
    AO --- AO1[Accont. Officer]
    AO --- AO2[Accont. Officer]
    AO --- AO3[Accont. Officer]

    NZ --- MrOPS1[Mr. O. P. Singh]
    NZ --- MrPN[Mr. Piyush Nehra]
    NZ --- MrAT[Mr. Ashutosh Tripathi]
    NZ --- MsN[Ms. Neelam Yadav]
    NZ --- MrAS[Mr. Abhishek Singh]
    NZ --- SmtP[Smt. Pragati Singh]
    NZ --- MrAY[Mr. Ashutosh Yadav]

    CZ --- MrAS1[Mr. Anar Singh]
    CZ --- MrPN1[Mr. Piyush Nehra]
    CZ --- MrMDV[Mr. Mangal Dev Verma]
    CZ --- MrRF[Mr. Rafiullah]
    CZ --- MrAG[Mr. Anand Gaurav]

    SZ --- MrRA[Mr. Ram Avtar]
    SZ --- MrVK[Mr. Vikash Kr. Nishad]
    SZ --- MrG[Mr. Gaurav Mishra]
    SZ --- MrM[Mr. Manish Kr. Singh]

    Z4 --- MrOPS2[Mr. O. P. Singh]
    Z4 --- MrPN2[Mr. Piyush Nehra]
    Z4 --- MsPS[Ms. Preeti Singh]
    Z4 --- MsC[Ms. Chandan Yadav]
    Z4 --- MrDS[Mr. Deepak Singh]

    MrK --- AsstEngNRW[Assit. Engineer for NRW]
    MrA --- JEforNRW[Junior Engineer for NRW]
    AsstEngNRW --- JEforNRW
    JEforNRW --- PHSforNRW[Pump House Superintendent for NRW]
  
```

Zone	Area
North	Sarnath, Sikrol, Shivpur, Jaitpur
Central	Adampur Chowk, Kotwali
South	Bhelupur, Nagwa
Zone 4	Dashaswamedh, Chetganj

Zone	Area
North	Sarnath, Sikrol Shivpur, Jaitpur
Central	Adampur, Chowk, Kotwali
South	Bhelupur, Nagwa
Zone 4	Dashaswamedh, Chetganj

Phase I: Pilot Project

Preparation

- Select One (1) of the Water Supply Scheme (WSS) in Varanasi for a pilot project
 - The water shall be provided 24hours/ day, 7days/week to avoid problems arising from Intermittent water supply. (please see the page [x] for more detail).
- Prepare pipeline drawing map, as well as customer list and profile of the WSS for the pilot project.
 - Customer profile is used as the basis of customer meter installation to each category of customers
 - Customers = Domestic + Commercial
 - Commercial = School(%) + Hospital(%) + Hotel(%) + Restaurant(%) + Shopping center(%) + Factory(%) etc.

(continued to the next page.)

(continued from the previous page.)

- Install flow meters for NRW analysis
 - Install Bulk Flow Meters at the exit of OHT
 - Install Customer Meters to customers
 - To represent the customers in the Pilot Project area, proportionally distribute the meters to all category of customers – such as domestic and commercial customers (School, Hospital, Hotel, Restaurant, Shopping center, Factory etc.)
 - Expected sample numbers depends on the total number of customers in the pilot area, but not less than 100, and not more than 1000 which is not easily manageable as a pilot project. (Suffice it to say that it should be from 100 to 500 customers.)
- Install new sluice valves or use existing ones (if necessary) to segregate the Pilot Project area from the surroundings. (This is to monitor the water volume supplied to and consumed in the Pilot Project area.)

Problems of Intermittent Water Supply for NRW reduction

During the Pilot Project in CIESV, JICA project team faced a series of problems of intermittent water supply. Intermittent water supply have the following negative impact on NRW reduction. JaIKal shall avoid such condition when choosing project areas.

- a. Metering inaccuracy: Bulk flow-meter will not show the water flow accurately when the pipelines are not fulfilled by the flowing water.
- b. Limited chance of Leak Survey: In general, leak survey is conducted midnight since project team needs to conduct minimum night flow survey and leak detection under quiet environment in midnight (less noise and less traffic). However, no water is available during midnight under intermittent water supply. Special arrangement for min-night water supply is necessary for activities of NRW reduction.
- c. Water Hammer: Intermittent water supply causes “water hammer” in pipelines, and damages pipes after repaired, and causes leaks repeatedly.

Conduct Water Balance Analysis

- In each Water Supply Area, Water Balance Analysis shall be conducted
 - System Input shall be measured at the exist of OHT
 - System Input [m³, or m³/day] = Inflow – outflow
 - Revenue Water(RW) shall be measured, by using the randomly installed customer meters in the area, and estimated as follows
 - RW [m³, or m³/day] = $\Sigma RW \times (\# \text{ of total Customers} / \# \text{ of metered customers of the category})$
 - Calculate NRW as follows
 - NRW [m³, or m³/day] = System Input – RW
 - NRW % [%] = $(\text{System Input} - \text{RW}) / \text{System Input}$
- Further breakdown analysis can be carried out, if there is serious concerns for the Authorized Unbilled Consumption, and Apparent Loss.

Develop Pressure Distribution Map

- In each Water Supply Area, Zonal team shall develop pressure distribution map
 - In principle, water pressure shall be managed appropriately between 0.1MPa and [0.3] MPa* .
- The Zone Team shall measure water pressure at least 10 different points, including the (1) near the exit of OHT, (2)four farthest points east, west, south, and north from the OHT, and (3) middle point between the OHT and the end of the pipeline.
- Two(2) pressure maps for the same area shall be developed -- one for the daytime pressures (called minimum dynamic pressure map), and one for midnight pressures (Maximum static pressure map).
- The pressure map will provide Jal Kal valuable information to figure out the possible leakage area. If some area have very low pressure, it may be caused by water leakage in the area.

* In Japan, water pressures at the junction of distribution pipe and service pipe are regulated to be from 0.1 MPa up to 0.74 MPa. The higher pressure is defined to meet the resilience of PVC pipes. So is the case for Varanasi.

Conduct Leak Survey

- Conduct Minimum Night Flow(MNF) survey in each WSS
 - Purpose of this survey is to narrow down the subzone which has more MNF(suspected leakage) than others
- Conduct Stress Test which has higher MNF than others
 - Purpose of this survey is to quickly find out surface leakage without using leak survey instrument
- Conduct Leak Survey by using Leak Survey Tools
 - After the surface leaks are identified and repaired, conduct Leak Survey by using Leak Survey Tools.
 - The Leak Survey Tools are provided by JICA Expert Team and the manual is ready for use.
 - For more details about the Leak Survey , please see the “*NRW Reduction Manual*” developed by JICA Expert Team.

Repair Leak and Record the result

- Once leakage map in PP is created, execute repair work.
- For proper repair work, please see “NRW Reduction Manual” developed in CIESV.
 - In the Manual, How to repair, check, backfill, and to restart water supply are suggested.
- Record the repair work for the Next round of Leak survey and Leak Repair in a few year. (Location, pipe size, pipe material, cost, photo of before and after shall be recorded)

Monitor NRW before, during, and after the Pilot Project

- NRW team shall monitor NRW volume and NRW% in each Pilot Project and evaluate the performance of each zone.
- All Relevant Data shall be shared by the zonal teams.
- NRW team shall assist the low performance zone if necessary.

Evaluate the outcome of the Pilot Project

- NRW team shall evaluate the outcome of the pilot project, especially including the cost – benefit analysis for further deployment NRW reduction.
- For more details about the analysis, please see the “Cost –Benefit Analysis of Pilot Project” developed by JICA Expert Team.

Specification of Customer meter and Bulk Flow Meter (Sample)

Hereunder is the actual specification used for the procurement of facilities in the Pilot Project, Konia.
The data can be used as a reference to the Pilot Project Preparation.

FM_ID	Category	Pipe Diameter and material [mm]	Type	Specification	Note
FM-1	Proposed	400mm DI	Electro Magnetic flowmeter	(A) Index of protection: IP68 (protection against immergion in water over long period is necessary) (B) Sensor Specification 1) Flow Rate: a) 0-10 [m/s], with inner Diameter 400 mm b) Maximum Water Flow Rate: 470 [l/s] c) Minimum Water Flow rate: 0 [l/s] 2) Accuracy: ±0.5% 3) Installation type: Flange (applicable standard needs to be defined) 4) Flange type: ISO or other international standard (C) Transducer Specification 1) Flow Rate Data shall be logged by Data Logger DLS-HS/DLS-WS (Fuji Tecom) 2) Output: Current output 4-20mA Pulse output (Open collector) 3) Pulse rate: 1, 10, 100, 1000 (L) selectable 4) Humidity: 0 - 100 % 5) Ambient Temperature Limits: 0 ~ 60 degree celsius 6) Power Supply: DC220-240v 50Hz (D) Indication Specification 1) LCD display with backlight 2) Contents of indication: Flow rate, velocity, total flow 3) Minimum scale unit: 1 (L) E) Maximum Operating Pressure: 1.0 MPa	1) The new exit line from the OHT, 400 DI, shall be laid on the ground horizontally with some support,so that the newly exposed line and the new EM flowmeter shall not be submerged even the surrounding area is inundated during monsoon seasons. 2) Overflow line shall be connected to the 400DI before the EM Flowmeter. (in other word, the new EM meter shall be installed after the junction of overflow line to the 400DI line) 3) The new EM flowmeter shall be installed at least 10D (namely 10X400mm=4 meter) away , from the bend. 4) The DI pipe shall have at least 10D (4m) "straight" above-ground line before and after the EM meter.

(Continue)

(Continued from the previous page)

FM-2	Proposed	110mm PVC	Mechanical flowmeter	1) Permanent Flow Rate(Q3): 160 (m ³ /h) or higher 2) Accuracy: ±2% over Qt 3) Minimum scale unit: 1 (L) 4) Index of protection: IP68 5) Installation type: Flange (applicable standard needs to be defined) 6) Flange type: ISO or other international standard	Meter shall be put it in water-tight concrete-made chamber
FM-3	Proposed	200mm AC,	Mechanical flowmeter	1) Permanent Flow Rate(Q3): 400 (m ³ /h) or higher 2) Accuracy: ±2% over Qt 3) Minimum scale unit: 1 (L) 4) Index of protection: IP68 5) Installation type: Flange (applicable standard needs to be defined) 6) Flange type: ISO or other international standard	Meter shall be put it in water-tight concrete-made chamber
FM-4	Proposed	300mm AC,	Mechanical flowmeter	1) Permanent Flow Rate(Q3): 1000 (m ³ /h) or higher 2) Accuracy: ±2% over Qt 3) Minimum scale unit: 10 (L) or smaller 4) Index of protection: IP68 5) Installation type: Flange (applicable standard needs to be defined) 6) Flange type: ISO or other international standard	Meter shall be put it in water-tight concrete-made chamber

Cost Estimation for the Pilot Project (Sample)

Hereunder is the actual cost data accumulated though the Pilot Project in Konia.
The data can be used as a reference to the preparation of new Pilot Project.

Cost of Leak Repair (Outsourced to contractors)

No.	Item	Unit	Note
d.1	Number of Repaired Leak in Konia	47 leaks	Out of 47 leaks, 1 leak(5-2) is repaired twice
d.2	Total Cost of Leak Repair Work	480,556 Rs/leak	Sources: Jai Kal Junior Engineer
d.3	Average Cost of Leak Repair Work	10,225 Rs	Rs.480,556 /47leaks =Rs.10,225/leak

*The calculation is based on the data JET received from Jai Kal. Only 10 cost data out of 42 pipe repair work were submitted by JaiKal to JET.

Cost of Public Tap Improvement (Outsourced to contractors)

No.	Item	Unit	Note
e.1	Total Cost of Public Tap Improvement (of 8 taps)	169,933 Rs	Sources: Data provided by UPJN (JE. Vikesh Yadav) on 20th June, 2023

Cost of Illegal Connection Improvement (Outsourced to contractors)

No.	Item	Unit	Note
e.2	Total Cost of Illegal Connection Improvement (of 7 taps)	75,995 Rs	Sources: Data provided by UPJN on 6th February, 2024

Cost of DMA Development

No.	Item	Unit Price	Qty	Amount	GST	Certage	Total	Unit	Note
f.1	Installation of Customer Meter (O)	9,000	335	3,015,000	542,700	375,875	3,934,575	Rs	Basic Facilities
f.2	Installation of Bulk Flow Meter, Suicse Valve and Chamber	1,073,006	1	1,073,006	193,141	134,126	1,400,273	Rs	Basic Facilities
f.2.1	at Inlet Point (B) to measure water supply volume								
f.3	Other improvement of malfunctioned facilities and	967000	1	772,000	138,960	96,500	910,960	Rs	Basic Facilities
f.3.1	Installation of Level Sensor, PLC Monitoring Panel	65,000	3	195,000	35,100	24,375	230,100	Rs	Basic Facilities
f.3.2	Replacement of NRV in CWR Pump (A)	65,337	1	65,337	7,840		73,177	Rs	Basic Facilities
f.3.3	Replacement of malfunctioned SV 8-2 by Jai Kal								
f.4	Installation of Bulk Flow Meter, Suicse Valve and Chamber	217,621	1	217,621	39,172	27,203	283,995	Rs	DMA Specific Development, Cost Data is provided by UPJN
f.4.1	at Outlet Point C (100mm)								
f.4.2	at Outlet Point E (200mm)	900,706	1	372,540	67,057	46,568	486,165	Rs	DMA Specific Development, Cost Data is provided by UPJN
f.4.3	at Outlet Point G (100mm)	232,149	1	232,149	41,787	29,019	302,954	Rs	DMA Specific Development, Cost Data is provided by UPJN
f.4.4	at Outlet Point I (300mm)	824,298	1	824,298	148,374	103,037	1,075,709	Rs	DMA Specific Development, Cost Data is provided by UPJN
f.4.5	at J,K, and 2 other locations	144,001	1	144,001	25,920	16,000	187,921	Rs	DMA Specific Development, Cost Data is provided by UPJN
f.5	Rearrangement of Piping								
f.5.1	Rearrangement of piping at F (by Jai Kal)	207,267	1	207,267	24,872		232,139	Rs	Optional Development (to improve water flow an water pressure
f.5.2	Rearrangement of piping at N (by Jai Kal)	84,997	1	84,997	10,200		95,197	Rs	Optional Development (to improve water flow an water pressure
f.5.3	Increasing pipe dia at Q (by Jai Kal)	84,997	1	84,997	10,200		232,139	Rs	Optional Development (to improve water flow an water pressure
f.13	Total Cost of Development			7,288,213	1,285,322	855,702	9,445,305	Rs	
	Breakdown(1) Cost of Basic Facilities			5,120,343	917,742	631,876	6,549,085	Rs	Subtotal of f.1, f.2.1, f.3.1, f.3.2, and f.3.3
	Breakdown(2) Cost of DMA Specific Development			1,790,609	322,310	223,826	2,336,745	Rs	Subtotal of f.4.1, f.4.2, f.4.3, f.4.4 and f.4.5
	Breakdown(3) Cost of Optional Development			292,264	35,072	0	559,475	Rs	Subtotal of f.5.1, f.5.2, and f.5.3

Phase II: Trial Phase for Citywide Roll-out

When Jal Kal gets ready for 24 hours/day and 7days /week water supply, Jal Kal Shall

- Choose 1 or 2 OHT-WSS from each Zone and Continue the same activities as done in Pilot Project (12-20 WSS out of 58 WSSs)
 - Jal Kal have 27 overhead tanks and WSS in Cis-Varna, and 31 in Trans-Varna, altogether 58 OHT- WSS in Varanasi.
- Form NRW team in JalKal, appointing designated engineers for NRW management beside the O&M engineers (for water supply and wastewater service)
- Install customer meters to all customers in the area.
- Execute the same activities conducted in the Pilot Project, such as pressure Map development, Minimum Night Flow Survey,

Continue Activities as did the pilot project in Phase I

- Conduct Water Balance Analysis
- Develop Pressure Distribution Map
- Conduct Leak Survey
- Repair Leakage and record the result
- Monitor NRW, before, during and After the project

Phase III: Citywide deployment Phase

Preparation

- Select 1 Water Supply Scheme (WSS) in Varanasi
 - Choose 3-5 OHT-WSS from each Zone and Continue the same activities as done in Phase II
 - Conduct Water Balance Analysis
 - Develop Pressure Distribution Map
 - Conduct Leak Survey
 - Repair Leakage and record the result
 - Monitor NRW, before, during and After the project

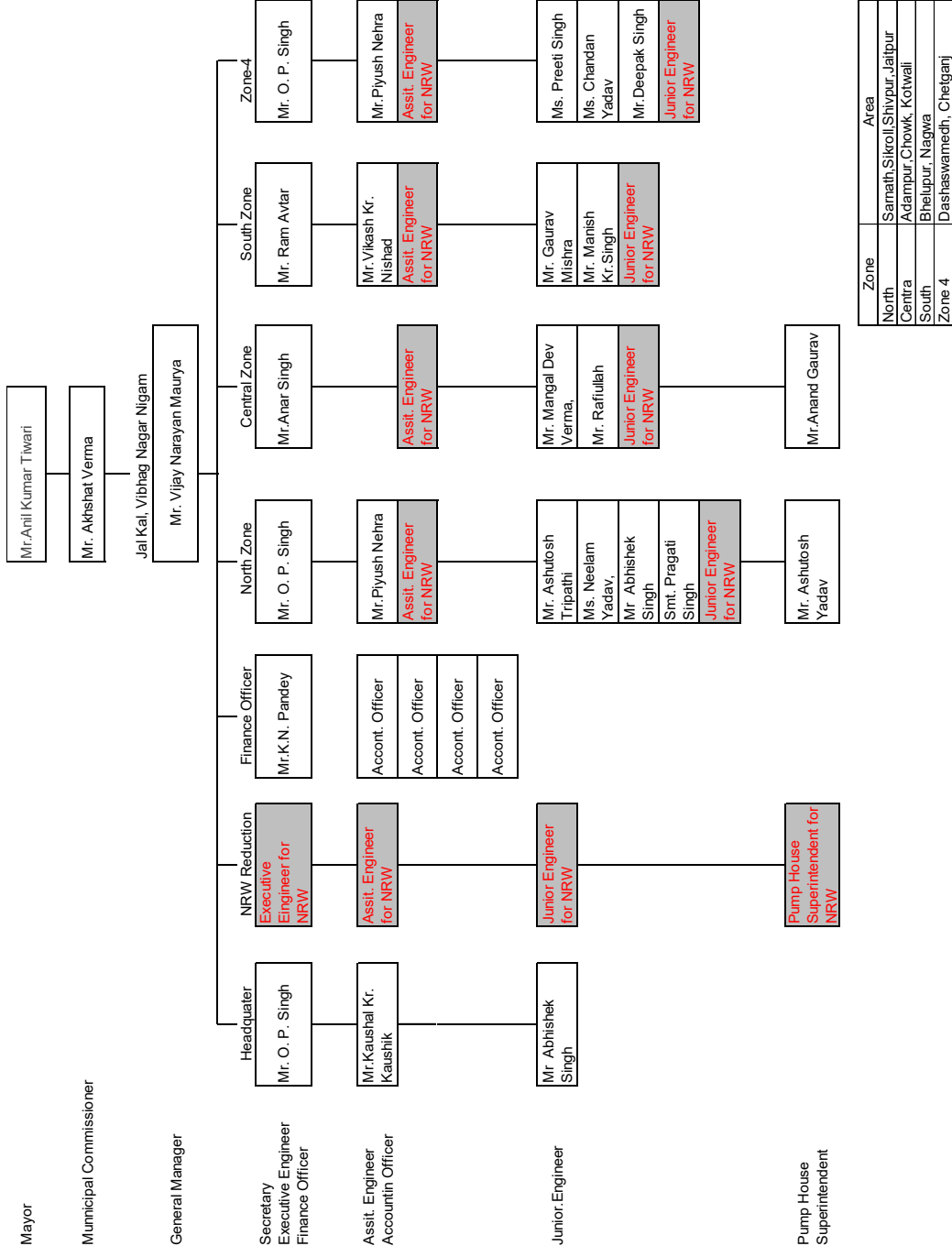
• The water shall be provided 24hours/ day, 7days/week.

- Jal Kal have 27 overhead tanks and WSS in Cis-Varna, and 31 in Trans-Varna, altogether 58 OHT- WSS in Varanasi.

(continued to the next page.)

Suggested Organizational Structure of Jal Kal

By the time of Full implementation of city-wide roll out, NRW team shall be created in each zone, and work together with the centralized NRW Team in HQ.



Expected Schedule

Task/Item	Year 1												Year 2											
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Phase I: Pilot Project																								
Selection of Pilot Project Area																								
Prepare Pipeline Drawing																								
Installation of Bulk Flow Meters etc.																								
Installation of Customer-Meters																								
Water Balance Analysis																								
Water Pressure Survey																								
Leak Survey																								
Leak Repair																								
Performance Review of Phase I																								
Phase II: Citywide Roll-out Phase																								
Selection of 5 OHT-WSS/ Zone																								
Prepare Pipeline Drawing																								
Installation of Bulk Flow Meters																								
Installation of Customer-meter																								
Water Balance Analysis																								
Water Pressure Survey																								
Leak Survey																								
Leak Repair																								
Performance Review of Phase II																								
Phase III: Acceleration Phase																								
Selection of Remaining OHT-WSS/ Zone																								
Prepare Pipeline Drawing																								
Installation of Bulk Flow Meters																								
Installation of Customer-meter																								
Water Balance Analysis																								
Water Pressure Survey																								
Leak Survey																								
Leak Repair																								
Performance Review of Phase III																								

Appendix

Jal Kal Balance Sheet as of 31st March 2022

P.K. SINGH & CO.
CHARTERED ACCOUNTANTS

TALKAL VIBHAG, NAGAR NIGAM, VARANASI
BALANCE SHEET AS AT 31st MARCH'2022

AMOUNT AS ON 31.03.2021	LIABILITIES	AMOUNT	AMOUNT AS ON 31.03.2022	ASSETS	AMOUNT	AMOUNT AS ON 31.03.2022
Rs.		Rs.	Rs.		Rs.	Rs.
790,849,734.00	CAPITAL FUND			FIXED ASSETS		723,444,811.09
	Opening Balance	790,849,734.00	582,941,223.54	As per annexed Schedule-20		
	Add: Electricity dues adjusted by Govt.	-	790,849,734.00	INTEREST		1,140,090.00
2,207,270,012.73	GRANT IN AID		1,140,090.00	Paid on World Bank Loan (Note no. 1)		
6,152,785.00	Interest fund (14th & 15th finance)			CURRENT ASSETS		1,791,161,645.86
303,885,219.00	LOANS & ADVANCES		1,626,869,596.85	As per annexed Schedule-18		
	As per annexed Schedule -14		303,885,219.00	MISCELLANEOUS ASSETS		
6,545,218,725.07	CURRENT LIABILITIES			Opening Deficit as on 01.04.2021	7,642,425,565.40	8,678,995,449.15
	As per annexed Schedule-19		7,176,131,796.38	Add: Deficit for the year	1,036,569,883.75	
9,853,376,475.80			11,194,741,996.11			11,194,741,996.11

Compiled and Prepared on behalf of
Jalkal Vibhag, Nagar Nigam, Varanasi
For P. K. SINGH & CO.

FOR F. K. SMITH & CO.
CHARTERED ACCOUNTANTS

PLACE:VARANASI
DATED:09-05-2008

(Pravin K. Singh)
Proprietor

Note no. 1: In absence of specific information regarding interest paid on world bank loans, the interest paid on the same is included in the interest paid on bank loans.

NOTE NO. 2: A notice of specific information regarding the above award is being provided to the public on the basis of a request under the Freedom of Information Act, 1997. The information is being provided to the public on the basis of a request under the Freedom of Information Act, 1997. The information is being provided to the public on the basis of a request under the Freedom of Information Act, 1997.

Finance Officer

विस्तृत अधिकारी
In Balance Sheet
जलकल विभाग, नगर

महाप्रबन्धक
जलकल विभाग, नगर निगम
वाराणसी

Profit & Loss Statement for the year ended 31st March 2022

TALKAL VIBHAG, NAGAR NIGAM, VARANASI INCOME AND EXPENDITURE STATEMENT FOR THE YEAR ENDED 31st MARCH 2022 SCHEDULE-16

INCOME/EXPENDITURE	G.R.S.	WATER SUPPLY	SEWERAGE	TOTAL
		Rz.	Rz.	Rz.
WATER TAX	5.1	318,900,000.00	-	318,900,000.00
EXCESS WATER CHARGES & METER RENT	5.1	-	-	-
PIPELINE CHARGES	15	-	-	-
MISCELLANEOUS RECEIPTS	15	5,451,307.00	-	5,451,307.00
SEWER TAX	5.1	-	117,500,000.00	117,500,000.00
TOTAL INCOME		324,351,307.00	117,500,000.00	441,851,307.00
EXCESS OF EXPS. OVER INCOME		1,104,695,222.06	(68,125,338.31)	1,036,569,883.75
TOTAL		1,429,046,529.06	49,374,661.69	1,478,421,190.75
ESTABLISHMENT EXPENSES				
AS PER CASH FLOW				
Add:	15	366,780,441.82	6,727,076.00	373,507,517.82
Deduction from Salary	17	31,533,320.40	1,832,374.00	33,365,694.40
Outstanding Liabilities of c/y	8.1	11,269,271.25	-	11,269,271.25
Provision for pension	11.1	247,317,926.00	-	247,317,926.00
Employer share :-				
Group Insurance	13	-	-	-
E.B.F.	13	149,812.00	-	149,812.00
Less: Outstanding Liabilities of L/Y	8.1	9,344,457.00	-	9,344,457.00
Recovery from Salary	17	1,082,659.75	75,600.00	1,158,259.75
		646,623,654.72	8,483,850.00	655,107,504.72
CONSUMPTION OF STORE				
As per cash flow	15	15,348,841.00	-	15,348,841.00
Add:				
Outstanding Liabilities of C/Y	8.1	-	-	-
Stock (Opening)	4.1	18,520,346.58	-	18,520,346.58
Less:				
Outstanding Liabilities of L/Y	8.1	8,198,410.00	-	8,198,410.00
Stock (Closing)	4.1	19,034,797.12	-	19,034,797.12
		6,635,980.46	-	6,635,980.46
ELECTRICITY CHARGES				
As per Provision	8.1	729,824,000.00	-	729,824,000.00
Less: Deduction from salary	17	47,250.00	-	47,250.00
		729,776,750.00	-	729,776,750.00

Page 24 of 27



TALKAL VIBHAG, NAGAR NIGAM, VARANASI INCOME AND EXPENDITURE STATEMENT FOR THE YEAR ENDED 31st MARCH 2022 SCHEDULE-16

INCOME/EXPENDITURE	G.R.S.	WATER SUPPLY	SEWERAGE	TOTAL
		Rz.	Rz.	Rz.
REPAIR & MAINTENANCE				
Repairs & Maintenance	15	23,155,082.00	34,244,058.69	57,399,140.69
Pipeline Expenses	15	6,846,417.00	-	6,846,417.00
Handpump Expenses	15	1,520,042.00	-	1,520,042.00
		31,541,541.00	34,244,058.69	65,785,599.69
MISCELLANEOUS EXPENSES				
As per cash flow				
	15	70,440.88	-	70,440.88
		70,440.88	-	70,440.88
INTEREST CHARGES				
	12.1	390,166.00	18,625.00	408,791.00
		390,166.00	18,625.00	408,791.00
DEPRECIATION				
	1.1	14,007,996.00	6,628,128.00	20,636,124.00
	2.1	14,007,996.00	6,628,128.00	20,636,124.00
		1,429,046,529.06	49,374,661.69	1,478,421,190.75
TOTAL EXPENDITURE				



प्रमुख विभाग, नगर निगम
 वाराणसी
 दिनांक 31/03/2022

Appendix 18

Guidelines for Introduction of PSTU, Its Operation and Maintenance



Guidelines for Introduction of PSTU, Its Operation and Maintenance

May 2024

Wastewater Management Sector Team

**The Project for the Comprehensive
Improvement of Environmental Sanitation in
Varanasi (CIESV)**

Preface

As a large area of the Varanasi City is not covered by centralized sewerage system, households are discharging their domestic wastewater untreated to nearby drains that end up in the River Ganga with huge pollution loads.

Since construction of sewerage infrastructure takes time (commonly decades), political decision is necessary whether allowing households in currently unsewered area to continuously discharge domestic wastewater untreated until they are connected to sewers in future, or introducing decentralized wastewater treatment system now.

For the latter, as an example of decentralized wastewater treatment technologies, a Packaged Sewage Treatment Unit (PSTU) with Japanese technology of *Johkasou* was installed on a pilot basis for community wastewater treatment in Kanchanpur village under the Project for Comprehensive Improvement of Environmental Sanitation in Varanasi (CIESV). It is expected that the decentralized wastewater with *Johkasou* technology can be replicated.

The Guidelines are to help officials of VNN / JaIKal and UPJN plan to introduce PSTU in other areas of Varanasi City and beyond.

Since *Johkasou* is one of the available technical options for decentralized wastewater treatment in India, comparison with other technologies would also be beneficial. For this purpose, it is recommended that the “Technology Book on Decentralized Wastewater Treatment”, also developed in the CIESV Project, can be referred to.

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(2) Selection of an installation site of PSTU	14
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Annex 2: Maintenance and Inspection Procedure	

1. The significance of promoting decentralized wastewater treatment in Varanasi

As the sewerage system covers only core part of the City, unsewered area has increased significantly with addition of surrounding 89 villages to Varanasi in 2000.

Although UP government has a vision of 100% connection to sewers, it is obvious that construction of centralized sewerage infrastructure requires huge investment and takes long time, commonly decades, for completion. Therefore, **it is recommended that decentralized systems are introduced to gradually improve wastewater treatment in unsewered area** for a short or middle term before centralized sewerage system is put in place for a long term.

Comparison between centralized and decentralized systems is shown below.

Centralized sewerage system:

- Serves large areas with concentrated populations.
- Requires extensive network of pipes and pumps for the collection of wastewater in addition to large treatment plants.
- Requires huge investment and time for construction (usually decades from planning to completion of the works).
- Requires considerable cost and skills for operation and maintenance.
- Cost becomes further elevated to cover peripheral area of the city due to scattered houses/ buildings and longer distance to STP.

Decentralized system:

- Easy to implement with smaller investment cost, although service area and number of beneficiaries are limited.
- Installation and start of operation in a short period with quicker achievement of impacts.
- Less costly and easy maintenance and operation.
- Applicable in both congested urban area and peripheral area.

2. Introduction of PSTU for decentralized wastewater treatment

(1) What is PSTU?

PSTU stands for **Packaged Sewage Treatment Unit**.

It is housed in specially designed and highly durable Fiber Glass Reinforced Plastic (FRP) tank. These tanks are compact which can be utilized in a decentralized manner at any location, either it is underground or above the ground.

Main technologies utilized for PSTU is **Johkasou** and **Moving Bed Biofilm Reactor (MBBR)**.

(2) Johkasou or MBBR?

Johkasou and MBBR are similar technologies. Both are based on biological treatment method with combination of anaerobic and aerobic treatments.

Johkasou is a biological treatment technology developed in Japan in 1950s in order to collect and treat both grey and black water on-site with equivalent treatment performance by which treated effluent meets discharge standards while **MBBR** was developed in 1980s in Norway as a more compact Waste Water Treatment Plant compared to the conventional activated sludge STP with improved treatment efficiency.

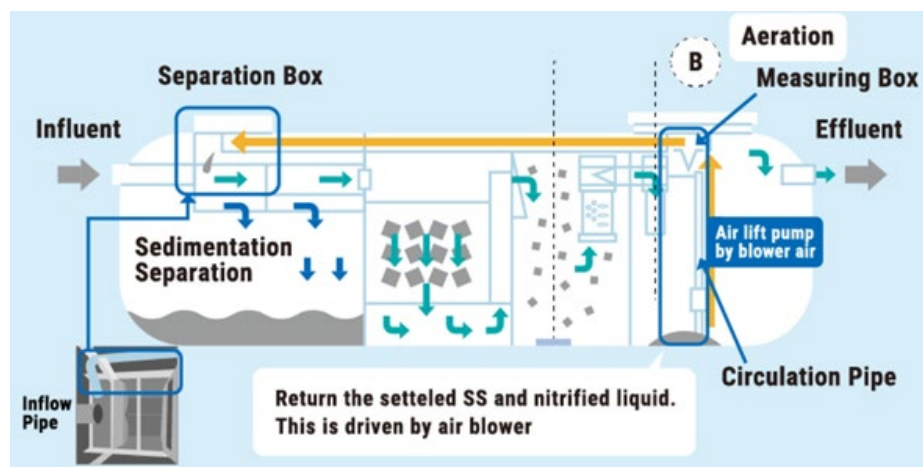
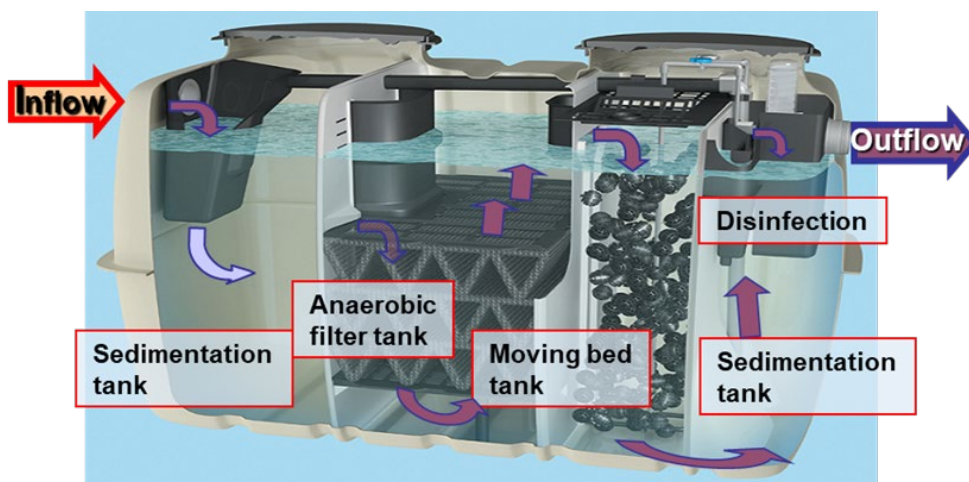
One noticeable difference between the two technologies is that **Johkasou, in its advanced type, has a Re-Circulation system by which nitrification and denitrification process is repeated thereby attaining higher removal of nitrogen** (see Figure 1 and Figure 2).

Therefore, if a treatment system is required to have effluent quality that meets NGT standards (as shown in the Table 1), **Johkasou should be the first choice**, although MBBR can attain this as well with addition to tertiary treatment facility.

Table 1: NGT standards for release into the sewerage network, a surface water body or land

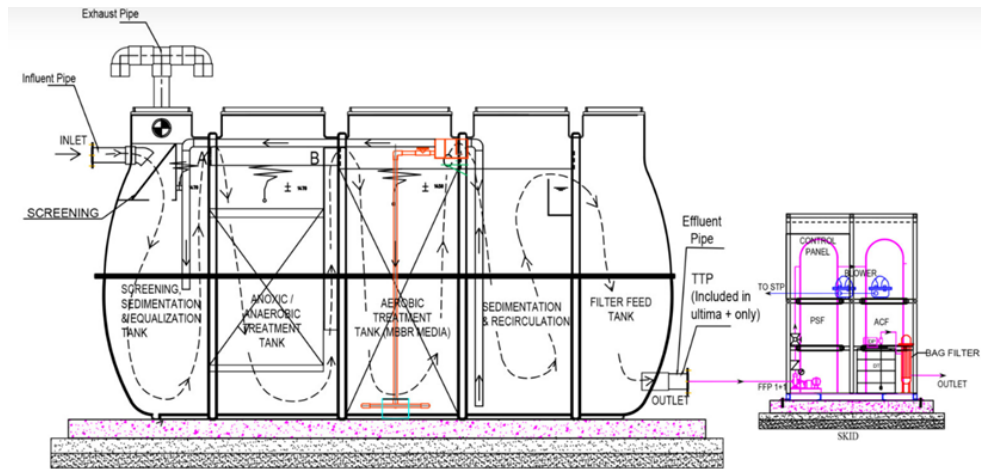
NO.	Parameter	Limits
1.	pH	6.5-8.5
2.	Total Suspended Solids (TSS)	< 20 mg/l
3.	COD	< 50 mg/l
4.	BOD (5 day)	< 10 mg/l
5.	Total Nitrogen	< 10 mg/l
6.	Ammoniacal Nitrogen	< 5 mg/l
7.	Faecal Coliform	<100 MPN/100 ml

Figure 1: Treatment process of Johkasou and its Re-Circulation System



Source: Daiki Axis India

Figure 2: Treatment process of MBBR

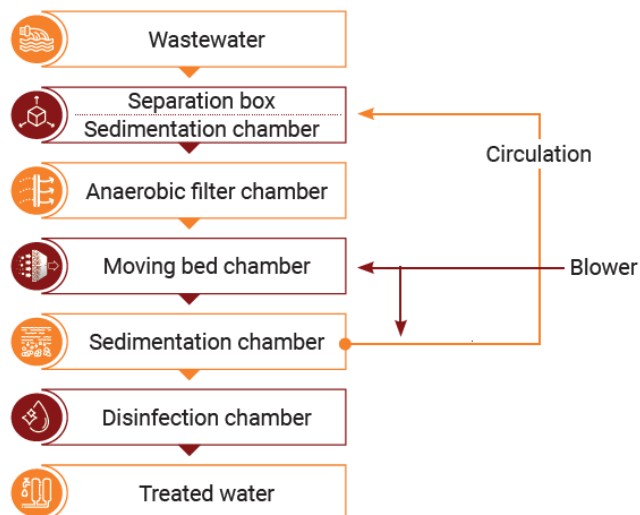


Source: HECS

(3) Key features of PSTU with Johkasou Technology

- In the Pilot Project, Johkasou AIJ-30 of Daiki Axis India was introduced. Flow process of Johkasou is shown in Figure 3.

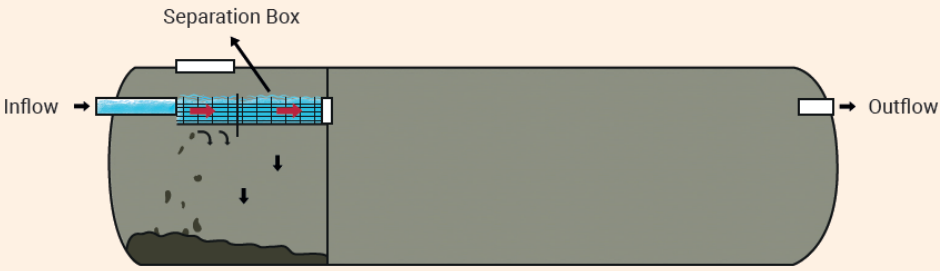
Figure 3: Flow process of Johkasou



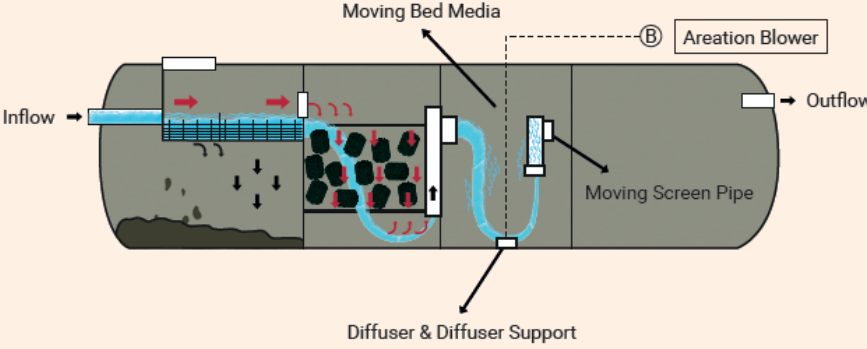
Source: Daiki Axis India

- Design and process description of Johkasou is indicated in the Table 2 below:

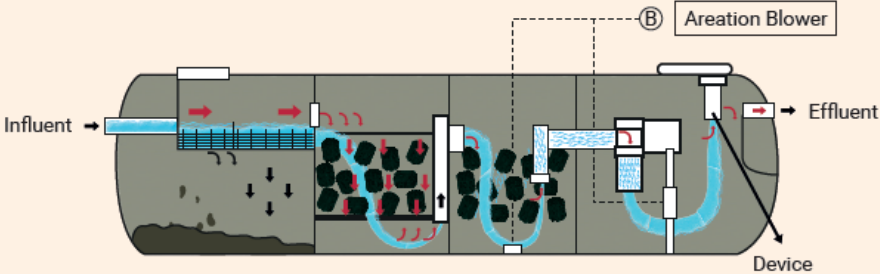
Table 2: Design and process description of Johkasou (source: Daiki Axis India)

<u>Sedimentation and Separation Chamber</u>	
Equipment	Separation Box
Illustration	 Source: Daiki Axis India
Function	Separating solid waste and liquid waste based on their gravity. Solid waste which has bigger density than water will be settled in the bottom of sedimentation chamber. On the other hand, lower density materials float and stay here.
Components	 Separation box • To separate solid waste and water • To collect large object in wastewater

Anaerobic Contact Media Chamber	
Equipment	Anaerobic Media and Transfer Baffle
Illustration	
Function	Anaerobic media inside of anaerobic contact media chamber is the place where Anaerobic bacteria is growing up to decompose organic material contained in domestic wastewater resulting more simple organic content. To store excess sludge at the bottom and scum at surface of the water. Small SS is caught and stored by anaerobic media to reduce a load of moving bed chamber. Almost of NO_2 and NO_3 are reduced to N_2 gas by denitrification bacteria which is settled in anaerobic media.
Components	 Anaerobic media (BA/BAE/BJ/BJE)  Anaerobic media (AI/AIJ) Anaerobic Media • The place where anaerobic microorganism is growing up. • Anaerobic media catches SS and stores it inside. Transfer Baffle • As wastewater channel • Desludging channel of anaerobic chamber

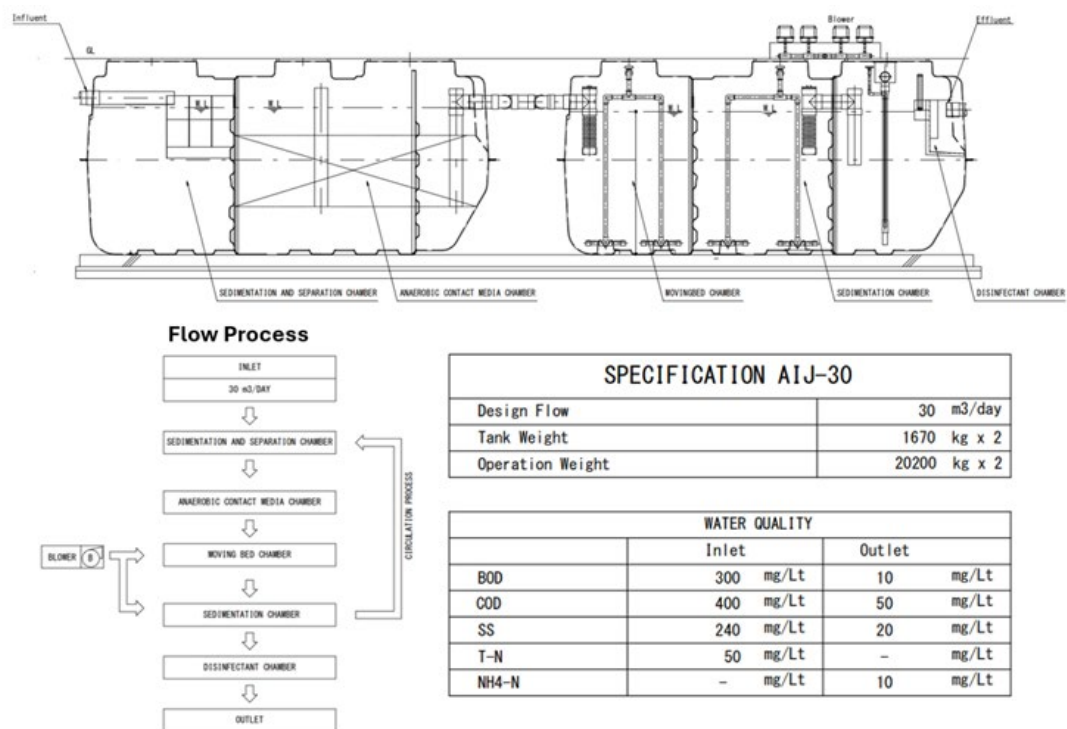
Equipment	<u>Moving Bed Chamber</u> Moving Bed Media, Diffuser, Media Screen/Trap
Illustration	
Function	Moving bed chamber consist of contact media called “moving bed media”, and aerobic microorganism is growing up inside of it. Moving bed chamber filled by moving bed media with 30–50 per cent of the volume. Aerobic microorganism will decompose organic material from anaerobic chamber. This aerobic microorganism consumption oxygen supplied by blower distributed through pipe line and diffuser located in the bottom of moving bed chamber. By generating oxygen in this chamber, moving bed media circulate in this chamber. Organic material is contacted to microorganism inside of moving bed media due to this circulation. In this process, organic material decomposition process will occur, and majority of the BOD, COD and other parameters level is decreased with in their limits Denitrification process occurs: NO_3^- (Nitrate) $\rightarrow$ NO_2^- (Nitrite) $\rightarrow$ NO (Nitric oxide) $\rightarrow$ N_2O (Nitrous oxide) $\rightarrow$ N_2 (Nitrogen)
Components	Moving Bed Media • The Place where aerobic microorganism is growing up. Diffuser • Air diffuser is a device that is designed to provide uniform air flow throughout a room. • It works to increase the efficiency of air-conditioning Media Screen/Trap • To prevent the media from transferring to the next chamber. Blower • It provides air to the moving bed chamber. It works for 24 hr. 

	Sedimentation Chamber Equipment Measuring Box, Circulation Process Illustration Function Sedimentation chamber is the place to settle sludge generated by aeration process, and treated water flows into disinfection chamber. Sludge accumulated in the bottom will be transferred to sedimentation and separation chamber, which is called circulation because besides returning sludge into the sedimentation separation chamber, it also helps the denitrification process.
Components	Measuring Box • Circulation flow control • *Circulated water quantity is controlled by adjustment of air quantity for air lift pump, and it can be checked at V-notch weir. Circulation Pipe V notch Air Valve for Air lift pump ✕ View of Sedimentation Chamber

Equipment	<u>Disinfection Chamber</u> Disinfection Device  Function Microorganisms consisting in the treated water are disinfected by chlorine in the device before discharged into the environment.
Components	 Disinfection tank Disinfection stage V-notch ⌗ View of disinfection device Chlorine tube Disinfection Device Disinfection device consists of V-notch, disinfection stage and disinfection tank • Treated water comes into the disinfection stage over a V-notch. • Chlorine tablet which is in the chlorine tube is dissolved with the treated water. • The treated water containing dissolved chlorine drops into the disinfection tank. • In the disinfection tank, microorganisms are killed by chlorine.

- Specifications of Daiki Axis India Johkasou AIJ-30 is shown in Figure 4.

Figure 4: Specifications of Daiki Axis India Johkasou AIJ-30



3. How to plan introduction of PSTU

(1) Selection of a target area

Key considerations:

- ① Proximity to existing network of sewerage system
- ② Availability of a land for installation of PSTU
- ③ Possibility of collecting domestic wastewater through sewers
- ④ Impact of decentralized wastewater treatment

Notes on the key considerations

- ① : If sewer network that leads to a STP exists or is planned in nearby areas, it could be reasonable to expand the network rather than installing a new decentralized system.
- ② : A land for accommodating PSTU and associated facilities is necessary. As PSTU itself is compact and even can be installed underground, layout of the facilities can be flexible.
- ③ : Two options can be considered:
 - a) Direct intake from a nala into which wastewater discharged from surrounding houses / buildings is flowing.
 - b) Through sewer pipelines connected to the houses / buildings.

In the case of b), experience shows that houses connect to existing underground drains that were originally installed for the purpose of stormwater drainage therefore intrusion of rainwater is unavoidable. **New installation of designated sewer pipes is preferable** in order to avoid inflow of excess raw sewage to PSTU and subsequent overflow under heavy rains.
- ④ : It is preferable to select an area where pollution of existing water environment (rivers, nalas, ponds, etc.) is serious and thus impact of decentralized wastewater treatment becomes easily noticeable.

(2) Selection of an installation site of PSTU

Key considerations:

- ① Property of the land
- ② Risk of inundation during rainy season
- ③ Accessibility to electricity and water supplies
- ④ Understanding/ collaboration of nearby residents

Notes on the key considerations

- ① : A land belongs to the government is preferable for the installation of PSTU. Otherwise it may take long time to secure the land.
- ② : Careful check is recommended whether the land is prone to inundation during the rainy season. If this is the case, it would be suggested to avoid such land or, if alternative land is difficult to find, to take necessary precautions such as installation of blowers and control panel in a higher positions for securing their operation with continuous electricity supply.
- ③ : As PSTU requires 24 hour operation of blowers and intermittent operation of raw water pump, supply of electricity is indispensable. Also for cleaning of PSTU, water supply is necessary.
- ④ : Promoting local residents' understanding on significance of the installation of a PSTU is important to get their collaboration to necessary civil works, particularly when house connections to sewer pipeline are involved.

(3) Type and treatment capacity of PSTU

Key considerations:

- ① Volume of wastewater generation in the target area
- ② Quality of raw wastewater
- ③ Target parameter and value
- ④ Capital cost of PSTU

Notes on the key considerations

- ① : Volume of wastewater to be treated should be estimated through:

- a) Conducting household survey in the target area to identify:
 - Number of houses and residents
 - How each house discharges black and grey water
 - b) Multiplying the number of residents with average volume of wastewater generation per capita per day (175L).
 - c) Measuring the flow volume of wastewater in drains.
- ② : Water quality of raw sewage should be tested on parameters: pH, TSS, BOD, COD, TN and Faecal coliform and check whether they are within design conditions of PSTU.
 - ③ : Targeting BOD and COD removal only or including Nitrogen and Phosphorus removal as well. If target value is set as $BOD \leq 10\text{mg/L}$ and $TN \leq 10\text{mg/L}$, PSTU with advanced treatment function is necessary.
 - ④ : In case of the Pilot Project, capital cost of 30KLD advanced Johkasou AIJ-30 was around INR 65 lakhs including blowers, pumps and control panel as well as transportation, commissioning and maintenance for initial 5 months.

(4) Pre- and Post-treatment arrangement

Key considerations:

- ① Removal of sands, grits, solids and other objects
- ② Measurement of inflow volume
- ③ Monitoring of treated effluent

Notes on the key considerations

- ① : Receiving tank of raw sewage should be provided for pre-treatment where sands and grits are settled by sedimentation and other solids are removed by a screen. Sewage is then sent to the measurement facility.
- ② : A facility to measure inflow volume to PSTU should be provided. Arrangement of overflow pipe for a case of excess flowing volume should also be considered.
- ③ : A facility to check treated effluent should be provided.

(5) Operation and maintenance of PSTU

Key considerations:

- ① How to deal with necessary O&M activities
- ② How to cover O&M costs

Notes on the key considerations

- ① : Receiving tank of raw sewage should be provided for pre-treatment where sands and grits are settled by sedimentation and other solids are removed by a screen. Sewage is then sent to the measurement facility.
- ② : O&M costs are basically for:
 - a) Manpower for daily O&M
 - b) Desludging (at least once in 6 months)
 - c) Electricity for blowers and pumps
 - d) Maintenance and inspection (once a year)
 - e) Supply of disinfectant (chlorine tablet)
- In case of the Pilot Project, annual O&M cost for 30KLD Johkasou was estimated to be INR 4 lakhs.
- Measures for covering of the O&M cost was also considered in the Pilot Project. One proposal was to store the treated effluent and sell it for gardening, construction and other purposes.

(6) Reuse or disposal of effluent and sludge

Key considerations:

- ① Reuse of treated effluent
- ② Treatment and reuse / disposal of sludge

Notes on the key considerations

- ① : If reuse of treated effluent is intended, installing facilities for its storage and/ or conveyance should be considered. In case of the Pilot Project, construction of an underground reservoir and filling station was proposed.

- ② : PSTU needs to be desludged at least once in every 6 months. How to deal with the collected sludge should be considered. In case of the Pilot Project, sludge drying beds were constructed for drying of sludge within the site. Dried sludge is stored and can be sold to local farmers as soil conditioner.

4. Operation & Maintenance of PSTU

Key O&M activities:

- ① Daily check and cleaning of chambers including removal of scum.
- ② Desludging at least once in every 6 months or more frequently whenever sludge accumulates to the level indicated in the “Maintenance and Inspection Procedure”.
- ③ Cleaning of the filters of blowers.
- ④ Check operation of pumps for any irregularity.
- ⑤ Other necessary checks indicated in the “Maintenance and Inspection Procedure”

Please refer the following annexures for operation and maintenance of PSTU.

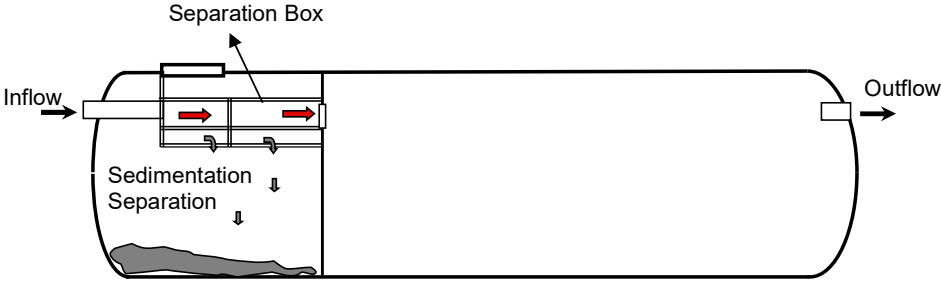
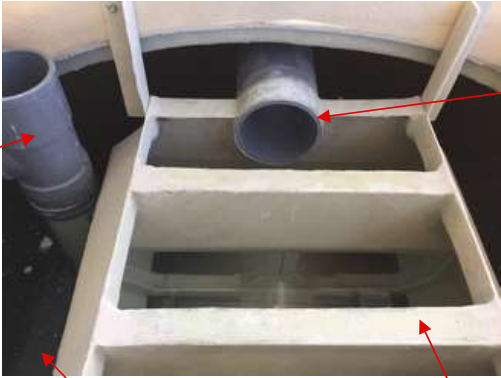
Annex 1: Johkasou Process Description

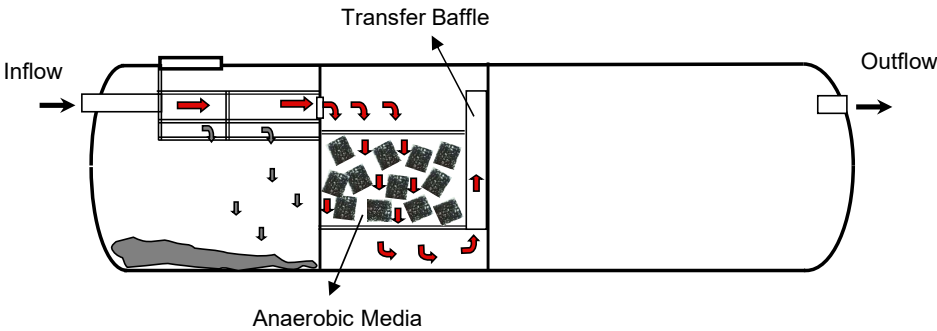
Annex 2: Maintenance and Inspection Procedure

Daiki Axis Johkasou (BA/BAE/BJ/BJE/AI/AIJ) Process Description



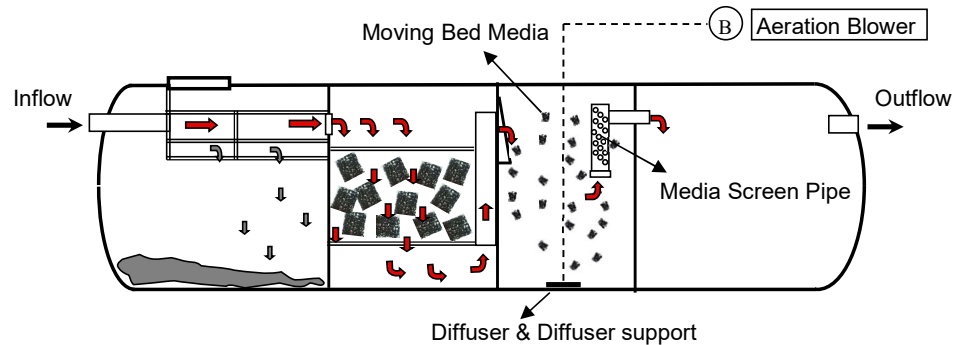
1	Process Description	1 / 6
Flow chart	Description	
<pre> graph TD A[DOMESTIC WASTE WATER] --> B["(1) SEDIMENTATION & SEPARATION CHAMBER"] B --> C["(2) ANAEROBIC CONTACT MEDIA CHAMBER"] C --> D["(3) MOVING BED CHAMBER (AEROBIC)"] D --> E["(4) SEDIMENTATION CHAMBER"] E --> F["(5) DISINFECTANT CHAMBER"] F --> G[TREATED WATER] D -.-> CIRCULATION E </pre>	(1) Sedimentation and separation chamber collects domestic waste water. It also has function to separate solid wastes from liquid waste based on their gravity. (2) Waste water then flows into anaerobic media contact chamber from sedimentation and separation chamber. It contains organic material which is decomposed by anaerobic microorganism. On the other hand, nitrite and nitrate contained in the circulated water are converted into N₂ gas by denitrification microorganisms. Anaerobic reaction shown as follow : <u>Organic Material -----> CH₄ + NH₃ + smaller materials + H₂O</u> <u>NO₂ + NO₃ -----> N₂ + H₂O</u> Anaerobic Microorganism (3) Anaerobic process treatment water flows into moving bed chamber. Organic material contained waste water is decomposed by aerobic microorganism, and becomes simpler product. In this case the organic waste material is used for development of new cells (protoplasm) and converted to other materials such as carbon dioxide, water, and ammonia. Aerobic reaction shown as follow : <u>CHONS + O₂ + nutrient-----> CO₂ + H₂O + NH₃ + Microbial cell</u> <u>NH₃ + O₂ + nitrate cells ----> NO₂, NO₃ + H₂O + Cells nitrate increase</u> Results of aerobic biological processes will also produce sludge which is suspended from treated water. (4) Sedimentation chamber has function as place of settled sludge which is resulted by biological processes in moving bed chamber. Settled sludge will be transferred to sedimentation and separation chamber. Concurrently NO₂ and NO₃ are transferred to its chamber. Note : Without sedimentation chamber sludge will flow out resulting turbid water detected as Total suspended solid and COD. (5) Disinfectant chamber serves as a place to put chlorine / disinfectant as a sterilization agent pathogenic microorganisms in the waste processed before discharged into the environment.	

2	Sedimentation and Separation Chamber	2 / 6
Equipment	: Separation Box	
Illustration		
Function	Separating solid waste and liquid waste based on their gravity. Solid waste which has bigger density than water will be settled in the bottom of sedimentation chamber. On the other hand, lower density materials float and stay here.	
Components	 1. Separation Box - To separate solid waste and water. - To collect large object in wastewater. Note: Image as viewed from top of tank.	

3	Anaerobic Contact Media Chamber	3 / 6
Equipment	: Anaerobic Media and Transfer Baffle	
Illustration		
Function	(1) Anaerobic media inside of anaerobic contact media chamber is the place where microorganism is growing up to decompose organic material contained in domestic wastewater resulting more simple organic content. (2) To store excess sludge at the bottom and scum at surface of the water. (3) Small SS is caught and stored by anaerobic media to reduce a load of moving bed chamber. (4) Almost of NO_2 and NO_3 are reduced to N_2 gas by denitrification microorganisms which settled in anaerobic media.	
Components	 Anaerobic Media(BA/BAE/BJ/BJE)  Anaerobic Media(AI/AIJ) 1. Anaerobic Media - The Place where anaerobic microorganism is growing up. - Anaerobic media catches SS and stores it inside. 2. Transfer Baffle - As waste water channel - Desludging channel of anaerobic chamber	

Equipment : Moving bed Media, Diffuser, Media Screen/Trap

Illustration



Function

Moving bed chamber consist of contact media called " Moving Bed Media", and aerobic microorganism is growing up inside of it. Moving bed chamber filled by moving bed media with 30 - 50% of the volume. Aerobic microorganism will decompose organic material from anaerobic chamber.

This aerobic microorganism consumption oxygen supplied by blower distributed through pipe line and diffuser located in the bottom of moving bed chamber. By generating oxygen in this chamber, moving bed media circulate in this chamber. Organic material is contacted to microorganism inside of moving bed media due to this circulation. In this process, organic material decomposition process will occur, and majority of the BOD, COD and other parameters are removed.

NH_3 is oxidated to NO_2^- and NO_3^- .

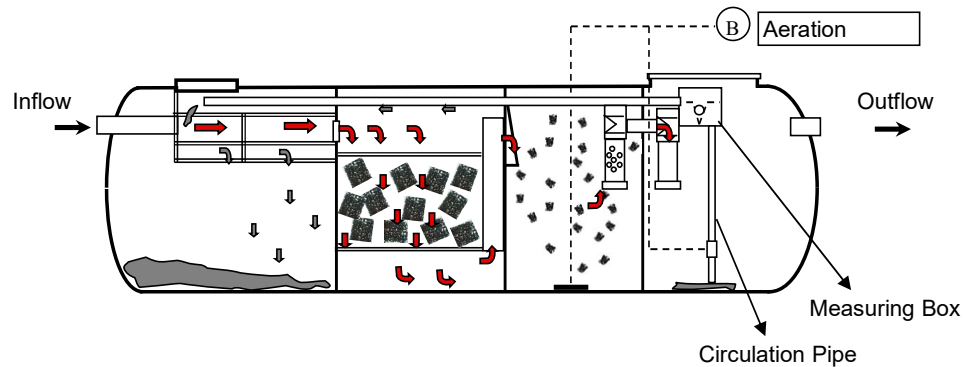
Components

1. Moving Bed Media
The Place where aerobic microorganism is growing up.
2. Diffuser
- Air diffuser is a device that is designed to provide uniform air flow throughout a room.
- It works to increase the efficiency of air conditioning
3. Media Screen/Trap
To prevent the media from transferring to the next chamber.
4. Blower
It provides air to the moving bed chamber.
It works for 24 hr.



Equipment : Measuring Box, Circulation Process

Illustration



Function

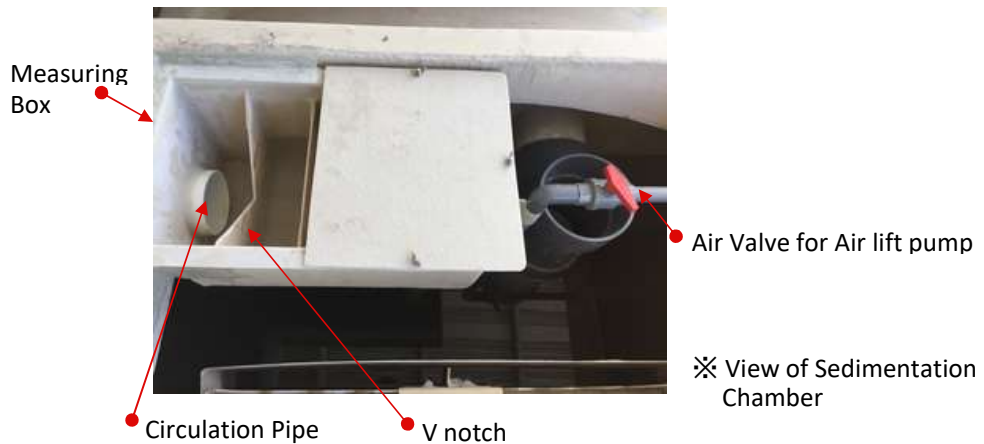
Sedimentation chamber is the place to settle sludge generated by aeration process, and treated water flowed into disinfection chamber. Sludge accumulated in the bottom will be transferred to sedimentation and separation chamber, which is called circulation because besides returning sludge into the sedimentation separation chamber, it also helps the denitrification process.

Components

1. Measuring Box

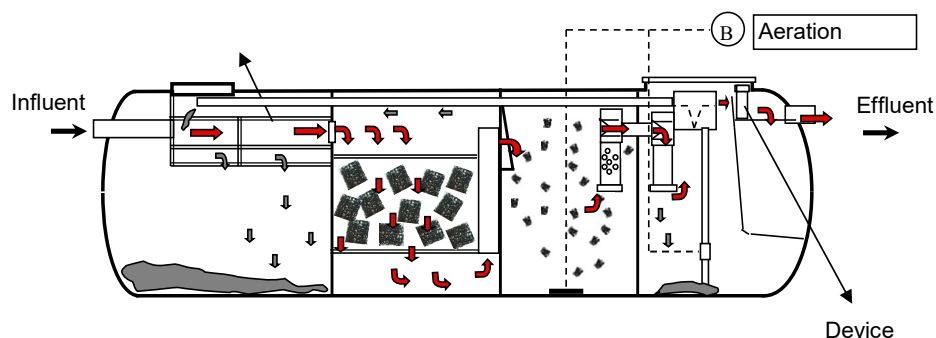
- Circulation flow control

*Circulated water quantity is controlled by adjustment of air quantity for air lift pump, and it can be checked at V-notch weir.



Equipment : Disinfection Device

Illustration



Function

Microorganisms consisting in the treated water are disinfected by chlorine in the device before discharged into the environment.

Components



Chlorine tube

Disinfestation tank

Disinfestation stage

V notch

※ View of Disinfestation device

1. Disinfestation Device

Disinfestation device consists of V notch, disinfestation stage and disinfestation tank

(1) Treated water comes into the disinfestation stage over a V notch.

(2) Chlorine tablet which is in the chlorine tube is dissolved with the treated water.

(3) The treated water containing dissolved chlorine drops into the disinfestation tank.

(4) In the disinfestation tank, microorganisms are disinfested by chlorine.

Maintenance and Inspection Procedures

Daiki AXIS Johkasou-STP (Domestic Wastewater Treatment System) **AI- & AIJ- Type**

Project Name	
Johkasou Type	
Handover Date	

This is that certify that the above product was handed over to the owner and this Maintenance and Inspection Procedures was explained by Daiki Axis or official dealer. Please note that the Johkasou will not exhibit its intended performance without prior maintenance and inspection, and the warranty guarantees under the normal conditions of use in accordance with the precautions in this procedure.

Daiki Axis / Partner

STP Owner

 Caution	Prior to installation of the Johkasou, carefully read the warnings and cautions in this document to fully understand them.
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Carefully store this document for future reference.

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Appendix 1. Maintenance and Inspection Checklist

Appendix 2. Water Sampling Method

1. Safety Precautions

- Prior to working, carefully read these safety precautions to perform the appropriate maintenance and inspection. After reading, carefully store this document.

- Explanation of Indication

 Warnin	Indicates presumable human death or serious injury resulting from ignorance of the indication and mishandling.
---	--

Warning

The maintenance and inspection personnel may be held responsible and liable for any accident arising from failure to observe the following.

 **Warning** ... 1) Prevention of ignition, explosion and hazardous gas accidents

(i) **The disinfectant is a strong oxidant.**

Disinfectants are divided into two types: chlorinated organic and chlorinated inorganic.

Do not put these two types of disinfectants into the agent container together.

(ii) **In the event of handling the disinfectant, be sure to wear rubber gloves, a dust mask, protection goggles and other protective equipment for protecting your eyes, nose and skin**

(iii) **For disposal of the disinfectant, contact your dealer.**

Do not put it into any trash bin or at a dump site because it has a risk of generating heat and flammability.

Note: Detailed precautions for handling of disinfectants are stated on the package of the product. Be sure to read them

Failure to observe these could result in ignition, explosion or generation of hazardous gas, which may cause injuries.

 **Warning** ... 2) Prevention of oxygen shortage during work

Before entering Johkasou, be sure to measure the oxygen concentration and the hydrogen sulfide concentration to verify safety. While working in Johkasou, be sure to implement forced ventilation.

Failure to observe this could result in a fatal accident.

 **Warning** ... 3) Prevention of electric shock, ignition and entanglement

(i) **Keep anything at least 50 cm away from the blower or the control panel.**

(ii) **Do not put anything on the power cord.**

Failure to observe this could result in an electric shock or ignition.

(iii) **After inspection of the blower, be sure to reattach the cover that was detached.**

Failure to observe this could result in entanglement.

 **Warning** ... 4) Prevention of fall from manhole and inspection hole and injury

(i) **After finishing the work, be sure to close the manhole and the inspection hole with their respective covers. If they have a lock mechanism, be sure to lock them.**

(ii) **If any crack, damage or other abnormality is found on the manhole cover or the inspection hole cover, immediately replace it.**

Failure to observe these could result in a fall or an injury.

During inspection, pay attention to the following for the purpose of maintaining Johkasou functions

Attention

- Attention** (i) Carry out the following to prevent ignition and fire at a power outlet.
Check if the power plug is free from **dust** and securely insert it into the base of the blades in a way that prevents it from **rattling**.
Attachment of dust and incomplete connection could result in an electric shock or fire.
- Attention** (ii) After finishing the work, do the following.
1) **Be sure to close the manhole and the inspection hole with their respective covers.**
2) **Turn on Johkasou.**
3) **Keep anything at least 50 cm away from the blower and the control panel.**
- Attention** (iii) If the frame and the cover of the manhole and the inspection hole are made of casting or steel, remove the rust and apply a coating on a regular basis.
- Attention** (iv) Carry out maintenance and inspection in firm compliance with the Technical Standards for Maintenance and Inspection, the Technical Standards for Cleaning and other laws and ordinances as well as with the manufacturer's Maintenance and Inspection Procedures.
- Attention** (v) Do not open the package of the disinfectant until Johkasou is put into use.
Failure to observe this notice could result in the generation of chlorine gas from the disinfectant, a reaction of the gas with moisture in the air to generate hydrochloric acid, which erodes metal.

2. System Management

1) Manager's obligations

Implement maintenance and inspection in accordance with the laws in the region.

Johkasou will not exhibit its intended performance without prior maintenance and inspection.

If the manager is unable to conduct maintenance, inspection and cleaning alone, ask a maintenance and inspection specialist to do so.

2) Obligations of maintenance and inspection operator

a) If those authorized to be commissioned to conduct maintenance and inspection are determined in the region, it is necessary to make a contract with them who have such qualification.

b) Make sure that Johkasou will be maintained and inspected properly in accordance with the Maintenance and Inspection Procedures.

3) Timing and frequency of maintenance and inspection

Conduct the first maintenance and inspection just before Johkasou is put into use. After that, carry them out at least once during each period specified in Table 1-1.

Table 1-1

Item	Frequency
Maintenance and inspection	At least once a month

Notes:

- Depending on the region, it may be stipulated that the maintenance and inspection must be conducted more frequently than specified in the table above for the stability of the treatment function.
- The inspection of operations of the drive unit and the pump unit and filling of disinfectant shall be conducted when it is necessary irrespective of Table 1-1.

4) Obligations of sludge removal operator

a) If those authorized to be commissioned to conduct sludge removal are determined in the region, those who have such qualification must conduct the removal.

b) Properly carry out sludge removal from Johkasou in accordance with the Maintenance and Inspection Procedures and appropriately dispose of the removed sludge as waste in accordance with local laws.

5) Frequency of Sludge Removal

Carry out cleaning at a frequency equivalent to or higher than that specified in Table 1-2.

Table 1-2

Item	Frequency
Sludge removal	Once every half a year or more Sludge Removal shall be conducted as necessary depending on the maintenance and inspection results and the state of sludge recipients in the region.

* The sludge removal work removes a large amount of sludge at a time. Prior to installation of the product, coordinate particularly with the sludge recipients.

6) Storage of records for maintenance, inspection and sludge removal

The manager of Johkasou shall create and store records on maintenance and inspection and sludge removal. If the region has any law that stipulates the storage period, store the records in accordance with the law. Even it is not stipulated by the law, it is recommended that the records be stored because they are important in verifying that proper maintenance and inspection have been implemented to maintain Johkasou functions.

7) Statutory Inspection

If the region has a law that requires Johkasou to undergo water quality inspection, make sure that the inspection is done in accordance with the law.

3. Structure and Function

Treatment result: Discharge BOD of 20 mg or less per liter

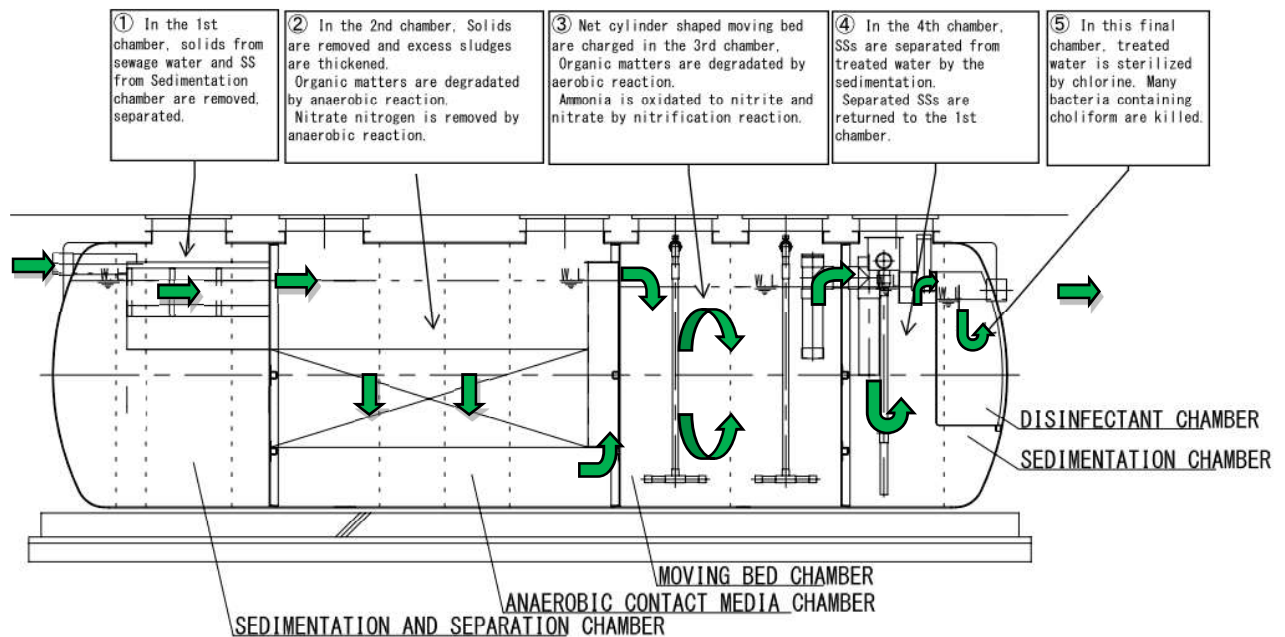


Fig. 1: Composition and Description of Functions

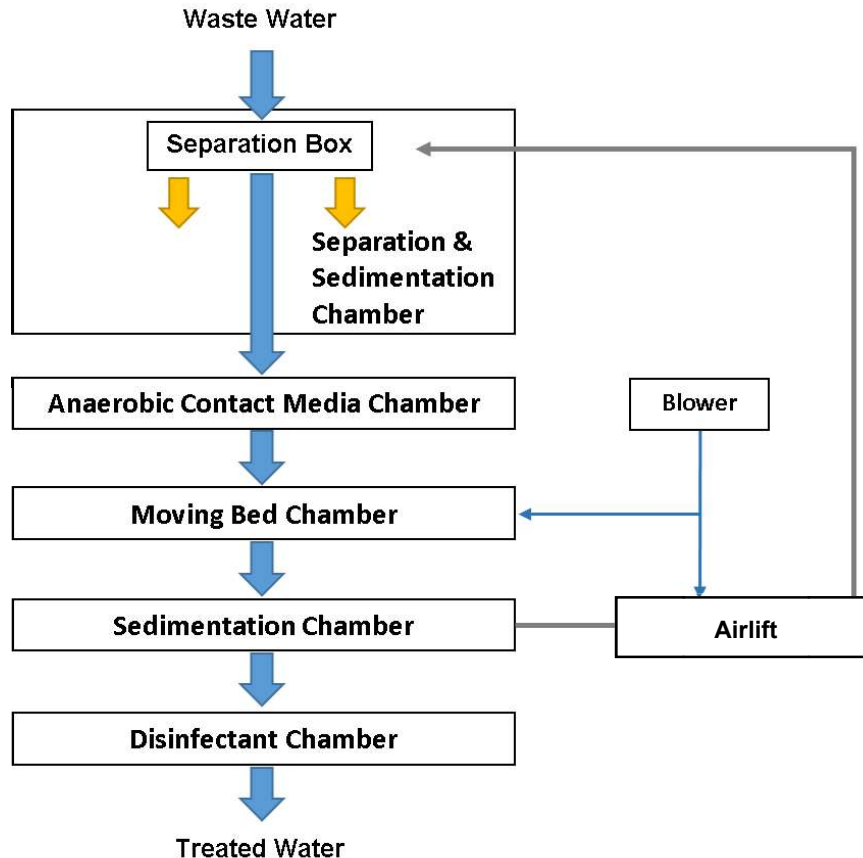


Fig. 2: Treatment Process Flow

4. Maintenance and Inspection

4-1 Main inspection items

Table 1 shows the apparatuses and equipment necessary for inspection.

Table 2 shows the main inspection items.

Table 1: Apparatuses and equipment necessary for inspection

Apparatus or equipment		Location where it is needed	Purpose
Ladle		Each chambers	- Removal of scum - Check on properties of sludge
Siphon Pump		- Sedimentation chamber - Disinfection chamber	- Sampling of treated water
Brush		- Inlet and outlet pipe - Separation box - Moving bed chamber - Sedimentation chamber - Airlift	- Cleaning the inside of pipes and tubes, the flow port, the overflow port, the Airlift, etc.
Measuring cup (two liters)		Moving bed chamber	- Check on moving bed quantity
Transparency meter		Treated water	- Measurement of transparency level
DO & pH meter (Temperature)		Moving bed chamber	- Measurement of dissolved oxygen - Measurement of pH - Measurement of temperature
Residual chlorine analyzer		Effluent water	- Measurement of residual chlorine
Ammonia measurement kit (for AIJ- Type)		Sedimentation chamber (Treated water)	- Measurement of ammonia nitrogen
Sludge level checker		- Separation & Sedimentation chamber, - Anaerobic chamber, - Sedimentation chamber	- Measurement of deposited sludge
Tools		Blower	- Repair and maintenance of blower
Maintenance and inspection Report			

Table 2: Main inspection items and frequency

Check item	Descriptions	Frequency
Influent pipe line	- Check on tight sealing of cover for inspection measure - Check on water stagnation, water leakage, sedimentation or attachment of foreign matter	At each inspection
Effluent pipe line	Check on water stagnation, water leakage, sedimentation or attachment of foreign matter	At each inspection
Sedimentation and separation chamber	- Check on floating or attachment of foreign matter - Check on any abnormal rise in water level	At each inspection
	Remove the sludge according to the state of sludge sedimentation	Once every six months
Separation box	- Check on sedimentation or attachment of foreign matter - Check on any abnormal rise in water level - Check on state of generation of scum - Check on state of generation of settled sludge	At each inspection
Anaerobic contact media chamber	- Check on sedimentation or attachment of foreign matter - Check on any abnormal rise in water level - Check on state of generation of scum - Check on state of generation of settled sludge - Check on occlusion of anaerobic media	At each inspection
	Remove the sludge according to the state of sludge sedimentation	Once every six months
Moving bed chamber	- Check on any abnormal rise in water level - Check on state of aeration and agitation - Check on state of foaming - Measurement of dissolved oxygen level - Measurement of pH level - Measurement of water temperature	At each inspection
Sedimentation chamber	- Measurement of transparency level - Measurement of ammonia nitrogen (*for AIJ Type only) - Check on any abnormal rise in water level - Check on state of generation of scum - Check on state of generation of settled sludge	At each inspection
Airlift	- Check on water volume for circulation - Check on attachment of massive biofilm on piping or on measuring box	At each inspection
Disinfection chamber	- Check on state of contact with treated water - Check on state of settled substances - Check on remaining amount of chemicals and refilling	At each inspection
Blower	- Check on operation status - Cleaning of air filters	At each inspection
	Overhaul	Once a year
Pump	Check on state of operation and positions of float switches	At each inspection
	Overhaul	Every other year

4-2 Pre-Use Inspection and Check and Adjustment

Before regular maintenance and inspection, checking on the construction and work on Johkasou and functions of the internal operation units just before use is very important to normal Johkasou operation and to the prevention of problems during the inspection and cleaning processes.

Check on Johkasou installation

- (1) Compare the physical Johkasou with the submitted documents
 - (i) Compare installed Johkasou with Johkasou reported in the application documents.
- (2) Check on the surrounding condition of Johkasou
 - (i) Observe the places where the main unit the blower and other equipment are installed to see if there are any problems with maintenance, inspection or cleaning work.
 - (ii) Check if there is any risk of rainwater leakage from the manhole for Johkasou.
 - (iii) Observe the state of use of the space above Johkasou. Especially if it serves as a parking area, check the design drawings and other documents to see if it is suitable for vehicles.
 - (iv) If Johkasou is installed at a residential building, check if the discharge pipes from the bathroom and from the kitchen are connected and if the rainwater piping is NOT connected.
- (3) Check the inside of Johkasou
 - (i) Open the manhole to check if maintenance and cleaning work can be conducted easily and safely.
 - (ii) Check if Johkasou is installed horizontally and if the water levels in each chamber and in the bottoms of feed pipes and discharge pipes are normal.
 - (iii) Carry out a visual inspection to see if the inside walls, the partition plate, piping and other internal equipment is damaged and check if moving beds flow out from the designated place.
 - (iv) Check if there is air leakage from any part of the piping. The piping is normal provided that the air valve is appropriate and that the pressure is roughly in the range of 20 kPa to 30 kPa.
 - (iv) Check the quantity of circulating water.

Note

At a restaurant, café or other place from which a high concentration of wastewater flows out, the foul odor generated at the start of Johkasou operation may be problematic. Put the blower into operation at least one week before the facility is opened to aerate the moving bed chamber.

Note

At the start of operation, moving beds are floating in the moving bed chamber, but it is not abnormal. The moving beds will no longer float after operation for some period of time (normally two to three weeks).

Note

At the start of operation, please fill chlorine tablets in the chlorine dispenser.

4-3 Key Points of Maintenance and Inspection

Daiki Domestic Wastewater Treatment Systems AI Type & AIJ Type both adopt the moving bed system. The following describes key points to be noted when performing maintenance and inspection.

1) Separation and sedimentation chamber

If there is any foreign matter or scum, remove it to ensure a smooth water flow in the separation box. If they are a little, Remove them out side of the separation box.

The separation and sedimentation chamber is the main chamber in which sludge is retained. If it is filled, water quality will deteriorate. Make sure that too much sludge is not retained or it does not flow out of the transfer outlet.

2) Anaerobic contact media chamber

Like the separation and sedimentation chamber, this chamber retains sludge. As soon as it becomes full, the water in the subsequent moving bed chamber will deteriorate. Make sure that too much sludge is not retained or it does not flow out of the transfer outlet. Note that this chamber is filled with anaerobic media. If it is clogged with sludge and foreign matter, that will disrupt the water flow. Check if there is any difference in the water level from the outlet to the moving bed chamber.

3) Moving bed chamber

Check if moving beds are floating and moving without staying in one place.

Check if biofilms are attached to moving beds.

Check that there is no large volume of suspended substances in the chamber.

Check if moving bed volume is appropriate level.

If these conditions are fulfilled, biological treatment will be effective.

4) Sedimentation chamber

Check if there is any floating scum. If there is, use the ladle to move it from this chamber to the separation and sedimentation chamber. The existence of floating scum means that the flow rate of the airlift is insufficient. Adjust the flow rate.

5) Airlift

Clean the airlift, measuring box and circulation pipe line after each inspection.

- ① Fully close the airlift valve and count 5 seconds.
- ② Fully open the valve and see high concentrated SS is lifted up in the measuring box.
- ③ When concentration of SS becomes low, return to ①, and repeat ① to ③ until the high concentrated SS is not lifted up.
- ④ Clean the measuring box and circulation pipe line with tap water.
- ⑤ Adjust the settings of the airlift valve.

4-4 Checking and Adjusting Individual Units

1) Types of valves and openings

There are two valves in the air piping. One is for air diffusion and the other is for the airlift. Fully open the air diffusion valve and adjust the circulation water volume. If the specified water volume is not secured even after fully opening its valve, narrow the air diffusion valve to increase the amount of air in the airlift.

2) Cleaning of air diffusion pipe

Clean the air diffusion pipe and the reverse cleaning pipe with tap water and valve operations.

<Steps for cleaning with tap water>

- (1) Turn off the breaker of the blower to stop its operation.
- (2) Remove the union from the inlet of the air diffusion unit and connect the inlet with the water supply faucet with a vinyl hose.
- (3) Open the faucet to let the tap water flow through the air diffusion pipe.
- (4) Close the water supply faucet and then restore the piping to its original form. Turn on the breaker of the blower to resume its operation.
- (5) Adjust the settings of individual valves.

<Steps for cleaning by valve operation>

- Air diffusion pipe

- (1) Make sure that Johkasou is in a state of air diffusion.
- (2) Completely shut the circulation valve.
- (3) Narrow part of the air diffusion pipe to increase the air volume per line to carry out ventilation.
- (4) Restore the settings of individual valves.

3) Setting of circulation water volume

Basically, set the circulation water volume to double (2Q) the daily average wastewater quantity (Q).

*For the AIJ type, set the volume to 4Q. (Table 4)

Calculate the circulation water volume using the equations below.

- Circulation water volume for AI- Type
= Daily average wastewater quantity (Q) × 2.0 ÷ number of measuring box
- Circulation water volume for AIJ- Type
= Daily average wastewater quantity (Q) × 4.0 ÷ number of measuring box

Adjust the air valve to achieve the appropriate water volume mentioned on the V-notch in the measuring box. Please refer to the table 3 (AI type) and Table 4 (AIJ type).

Table 3: Wastewater Volume and Circulation Water Volume to be Set (for the AI- Type)

Daily average wastewater volume [m ³ /day]	5	10	15	20	25	30	35	40	45	50
Circulation water volume [m ³ /day]	10	20	30	40	50	60	70	80	90	100

Table 4: Wastewater Volume and Circulation Water Volume to be Set (for the AIJ- Type)

Daily average wastewater volume [m ³ /day]	5	10	15	20	25	30	35
Circulation water volume [m ³ /day]	20	40	60	80	100	120	140

4-5 Inspection and Maintenance Work

The following descriptions pertain to the items for each chamber subject to inspection, rough guides to the normal state and maintenance work to be performed in the event of an abnormality.

1) Sedimentation and separation chamber

Inspection Item	Inspection Method	State of Abnormality	Maintenance Work
Inlet and outlet Separation box	Visual test	Filth and scum are accumulated in large quantities.	Remove the foreign matter.
Smell & Odor	Smell test	There is a strong odor even when the manhole and the square-type cover are closed.	- Check the piping on the inlet line. - Add deodorant and seeding agent. - For manholes, apply packings onto their frames. - Properly install a ventilation pipe and ventilation fan.
Scum conditions	Visual test Ladle	Scum is present in such large quantities that it may overflow into the separation box.	- Carry out sludge removal. - Table 5 indicates upper value. When any value approaches the upper value, carry out cleaning.
Sludge conditions	Visual test Sludge level checker	Sludge flows out through the transfer port to the anaerobic contact media chamber.	- If a considerable amount of sludge discharge from the separation box is observed, remove the sludge. - When value approaches the upper value of Table 5, carry out cleaning.
Foreign matter	Visual test	Sanitary goods and disposable diapers and plastics are present.	Advise the user not to add any foreign matter.
Grease	Visual test	Grease floats in large quantities.	Ask the user if they poured in any large amount of grease. If yes, ask the user to reduce the amount of grease to discharge.

Table 5 Thickness limits of scum and settled sludge in sedimentation and separation chamber

Water amount [m ³ /D]	AI-	1	2	3	4	5	6	8,10	12,15	≥ 20
	AIJ-	-	1	2	3	4	5	6	8,10,12	≥ 15
Scum	Over surface	100	100			150				
	Under surface	300	350			400				
Settled sludge	Bottom	400	450	650	900			1000	1200	

2) Anaerobic contact media chamber

Inspection Item	Inspection Method	State of Abnormality	Maintenance Work
Scum conditions	Visual test Ladle	Scum is present in large quantities	- Carry out sludge removal. - Table 6 indicates upper value. When any value approaches the upper value, carry out cleaning.
Sludge conditions	Visual test Sludge level checker	The moving bed chamber has a very large quantity of suspended substances.	- If a considerable amount of sludge is advected into the moving bed chamber, remove the appropriate amount of sludge. - Table 6 indicates upper value. When any value approaches the upper value, carry out cleaning.
Anaerobic media	Visual test	- The water level in the anaerobic media part is higher than that in the cleaning hole. - A large number of solids has accumulated on the surface of the anaerobic media.	Clean the anaerobic media with pressured water and, if necessary, remove an appropriate amount of sludge from the bottom.
Grease	Visual test	Large quantities of grease are floating.	Ask the user if they poured in any large amount of grease. If yes, ask the user to reduce the amount of grease to discharge.

Table 6 Thickness limits of scum and settled sludge in anaerobic chamber

Water amount [m³/D]	Al-	1	2	3	4	5	6	8,10	12,15	≥ 20	
	AIJ-	-	1	2	3	4	5	6	8,10,12	≥15	
Scum	Over surface	100					120				
	Under surface	100					100				
Settled sludge	Bottom	200	250		300		450				

3) Moving bed chamber

Inspection Item	Inspection Method	State of Abnormality	Maintenance Work
Air diffuser	Visual test	▪ Bubbles come up only on one side. ▪ No bubbles come up. <i>Normal state:</i> <i>Bubbles come up evenly.</i>	▪ Adjust the air diffusion valve. ▪ Inspect the air diffuser and the air piping (to see if it is clogged or if air is leaking). ▪ Inspect the blower. ▪ Clean the air diffuser.
Foaming	Visual test	A large amount of foams is floating. Condition like foams overflow the partition wall.	▪ Inject anti-foaming agent. ▪ Inject seeding agent.
Water conditions	Visual test	There are large quantities of suspended substances.	▪ Adjust the circulation water volume. ▪ Remove sludge from the sedimentation and separation chamber and the anaerobic contact media chamber.
DO level to be measured	DO & pH meter	1.0 mg or less per liter	▪ Adjust the air diffusion valve. ▪ Inspect the air diffuser and clogging of or leakage from the air piping. ▪ Inspect the blower. ▪ Inspect the operation and the circulation water volume.
pH level to be measured	DO & pH meter	Out of the range of 6 to 8	▪ Check if there is any abnormal influx of water. ▪ If nitrification increases excessively, adjust the air blow rate.
Water level	Visual test	Higher than the water level of sedimentation chamber	▪ Check and clean the transfer point

4) Sedimentation chamber

Inspection Item	Inspection Method	State of Abnormality	Maintenance Work
Scum Conditions	Visual test	Scum is floating on the entire surface (>80%)	▪ Scoop the scum to move it from this chamber to the sedimentation and separation chamber. ▪ Check and adjust the operation and the circulation water volume.
Transparency (to be measured)	Transparency meter	Less than 20 cm	▪ Check if there is any abnormal influx of water. ▪ Check if the DO level and the pH level are normal and, if there is any abnormality, follow the appropriate measures. ▪ Check if a sufficient amount of microorganisms are attached. If it is insufficient, carry out seeding. ▪ If nitrification advances excessively (pH,6), adjust the air blow rate.
Ammonia Nitrogen (to be measured) *(for AIJ Type)	Ammonia measurement kit	More than 10 mg per liter	▪ Check if DO level and pH level are normal and, if any are abnormal, take the appropriate measures. ▪ Check if a sufficient number of microorganisms are attached. If it is insufficient, carry out seeding.
Circulation water	Visual test	There is no difference between the concentration of SS in the moving bed chamber and the circulation water.	▪ Check if the accumulated sludge on the bottom is hardened with the use of a long stick. ▪ Lower the flow rate for sludge removal (circulation volume).

5) Disinfection chamber

Inspection Item	Inspection Method	State of Abnormality	Maintenance Work
Chlorine dispenser	Visual test	The chlorine dispenser is slanted.	Set it at the normal position to ensure that treatment water is in sufficient contact with disinfectant.
Chlorine tablet	Visual test	- The tablet is rapidly consumed. - The tablet is not consumed.	- If the level of tablet is judged to be high from the residual chlorine concentration in the Disinfection chamber, reduce the amount of water in contact with the discharge water by adding the disc into the bottom of dispenser. If the level is judged to be low, increase the amount of water in contact with flow water by removing the disc. - Clean the bottom of dispenser regularly.
Existence of any sediment	Visual test	Sediment is present and the discharge water is confirmed to be turbid.	Carry out cleaning.
Be sure to refill disinfectant irrespective of its residual level. - Refill disinfectant with care to avoid accidentally dropping it into the tank. - If the disinfectant is dissolved in any chamber other than the Disinfection chamber, it will kill the microorganisms in Johkasou and the treatment performance will be deteriorated. - Use a disinfectant that meets the specifications in the design calculation. <u>Never use any inorganic chlorinated disinfectant and any alkaline substance together. It would cause an explosion.</u> - If the disinfectant fails to meet the specifications mentioned above, <u>it will fail to carry out proper disinfection or result in an inadequate storage period.</u> * If the amount of water is small, some of the treated water may move to the Disinfection chamber without passing the overflow weir. This poses no problem.			

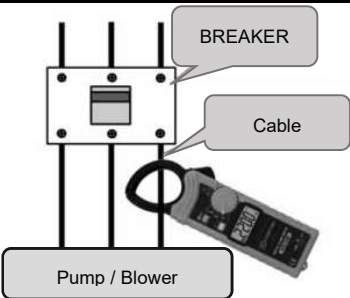
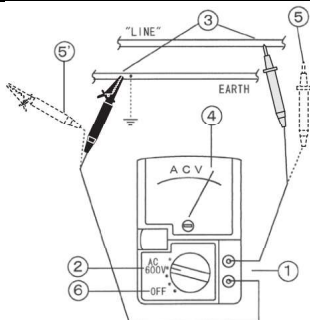
6) Blower

Inspection Item	State of Abnormality	Maintenance Work
State of operation	The blower is not in operation	- Check the power supply. - For details, refer to the operation manual of the blower.
Piping joint	Air is leaking	Repair it.
Sounds and vibrations	Abnormal sounds or vibrations are generated	- Check how the blower is installed - Check if the diaphragm is damaged.
Air filter	It is stained or clogged	Clean it or replace it. (It is recommended to regularly replace it.)
Replace the diaphragm valve, clean or replace the air filter on a regular basis and carry out other maintenance work in accordance with the operation manual of the blower.		

7) Pump

Inspection Item	State of Abnormality	Maintenance Work
State of operation	- The pump does not work properly at the determined water level. - The pump is not in operation. - No or little water comes out.	- Check if it is powered on and if it is powered off, power it on. - If the wire is broken, replace the pump. - Check if the float switches are faulty or placed in inappropriate positions. Take remedial action or replace it. - If the non-operation is attributed to any tangled foreign matter (which makes the current level high), remove the foreign matter. - For details, refer to the operation manual of the pump.
Replace lubricant (around once a year) and carry out an overhaul (around once every two years) and other maintenance work in accordance with the operation manuals of the pump and the float.		

8) Terminal Box / Control Panel

Inspection Item	State of Abnormality	Maintenance Work
Currency (To be measured)	The current value of equipment is +20% of rated current value.	- Check if air piping is clogged, air valve is closed too much, and diffuser is clogged. - Clean filters of blowers. - Check if piping for pump is clogged, and any foreign substances is adhered with screws.
	The current value is -20% of rated current value.	- Check if there is an air leakage. - Check if there is an air leakage from piping for pumps. - Check on screws.
【Measurement of currency】 Use a clamp meter. Measure when the equipment is on an operation. Measure every cable one by one.		
Insulation resistance (To be measured)	Insulation resistance indicates lower than specified values. 【Specified values】 < 300V: 0.2 MΩ > 300V: 0.4 MΩ	- Identify the earth leakage location. - Replace the equipment. - When recovery is not recognized by equipment replacement, please contact a specialist.
【Measurement of insulation resistance】 Measure with insulation-resistance tester. When you carry out measurement, please be sure to turn off the circuit breaker. Measure by connecting red line to terminal and black line to the earth. Please refer to "Instruction Manual" for details.		

9) Common

Inspection Item	State of Abnormality	Maintenance Work
All Chamber	Scums are adhered to partition plate and the wall	Clean dirty part with a brush

4-6 Action in the Event of Abnormality

1) Action against Odor

It takes some time until this Johkasou starts to exhibit its intended functions and in the meantime, it may cause foul odor. A variety of factors can cause odor generation from the moving bed chamber. In many cases insufficient aeration or a large amount of circulation water hampers effective biological treatment. Possible remedial actions include increased aeration and seeding. The following describes examples of actions against odor.

There are a variety of possible measures to address odor issues, such as:

- (1) Sealing the manhole with packings, as a temporary measure.
- (2) A reverse flow of odor to the building may occur when the trap is not properly in place in the piping for the Johkasou.
Review the piping route to check if the trap is appropriately installed.
- (3) Properly install a ventilation pipe and a ventilation fan. Make sure that the ventilation pipe is taller than the eaves of neighboring buildings and erect it with full consideration of wind directions and other factors.
- (4) Add a seeding agent and deodorant to the anaerobic contact media chamber and the moving bed chamber.
* For seeding, use a commercially available seeding agent, digested sludge in a STP, a night soil disposal plant or sludge in the aeration tank. If sludge is added, adjust the added amount to ensure that the sludge concentration will be roughly within the range of 200 mg to 300 mg per liter in the anaerobic contact media chamber and roughly within the range of 100 mg to 200 mg per liter in the moving bed chamber.

2) Action against bubbles

Bubbles may be generated in the early period of operation during which the quantity of microorganisms is still limited or in the case of a huge gap between the water temperature and the air temperature or where a large amount of inflow of detergent. It often occurs particularly in the early period of operation and in most cases, the phenomenon will cease after some time.

If action needs to be swiftly taken, use an anti-bubble agent that is sold separately to eliminate bubbles. In addition, seeding and supplying microorganisms to the moving bed chamber for ensuring orderly biological treatment is another solution against bubbles. In the event of a massive inflow of detergent, either carry out the actions mentioned above or ask Johkasou manager (user) to use an appropriate amount of detergent.

3) Action against discharge of moving beds

If the water level is at an abnormal level, moving beds in the moving bed chamber may flow out. Pick up those moving beds and put them back into the chamber.

5. Sludge Removal

5-1 Rough Guide to Timing of Sludge Removal

It is stipulated that sludge removal shall be carried out at least once every half a year in a normal state of use.

As a rough guide, it is time to carry it out in any of the states described below.

- 1) There is a considerable amount of scum sediment in the sedimentation and separation chamber or in the anaerobic contact media chamber, or a considerable amount of sludge sediment at the bottom of the chamber.
- 2) A dramatic rise in water level in the tank or any trace thereof is observed.
- 3) SS are generated in large quantities in the moving bed chamber that do not decrease even after the circulation process.

Note

Sludge removal from the moving bed chamber or the sedimentation chamber is normally not required. If it is necessary, do not directly remove sludge from the center of these chambers. Failure to observe this instruction will result in the removal of moving beds together with the sludge. In the event of removal, carry out the work in accordance with the following.

○ Moving bed chamber

Stop aeration and allow some time until the sludge is settled. Attach a net or equivalent with the spacing of 14 mm or less. Remove sludge while paying attention to avoid shifting moving beds from the bottom of the tank.

○ Sedimentation chamber

Set the end of a hose inside the tank to carry out the removal. In this event, pay attention to avoid damage to the airlift.

5-2 Steps for Sludge Removal

1) Preparation work

Prior to the cleaning of individual units, take the following steps.

- ① Turn off the breaker of the blower to stop its operation.
- ② Remove accretions on the feed pipe (and the baffle) and the discharge pipe (and the baffle).
- ③ For removing suspended substances from the moving bed chamber or sludge from the sedimentation chamber, take the steps mentioned in the previous paragraph.

2) Sedimentation and separation chamber

Positions for insertion of the cleaning hose

Lateral surface of the separation box and the manhole installation position (Refer to Fig. 3)

- ① From the position shown in the diagram, remove scum through a suction hose while breaking it up with a stick or equivalent.
- ② Insert a suction hose to the bottom of the chamber and remove all of the sludge.

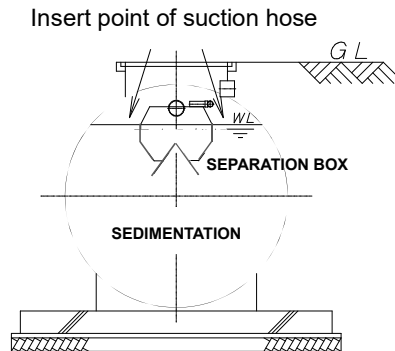


Fig. 3: Positions on the sedimentation and separation chamber for insertion of a sludge removal hose

3) Anaerobic contact media chamber

Positions for insertion of the cleaning hose

The sludge cleaning hole and the baffle (See Fig. 4)

- ① Insert a suction hose into the chamber to remove scum.
- ② Remove sludge on the anaerobic media roof net until the media becomes visible.
- ③ Insert a suction hose through the cleaning hole to the bottom of the chamber, and remove an **appropriate amount** of sludge on the bottom while washing sludge off the internal wall of the tank using pressured water or the equivalent.

Note

Be sure to remove scum before removing sludge. Removing the sludge at the bottom of the chamber could lower the water level to possibly allow sludge on the anaerobic media roof net to enter the anaerobic media and cause occlusion.

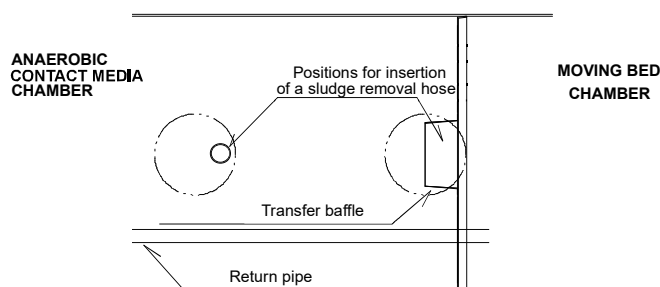


Fig. 4: Positions on the anaerobic contact media chamber for insertion of a sludge removal hose

4) Work after removal

After finishing the sludge removal, fill the chamber with water to the specified level (at which the water overflows).

Then turn the breaker of the blower on to put the blower into operation.

Note

Do not remove a large portion of water in the chamber at a time or leave the tank empty for a long time. Failure to observe the instruction above could result in application of a significant buoyant force or load onto the tank and cause damage to the tank.

6. After-Sales Services

6-1 Period and Scope of Warranty

1) After-sales services

Should any abnormality occur while Johkasou is in use, contact us or your maintenance and inspection service operator.

2) Warranty

The warranty period is three years from the date of shipment for the main unit and one year from the same date for the drive unit and the internal components. We will repair problems as mentioned in the warranty certificate.

For repairs after the expiration of the warranty period, please feel free to contact us.

The warranty guarantees that we will offer free repair for system failure during the warranty period under the normal conditions of use in accordance with the precautions in the maintenance and inspection procedures.

It is meant to guarantee the functions of Johkasou and not its performance.

Items covered by the warranty

- ① Main unit: the outer shell of the unit and the partition board (including moving beds)
The warranty does not apply if Johkasou is not used as a STP.
- ② Drive unit (including the blower, the pumps, the control unit and other equipment) and internal components
 - * The warranty does not apply to any scratches, rust or others on the exterior generated during its use.
The warranty is intended to guarantee the function, or the withstanding load strength, of the cover.
 - * The warranty does not cover expendable components, such as belts, chemical agents, packings, grease, diaphragms, valves, disinfectants and batteries.

3) Component retention period

Components of Johkasou will be retained for at least five years. Please note that we may be unable to supply components and that the whole unit may have to be replaced after five years.

For details, please contact your maintenance and inspection service operator.

4) In the event of loss or damage of the operation manual for Johkasou, please contact us and we will immediately send you another copy.

5) If you have any other query, please contact us.

- * This Johkasou will not exert its functions without maintenance and inspection, specifically maintenance, inspections and sludge removal. These are at your expense.

MEMO

Appendix 19

Guidelines for FSSM Implementation in Varanasi



Guidelines for FSSM Implementation in Varanasi

May 2024

Wastewater Management Sector Team

**The Project for the Comprehensive
Improvement of Environmental Sanitation in
Varanasi (CIESV)**

Preface

As the Guidelines for Faecal Sludge and Septage Management in Uttar Pradesh (February 2018) and the Faecal Sludge and Septage Management Operative Guidelines of Uttar Pradesh, which were developed in line with the National Policy on Faecal Sludge and Septage Management (FSSM) (February 2018), state that “each state and city needs to formulate its own FSSM strategy and integrate the same in their respective state and city sanitation plans in conformity to the National Policy”, Varanasi Nagar Nigam (VNN) drafted **Faecal Sludge and Septage Management Policy and Operating Guidelines – Varanasi** in 2019.

Although the draft Policy is yet to be officialized and enacted, it was agreed that some key features of the draft Policy would be piloted in the wastewater management component of the JICA Project for Comprehensive Improvement of Environmental Sanitation in Varanasi (CIESV) as an important contribution for officialization of the draft Policy and its implementation.

The Guidelines indicate, based on the result of the FSSM pilot activities in the Project, steps towards effective implementation of the draft Policy after it is finalized and enacted.

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1. Need for improving FSSM in Varanasi

1) On site Sanitation Systems are still prevalent in Varanasi

With on-site pit latrines and septic tanks (On-site Sanitation (OSS) Systems) accounting for around 30% of households in the city (draft FSSM Policy Varanasi, 2019), limited attention has been accorded to proper construction, maintenance of OSS and their management as well as safe disposal of faecal sludge and septage from such septic tanks and pit latrines.

2) Septic tanks are constructed without observing the established standards

While the construction guidance for OSS (especially the septic tanks) have been established by the Bureau of Indian Standards (BIS) and National Building Code of India (NBC, 2005), on-ground construction is largely left for the households to manage. In practice, the installations are subject to local practices at the whims of the masons and considerable variations are practiced. During on-ground construction, Septic Tanks guidelines specified by code are seldom observed. Therefore, in absence of proper guidance from the experts, the tanks are constructed in a haphazard manner leaving almost no scope for their cleanliness once there are filled with Septage.

3) Overflow of septic tanks are common posing environmental and health hazards

Even the drainage system for effluent is not properly provided in the form of a soak pit and sludge is allowed to overflow in the open drains causing bad odor and spreading pathogens. This leads to serious health and environmental hazards in the neighborhood.

4) Lack of periodical desludging and inappropriate discharge of collected faecal sludge and septage exacerbates the situation

In Varanasi, the average desludging frequency varies from 10 – 15 years (draft FSSM Policy Varanasi, 2019), against the CPHEEO norms of cleaning frequency of 2 – 3 years. As the septic tanks are not emptied regularly, the septic tank effluent and septage, with appreciable levels of organics, nitrogen, and pathogens are disposed without proper treatment. Exposure to untreated septage and effluent can, therefore,

have negative impact on the environment and health of living organisms. Also, the private operators dump the faecal sludge/ septage into open drains instead of discharging at designated points or at treatment plants for the safe treatment of faecal sludge.

5) Varanasi City needs to address the issue urgently

Keeping in view the importance of addressing this problem of treatment and disposal of Faecal Sludge and Septage, Varanasi Nagar Nigam needs to put in place a policy for regulating the provisions of OSS along with their maintenance, cleaning, treatment and disposal of Sludge and Septage in most scientific manner.

2. FSSM improvement: Where to start?

Faecal Sludge and Septage Management Operative Guidelines of Uttar Pradesh indicates, as “Step by step approach: Operationalisation of Septage Management Plan for Urban Local Bodies”, the followings:

5.1 Preparation of Plan for Septage Management

5.1.1 Existing situation assessment across sanitation service chain

- Steps for **assessment of existing toilets and septic tanks and creation of database.**
- Steps for Scheduled septic tank emptying services.
- Steps for **Planning of septage treatment facility.**

5.1.2 **Awareness generation and capacity building activities.**

5.1.3 Record-keeping, reporting (MIS), monitoring and feedback systems.

5.1.4 Explore private sector participation for septage management activities.

Since the implementation status of the City of Varanasi is yet **in a preparation stage** as the draft FSSM Policy remains as it was in 2019, the actions indicated above should be taken.

For this purpose, pilot activities have been conducted in the CIESV Project, addressing the following **topics** that correspond to the actions indicated above.

- 1) Assessment of existing toilets and septic tanks and creation of database
- 2) Planning of septage treatment facility
- 3) Awareness generation and capacity building activities

In the following sections, activities conducted to address the topics 1) to 4) as well as additional instructions are presented so that VNN/ Jal Kal can extend the pilot to other areas in Varanasi.

3. Assessment of existing toilets and septic tanks and creation of database

(1) Instruction of the Faecal Sludge and Septage Management Operative Guidelines of Uttar Pradesh

Steps for assessment of existing toilets and septic tanks and creation of database

- (a) City level assessment of coverage of toilet and on-site sanitation facility using the existing database (like property tax module, Census 2011 etc.) or based on recent survey carried out under SBM.
- (b) If the ULB do not have database, then **ULB shall create database of toilets and septic tanks**. Ideally, all ULB shall link the key result related to toilet availability, type of toilet and its connection with waste water outlet with property tax database on e-governance platform.
- (c) ULB shall keep updated database related to toilet availability and on-site sanitation through property tax assessment survey carried out at every four years of interval
- (d) Evaluate existing septic tank designs and other storage/treatment systems and modify (in case of variation) based on design mentioned in Annexure 1.
- (e) Notices should be issued to all property owners whose septic tanks do not meet the standard septic tank design.
- (f) Identify insanitary toilets and convert them to sanitary latrines for safe collection and disposal of waste as per norms set out in Annexure 1.
- (g) All existing septic tanks should have access covers for each chamber, so that they can be easily opened during emptying process. Where such covers are not available, it should be made compulsory for all property owners to provide proper covers.
- (h) The new septic tanks need to be designed and constructed as per the norms suggested in National Building Code, 2005 and CPHEEO Manual, 2013 which takes reference of design norms from IS: 2470 on Code of practice for installation of septic tanks - Part 1: Design and Construction and Part 2: Secondary treatment and disposal of septic tank effluent 1985 (Reaffirmed 1996). The design norms CPHEEO Manual, 2013 is compiled in Annexure 1

(2) Useful output of the Pilot Project – Utilization of SaniTab

1) Introduction

CEPT University is located in Ahmedabad, Gujarat, and is known for its work on city-wide inclusive sanitation through its Center for Water and Sanitation (CWAS). In particular, it has made significant achievements in supporting some Indian cities in improving FSSM, and has contributed to the establishment of **India's first scheduled desludging system for septic tank sludge** in Wai and Sinnar cities in the state of Maharashtra. Their experiences are presented in the material "Citywide inclusive services for Faecal Sludge and Septage Management in Maharashtra" (Annexure 2).

The university has developed various tools for improving FSSM, one of which is **SaniTab**, a smartphone application for building an on-site sanitation facility database. The use of SaniTab for household surveys related to on-site sanitation facilities is expected to provide the following benefits.

- Data entered by multiple investigators on their smartphones is instantly/simultaneously transmitted to and stored on CEPT University's servers. This makes it possible to avoid bothersome paperwork and reduce human error.
- GPS location information and photo data can also be input and transmitted, enabling rapid mapping and visualization of the survey status and results.

"SaniTab": Creating Database for Onsite Sanitation System



The image shows a smartphone displaying the SaniTab application interface. The interface includes a header with the CEPT logo, a list of survey locations, and a form for data entry. The text on the right side of the image describes the app's purpose and its use by ULBs.

- CEPT has developed a generic Mobile Application - "**SaniTab**"
- To create database for Onsite sanitation system
- SaniTab can be used by any ULBs

"SaniTab" – Key Features:

- Citywide digital data collection tool
- Providing enabling environment for spatial analysis
- Quick and ease in survey, minimizing human error
- "Real time" monitoring of survey activity
- Survey at scale

“SaniTab”: Creating Database for Onsite Sanitation System

Assessment captures the following aspects

- Toilet availability
- Where is the toilet connected to
- Size and shape of septic tank
- Number of chambers in septic tank
- Access covers to septic tanks
- Accessibility of septic tanks
- When was the septic tank last cleaned.
- Cleaning frequency of septic tanks
- Problems encountered while cleaning of septic tanks
- Reasons for emptying septic tanks

Sample Questionnaire

Toilet availability assessment	
19	Where do you dispose greywater from kitchen and bathroom? (1. Sewer, 2. Septic tank, 3. Soak Pit, 4. Covered drains, 5. Open drains, 6. Others, specify, 7. Don't know)
20	Do you have your own toilet on your premises? 1. Yes 2. No.
21	If 20=1, Does any member of the household still go for defecation in the open? (1. Men, 2. Women, 3. Children, 4. No one)
Septic tank assessment	
22	What is the type of toilet facility is being used? (1. Flush/pour flush toilet connected to piped sewer system, 2. Flush/pour flush toilet connected to septic tank, 3. Flush/pour flush toilet connected to other system, 4. Single Pit toilet with slab, 5. Single pit toilet with ventilated improved pit, 6. Single pit toilet without slab / open pit, 7. Twin/Double pit toilet, 8. Night soil disposed into open drain, 9. Service toilet with night soil removed by humans, 10. Service toilet with night soil services by animals)
If Q22 is 2 (toilet connected to Septic tank) answer Q23 to Q46	
If Q22 is not 2 (toilet connected to Septic tank) go to B	
23	No. of septic tanks in the property (1. Number, 2. Don't know)
24	Distance of septic tank from the nearest well/bore (1. Distance, 2. to on-site system, 3. Don't know)
25	Septic tank outfall is connected to (1. Soak pit, 2. Open drain, 3. Covered drain, 4. Others (Specify) 5. Don't know)
26	What is the average frequency of cleaning of septic tank? (1. 1 year, 2. 2 years, 3. 3 years, 4. 4 years 5. More than 5 years, 6. Don't know)
27	What is the shape of your septic tank (1. Rectangular, 2. Circular, 3. Don't know)
28	Can you provide the dimensions of the septic tank? (1. Yes 2. No.)
29	If Q. no 27= 1 and Q.no 28=1, provide L _____ ft, B _____ ft, H _____ ft.
30	If Q. no 27= 1 and Q.no 28=1, provide Diameter _____ ft, Depth _____ ft.
31	How many chambers are there in the septic tank (1. one, 2. two, 3. three, 4. Don't know)
32	The base of septic tank is (1. Sealed with concrete and/or plaster, 2. No base – only soil, 3. Other, please specify, 4. Don't know)
33	Are there ventilation pipes for septic tanks (1. Yes, 2. No)
34	What construction materials have been used for constructing septic tanks? (1. R.C.C, 2. Cement concrete and brick, 3. Prefabricated unit, 4. Don't know, 5. Other, specify)
35	What is the age of septic tank? (1. No. of years, 2. Don't know)
36	Where is septic tank located? (1. Front yard, 2. Back yard (easy access), 3. Back yard (no access/through house), 4. House side, 5. Under house, 6. Near the toilet, 7. Don't know) (Note: The person can be allowed to answer more than one option i.e. Backyard (easy access) and near the toilet)
37	If Q 36 = 6, Where is the septic tank located near the toilet? (1. Away from toilet, 2. Only 1st chamber is below the toilet, 3. All the chambers are below the toilet or other structures, 4. Don't know)
38	Is the septic tank accessible from road for cleaning by using a suction emptier truck? (1. Yes, 2. No, 3. Don't know)
39	What is the approximate distance of septic tank from the road? (in meters)
40	Is there proper access with manholes/covers for any of the chamber of septic tank which can be easily opened (1. Yes, 2. No)
41	If 40 = 1, then type of material of access cover (1. Concrete, 2. Cast iron, 3. Farsi (Tiles), 4. PVC/FRP cover, 5. Others, specify, 6. Don't know)
42	When the septic tank was cleaned the last time? (1. Last 6 months 2. from 6 to 12 months 3. 12-24 months 4. 24-36 months 5. more than 36 months 6. Never 7. Don't know)
43	Why was the septic tank emptied? (1. Blocked toilet, 2. Overflow from access hole/manhole, 3. Smell, 4. Others, specify, 5. Don't know/remember)

2) Data collection utilizing SaniTab

In the pilot Project, a household sanitation survey was conducted covering 1,172 houses in the pilot village (Kanchanpur) utilizing SaniTab. The data were collected on the following questions which were made based on an advice provided by experts of CEPT University.

- ① Locality name
- ② Property number
- ③ Property status (Open / Locked)
- ④ Property typology
- ⑤ Tenue status
- ⑥ In case of tenant, name of owner and contact
- ⑦ Number of people living in the property
- ⑧ Number of toilets
- ⑨ Toilet outlet is connected to: sewer network, septic tank, soak pit, open/closed drain, open land/pond/river, etc.
 - Septic tank with soak pit
 - Septic tank connected to open/closed drain
 - Septic tank connected to open land/pond/river
 - Septic tank connected to sewer network
- ⑩ Number of septic tanks

- ⑪ Septic tanks sharing status
- ⑫ Shape of septic tank (Rectangular/ Circular)
- ⑬ Size of septic tank (Length/ Breadth or Diameter/ Depth)
- ⑭ When septic tank was last emptied
- ⑮ Why emptied the septic tank
- ⑯ Any problem during emptying
- ⑰ Name of desludging service provider
- ⑱ Existence of manhole/access cover
- ⑲ Property location with GPS
- ⑳ Photo of the property with respondent

3) Utilization of SaniTab

- CEPT University allowed the Pilot Project to utilize SaniTab based on the MoU signed between the Director of the University's Research and Development Fund (CRDF) and the Municipal Commissioner of VNN on September 12, 2022 (Annexure 3).
- Although the MoU has already expired, VNN can contact CEPU University whenever wants to utilize SaniTab for similar survey. Contact of CEPT University is as follows:

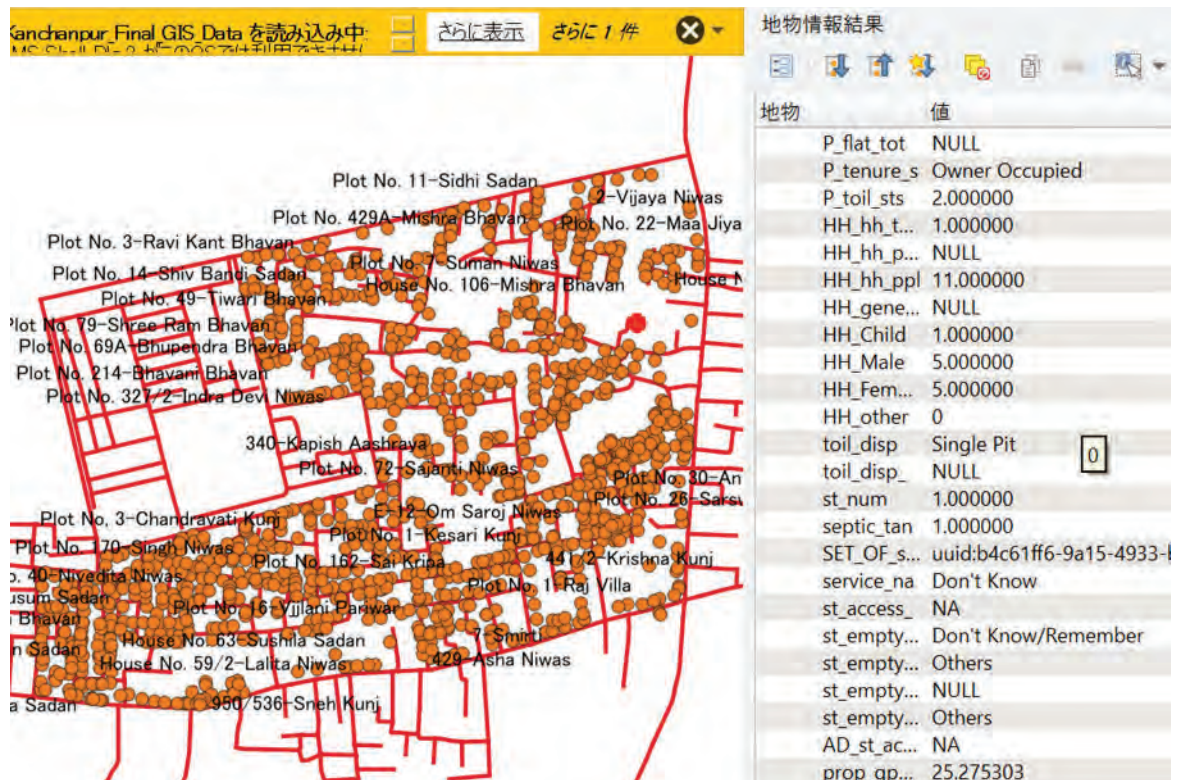
Ms. Aditi Dwivedi
 Senior Research Associate
 Center for Water and Sanitation, CEPT University
 +91 9601938930



- The material provided by experts of CEPT University for training of surveyors on SaniTab is attached as Annexure 4.

(3) Useful output of the Pilot Project – Development of FSSM database

In the Pilot Project, a GIS based database was developed and all data collected through the household sanitation survey conducted in October 2022 utilizing SaniTab were uploaded. A sample data is shown below.



VNN can contact the local advisor of the Project Mr. Ashish Gupta for any instruction on utilization or possible expansion of the database.

Contact: Mr. Ashish Gupta

+91-98107 47491

ashishguptasolar@gmail.com

4. Planning of septage treatment facility

(1) Instruction of the Faecal Sludge and Septage Management Operative

Guidelines of Uttar Pradesh

1) Steps for Planning of septage treatment facility:

- (a) Septage collected from the septic tanks or pits should not be disposed without any treatment.
- (b) ULB should first assess the possibility of septage treatment at existing STP in the city or STP of nearby city through appropriate agreements with STP operators and receiving ULBs.
- (c) If STP is not available in the city or nearby that can receive the sludge, then ULB should plan for new septage treatment facility. Such a new septage treatment facility should be designed to cater to expected volumes of septage generated in urban local body and if faecal waste is expected from nearby urban local bodies.
- (d) Input quality of the collected septage should be tested at the treatment facility for checking presence of any metal or traces of industrial waste.
- (e) The faecal sludge treatment plant should be operational during working hours only and a responsible person should be appointed in the facility to ensure that no commercial or industrial waste is unloaded in these facilities.
- (f) Septage should be reused / safely disposed only after it meets the parameters.

2) Steps for Planning of septage treatment facility:

Following parameters to be taken into consideration before finalization of treatment sites:

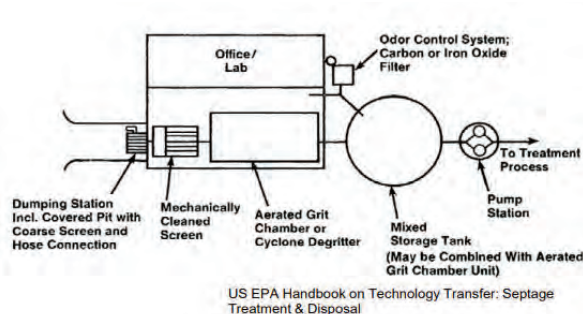
- Distance of treatment site: Distance from emptying to delivering and accessibility of the treatment site are major issues. The transport of relatively small faecal sludge volumes (5-10m³ per truck) on congested roads over long distances in large urban areas is financially unfeasible. A site that is too far away implies fewer trips per day, less revenue and more fuel costs to private operators.
- Reliability of electricity: It is also important to assess the availability and reliability of electricity if treatment technology has mechanical operated parts; as in case of fluctuations it will increase treatment time and will affect optimal utilization of treatment capacity.

- Neighbourhood: A treatment site may generate nuisance, especially bad odours. For this reason it should be located at an appropriate distance from the residential areas.
- Land availability: Projects are often delayed because of non-availability or high price of land. ULB should identify the land bank for treatment facility. ULB should also explore the possibility of developing septage treatment facility at solid waste dumping or treatment site.
- Geological Parameters: Assessment of existing geological conditions on site like groundwater table, type of soil, prone to flooding is always recommended as it may directly affect selection of technology option.

(2) Useful output of the Pilot Project – Possibility of Co-treatment

1) Necessary facilities for Co-treatment

Concerning the septage treatment at existing STP (or Co-treatment of septage with sewage), collected septage **must not be discharged** into STP or sewer line without pre-treatment. A **septage receiving station** where grits and other objects are removed and septage is equalized, as shown below, should be provided.



Components of Septage receiving station

- Dumping stations
- Screens
- Grit removal
- Equalization tank
- Odor control unit

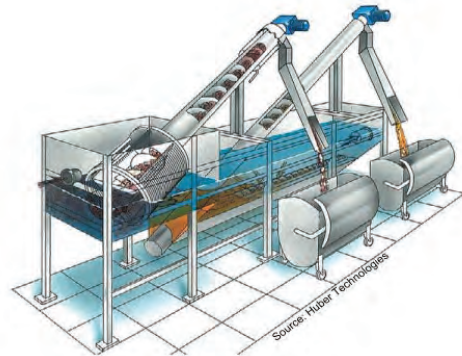
Objective

To pretreat the septage and safely transfer it to the STP or the sewer network

Source: FSSM Orientation Module by National Institute of Urban Affairs

Mechanized receiving stations

- Mechanical septage receiving stations provide screening, grit removal
- Washes and compresses the screenings for easy transfer or disposal
- Washes the grit and makes it safe further handling or disposal
- Compact and easy to install
- Smaller foot print



Source: FSSM Orientation Module by National Institute of Urban Affairs

2) Possibly of installing co-treatment facilities in STPs in Varanasi

In the course of the Pilot Project, discussions on the subject were made with UPJN. Main points are as follows:

- Dinapur STP: no availability of land to accommodate the co-treatment facility due to expansion of the plant to meet the NGT standards.
- Goithaha STP: no availability of land to accommodate the co-treatment facility due to planned installation of solar panels.
- Ramna STP: 50KLD co-treatment facility has already been constructed and expected to be operational in May 2024.

(3) Useful output of the Pilot Project – Possibility of establishing FSTPs

In the Pilot Project, a 30KLD Packaged Sewage Treatment Unit (PSTU or Johkasou) was installed in Kanchanpur. It aims to treat domestic wastewater generated in a surrounding community but also receive and co-treat 4KLD septage as shown in the photos below.





30KLD PSTU and septage receiving facility

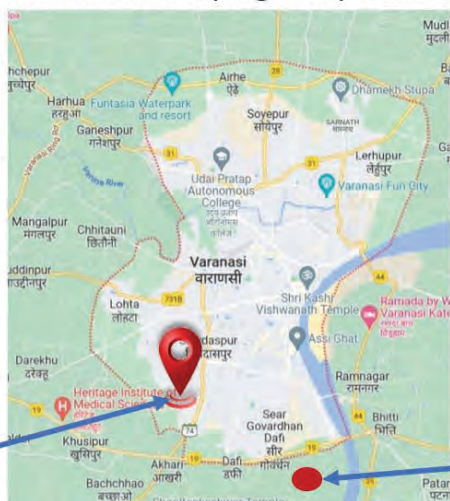
Although this is the second facility that can receive septage in the south of the City after the co-treatment facility at Ramna STP, no facilities can be found in central and north part of the City. For desludging operators to discharge collected septage appropriately at nearby facilities, construction of FSTPs in these areas of Varanasi is recommended.

◆ Safe treatment facilities of collected septage for private desludging operators are still lacking

The first septage decanting facility for three desludging operators registered in Jalkal



30KLD PSTU in Kanchanpur (Septage: 2KLD)



50KLD Co-treatment plant at Ramna STP

(4) Useful output of the Pilot Project – Technology Book on Decentralized Wastewater Treatment

In parallel with these Guidelines, the CIESV Project produced the Technology Book on Decentralized Wastewater Treatment, in which key technologies utilized for FSTP are presented. It can provide a good reference when VNN plans construction of FSTPs.

5. Awareness generation and capacity building activities

(1) Instruction of the Faecal Sludge and Septage Management Operative

Guidelines of Uttar Pradesh

Awareness generation activities need to be taken up for successful implementation of faecal sludge management plan and community acceptance and adherence to regulations and service plan set up by the ULBs. Associated training and capacity building of municipal staff as well as private sector contractors also needs to be taken up.

- (a) Awareness generation for residents: Members of Resident Welfare Associations, community organizers, self-help groups and the general public should be made sensitized periodically regarding the need for a sound faecal sludge management system including a 3-year cycle. The health hazards associated with improper collection and treatment of waste, and the ill-effects of sewage discharge into fresh water/storm water drains should be explained to the residents.
- (b) Capacity building for municipal staff: Municipal Commissioners/ Chief Officers, Engineers, Sanitary Inspectors, Health Officers, and Sanitary Workers should be well trained in safe septage management and its best practices. This involves regular training sessions on safe collection, treatment and disposal. Information regarding standard septic tank design, the need for periodic inspection and de-sledging of septage, design of a treatment facility, tender details for engaging licensed transporters, etc. should be disseminated widely to achieve a safe faecal sludge management system. Training should also be provided on safety standards.
- (c) Capacity building for septage transporters / private vendors: Local Bodies should ensure all safety norms are clearly explained to the septage transporters. Private Operators and Transporters should be well trained in safe collection and transportation of sewage including vehicle design, process of de-sledging, safety gears and safe disposal at the nearest treatment facility.

(2) Useful output of the Pilot Project – Leaflet for awareness raising

In the Pilot Project, a leaflet for awareness raising on periodical desludging of septic tanks was developed in collaboration with Solid Waste Management sector and distributed to all householders in Kanchanpur. The leaflet is attached in Annexure 5.

(3) Useful output of the Pilot Project – Material for safe and hygienic desludging operation.

In the Pilot Project, a material for safe and hygienic desludging operation “How to safely empty a septic tank” was prepared and distributed to private desludging operators for training of their workers. The material is attached in Annexure 6.

Annexes

- Annex 1: Conventional septic tank design as per CPHEEO**
- Annex 2: Citywide inclusive services for Faecal Sludge and Septage Management in Maharashtra**
- Annex 3: MoU between VNN and CRDF, CEPT University**
- Annex 4: “SaniTab” Training for surveyors in Kanchanpur village**
- Annex 5: Leaflet for awareness raising on periodical desludging of septic tanks**
- Annex 6: How to safely empty a septic tank**

Annex I

Annexure 1. Conventional septic tank design as per CPHEEO, 2013⁵

Recommended size of septic tank up to 300 users (Source CPHEEO, 1993)

No. of Users	Length(M)	Breadth(M)	Liquid Depth (Cleaning interval of)	
			2 Years	3 Years
Recommended size of septic tank up to 20 users				
5	1.50	0.75	1.00	1.05
10	2.00	0.90	1.00	1.40
15	2.00	0.90	1.30	2.00
20	2.30	1.10	1.30	1.80
Recommended size of septic tank for housing colony up to 300 users				
50	5.00	2.00	1.00	1.2
100	7.50	2.65	1.00	1.2
150	10.00	3.00	1.00	1.2
No. of Users	Length(M)	Breadth(M)	Liquid Depth (Cleaning interval of)	
			2 Years	3 Years
200	12.00	3.30	1.00	1.24
300	15.00	4.00	1.00	1.24

Note 1: The capacities are recommended on the assumption that discharge from only WC will be treated in the septic tank

Note 2: A provision of 300 mm should be made for free board.

Note 3: For population over 100, the tank may be divided into independent parallel chambers of maintenance and cleaning.

Note 4: The sizes of septic tank are based on certain assumption on peak discharges, as estimated in IS: 2470 (part 1) and while choosing the size of septic tank exact calculations shall be made

⁵ Source: Central Public Health and Environmental Engineering Organization (CPHEEO) and Japan International Cooperation Agency. (2013). Manual on Sewerage and Sewage Treatment Systems, Part A – Engineering, Chapter 9 – Onsite Sanitation, Page no: 9-15 to 9-21.

(Source: CPHEEO, 1993)



Annex 2

Citywide inclusive services for Faecal Sludge and Septage Management in Maharashtra

Presentation at JalKal Varanasi

Center for Water and Sanitation, CRDF, CEPT University

CWAS

CRDF

CEPT
UNIVERSITY

Center for Water and Sanitation

CEPT
UNIVERSITY

CEPT University's core focus is human habitat. Through its education, research and advisory activities, it strives to improve the impact of habitat professions in enriching the lives of people in India's villages, towns and cities

CRDF

CEPT Research and Development Foundation (CRDF) was established by the University to manage their research and capacity building activities. There are nine domain-focused centers in the CRDF.

CWAS

CWAS carries out activities related to action research and capacity building – working closely with city and state governments, enabling them to improve delivery of services.

“Transforming governance and monitoring systems for safe and equitable water and sanitation services at scale”

Academics | Action-Research |
Capacity Building | Government support

CWAS

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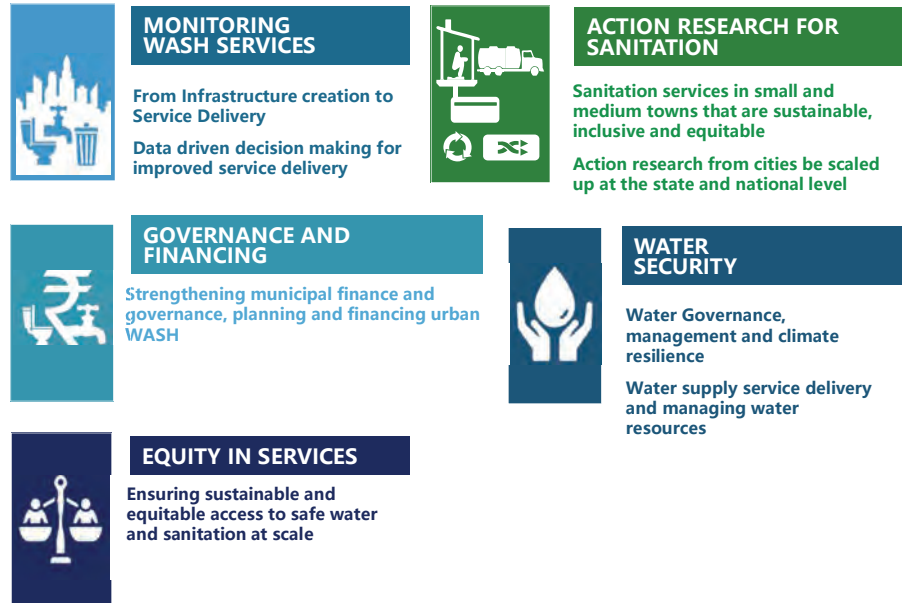


CWAS – Approach and areas of work

Core values



Thematic areas of work



3

CWAS focus on sanitation



Performance Assessment for Urban Water and Sanitation-PAS - Focus on onsite sanitation indicators and equity



Bringing sustainable and equitable sanitation services to small and medium towns -Wai and Sinnar



Citywide Inclusive Sanitation – Wai



Making Sinnar ODF+ and ensuring sustainability



Support to Kolhapur and Satara for FSSM



Support to Lukanga Water and Sanitation Company for Scheduled desludging pilot in Kabwe, Zambia



Capacity Building of Cities as part of the Sanitation Capacity Building Platform



Technical support to the State Government of Maharashtra on urban sanitation and FSSM

4

**1 truck of Faecal Sludge and Septage
carelessly dumped
= 5,000 people shitting in the open!**

Are we really ODF?



Source: Chary, Srinivas, (2017). *Water and Sanitation: Operationalising FSSM Regulations & Case study of Warangal City* at Ujjain Workshop by Water Aid, ASCI (mimeo)

FSSM has become a major focus area in India

- The Prohibition of Employment as Manual Scavengers and their Rehabilitation Act, 2013 - 'sanitary' toilets, protective gear and mechanized emptying
- Advisory note on Septage Management in Urban India – 2013
- AMRUT Mission with funding for cities on septage management – 2014
- National Policy on Faecal Sludge and Septage Management- 2017
- Swachh Sarvekshan - Weightage for onsite system status, collection of the septage by ULB, preparing FSSM plan, IEC activities – 2018
- SBM ODF+ and ODF++ Framework - FSSM focus with conveyance and treatment
- AMRUT 2.0 and SBM 2.0 – Focus on reuse of treated water

Ideas demonstrated by CWAS in these cities have become models for FSSM

Wai, Sinnar, Kolhapur, Satara, Khopoli



Comprehensive City Sanitation planning



Pioneer cities in India to implement citywide scheduled emptying of septic tanks



City Wide Inclusive Sanitation



Scheduled emptying of septic tanks



Involving Private sector for emptying operations



Levying a Sanitation tax to support operations



Faecal Sludge and Septage treatment facility (FSTP)



Use of Own (DBO) / Philanthropy funds for FSTPs



Reuse of treated wastewater



Online monitoring systems for emptying and treatment



Municipal council commitment and leadership



Gender inclusivity in sanitation



Involvement of SHGs



San Workers training



Equitable Services for Slums and Vulnerable areas



CWAS

CENTER FOR WATER AND SANITATION

CRDF

CEPT UNIVERSITY

Wai and Sinnar Cities

Wai

- Known for its **Ghats** on the **banks of River Krishna** and around **250 temples**.
- Holy river
- Also known as site for Bollywood shoots



Sinnar

- Flourishing industrial districts
- Fast growing town



CWAS

CENTER FOR WATER AND SANITATION

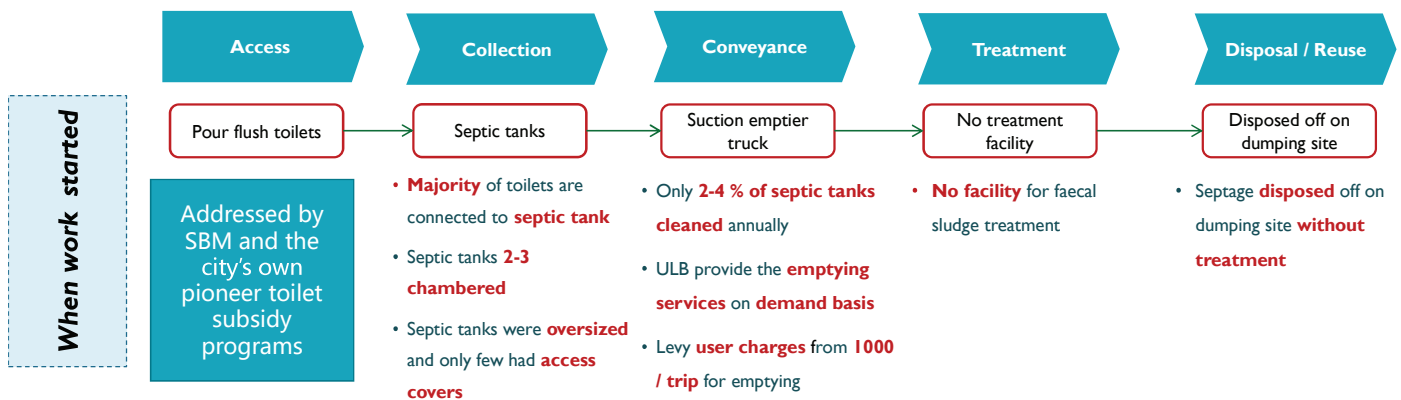
CRDF

COMMUNITY RESPONSE DEVELOPMENT FOUNDATION

CEPT

INDIA IS TV

Sanitation Situation – in 2013 when we began work



Wai and Sinnar resolved to implement FSSM plan in the city through a council resolution



The resolution covers aspects like:

- ❑ Citywide FSSM
- ❑ Involving Private sector
- ❑ Scheduled cleaning
- ❑ Land for treatment facility
- ❑ Taxes to be levied

One of the 1st Cities in INDIA to have passed such a resolution . . .

Current practice of desludging in Indian cities is of complaint redressal and NOT a public service the way sewerage and SWM are!

Low frequency of desludging

On-demand desludging
= only done when septic tanks overflow
= frequency of 8-10 years+

CPHEEO norm is 2-3 years

Environmental impacts of poor quality effluent

Low desludging frequency
= poor efficiency of septic tank
= poor quality of supernatant / effluent
overflow being released in rivers

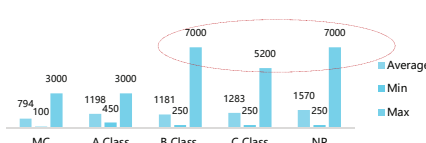
Increased chances of Manual Scavenging

Low desludging frequency
= sludge hardens in the tank
= requirement of manual labour to remove it

High cost per desludging

Emptiers need to achieve economies of scale.
Cannot optimize trips or have assured amount of business in on-demand service

Small towns paying still higher prices



High desludging charges discouraging HHs from actually using their toilets

Adversely affecting ODF sustainability

Introduced scheduled desludging

- ✓ Moving from compliant redressal to a services model
- ✓ All septic tanks in the city emptied once every 3 years – mandatory desludging
- ✓ Route planning and predetermined scheduled. 3 zones – 1 each year
- ✓ Licenced service provider can achieve economies of scale. Assured business and clustering bring down cost per tank
- ✓ Service mandatory but not linked to “user charges” – service to ALL – equitable and inclusive
- ✓ Especially service vulnerable areas – long pipes, no user charges
- ✓ Sustainably financed through “sanitation tax”
- ✓ Monitored and ensures safe conveyance to treatment site



Plan for Scheduled desludging in WAI

1. Zones of Emptying cycle

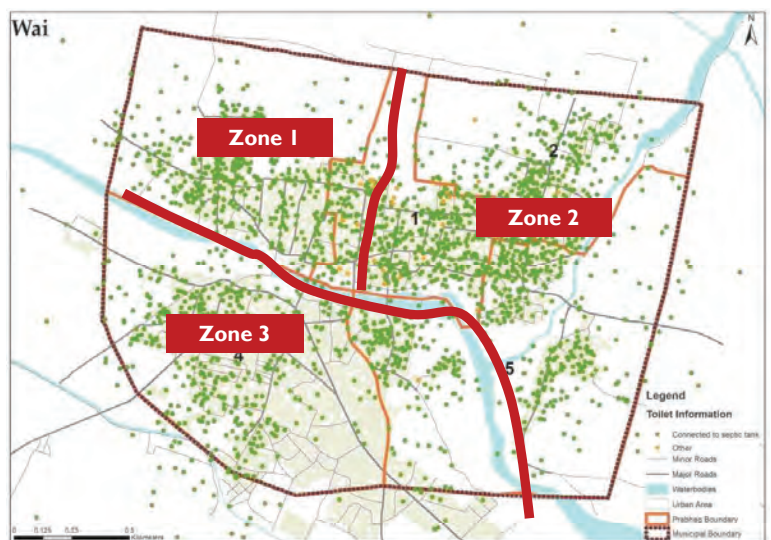
- The city was divided into 3 zones as per the citywide database on toilets and septic tanks.

2. Emptying Truck: Number and capacity

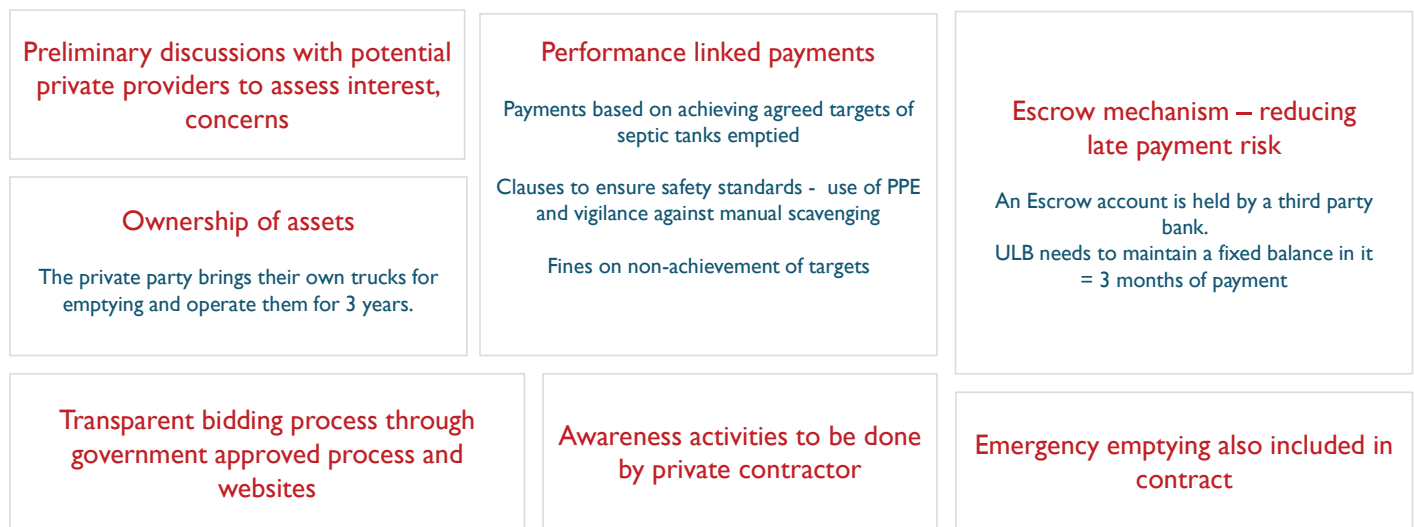
- Number and capacity of vehicles required for desludging operations.

3. Route planning

- Deciding the truck movement within the zone

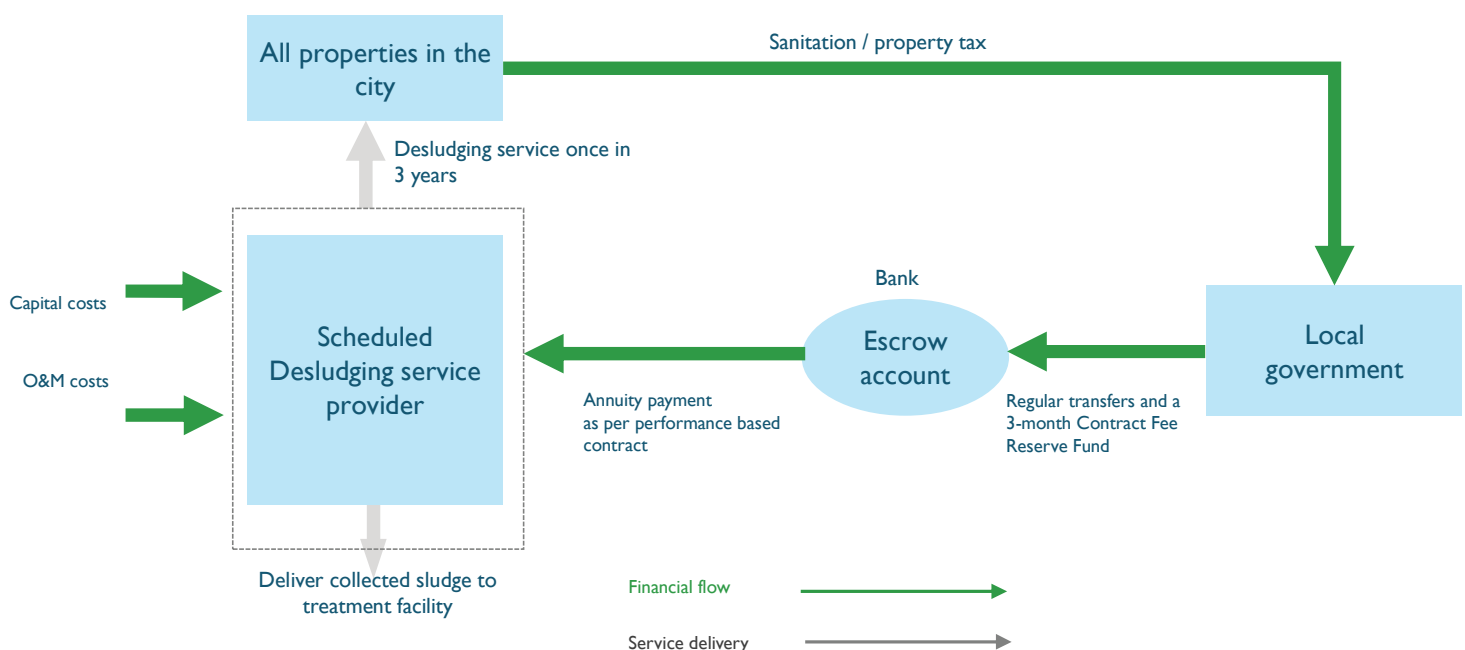


Councils decided to involve private enterprise for providing service



15

Financing model : Performance Linked Annuity Model (PLAM) for scheduled desludging



16

FSTPs set up to treat the septage

Wai



Funded through grant

Sinnar



Funded by city's own funds
Private enterprise contracted to Build-Operate-Transfer

Performance linked Monitoring Mechanism

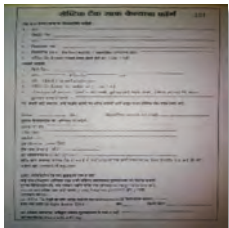
Daily report on septic tanks emptied by private emptier to council



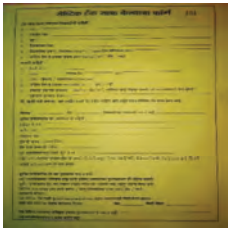
Govt's copy



Property holder's copy



Treatment plant's copy



Private enterprise copy

Collection and transport record form

Serial No: _____

i. Details of Waste Generator

a) Name : _____

b) Phone Number: _____

c) Address : _____

d) Property Tax Number : _____

e) Type of building : Individual house / Apartment / Commercial complex / Other (specify) _____

f) Was the Septic tank cover open (Yes / No) _____

ii. Identification of Waste:

a) Volume : _____ liters

b) Type : _____ Septic Tank _____ Others _____

c) Source : Residential/Commercial/Restaurant/Others _____

d) Septic tank cover placed back on Septic tank : Yes / No _____

e) Septic tank emptied : Yes / No _____

f) Any kind of deficiencies, missing pipes or fittings, improper manholes or access covers, any other cracks or damage observed : _____

The undersigned being duly authorized does hereby certify to the accuracy of the source and type of Fecal Sludge and septage collected and transported.

Date: _____ Time: _____ Name and Signature – Property owner: _____

iii) Details of Sumect Facilities Operator

a) Name of Driver : _____

b) Permit : _____

c) Vehicle License no : _____

d) Truck Capacity : _____

e) Pump Out Date : _____

f) No. of trips taken to empty the septic tank: _____

The above described wastewater was picked up and hauled by me to the disposal facility named below and was discharged. I certify that the foregoing is true and correct:

Name and Signature of authorized transport agent and title: _____

iv) Acceptance by Wai Municipality's authorized FSTP

The above transporter delivered the described Fecal sludge and Septage to this treatment facility and it was accepted.

The waste was contaminated with solid waste or other kinds of waste: YES / No _____

Details (if yes): _____

No of trips received at the FSTP for this form: _____

Septage received at treatment plant: Date: _____ Time : _____ Volume : _____ liters

Name and Signature of authorized treatment plant operator signatory and title: _____

NOTE: SUBJECT TO THE TERMS AND CONDITIONS OF WAI MUNICIPALITY

IT enabled monitoring systems for FSSM . . .

“Real time” monitoring
No need to process data for results

Easy to Operate,
Reduce paper work,
Minimize human error

Monitors performance of FSSM services

Photo stamping,
Geo stamping,
Signatures

Unique database

SaniTab

SaniTrack

SanQ

Monitoring Scheduled Desludging in Wai

Logged in User: CPMF

CONSOLIDATED PROGRESS REPORT

3835 Sapling Plants (According to the Desludging)	2165 Desludged	1974 Unlabeled	191 Pending
2318 Sapling (Yield)	184 Properties Reduced	4487 Properties Covered	6552 KL Volume Desludged

Spatial View

Property Details

- 1. Nature of service
- 2. Type of properties visited
- 3. Volume of waste covered

Desludging Details

- 1. Last time ST was emptied
- 2. Covered covers for service
- 3. Problems faced during emptying
- 4. Volume of waste left to be emptied

Performance Metrics

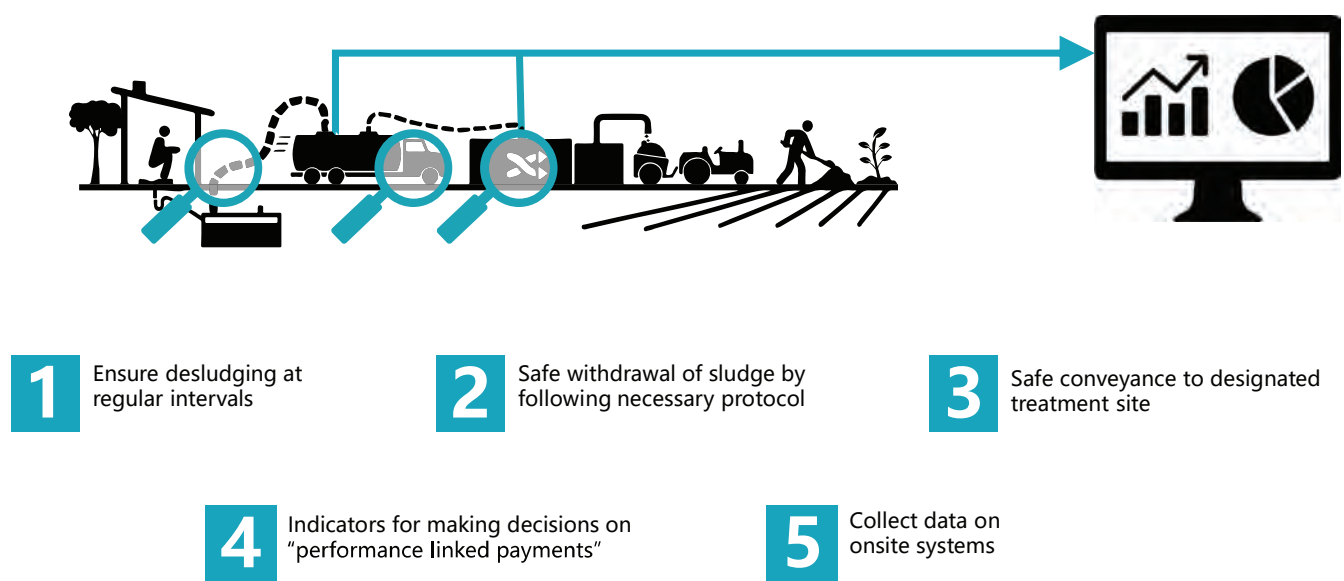
- 1. PPS usage
- 2. Time and mileage etc.

CWAS CENTER FOR WATER AND SANITATION

CRDF COMMUNITY RESOURCE DEVELOPMENT FOUNDATION

CEPT COMMUNITY ENGAGEMENT PLATFORM TECHNOLOGY

FSSM Monitoring using these tools

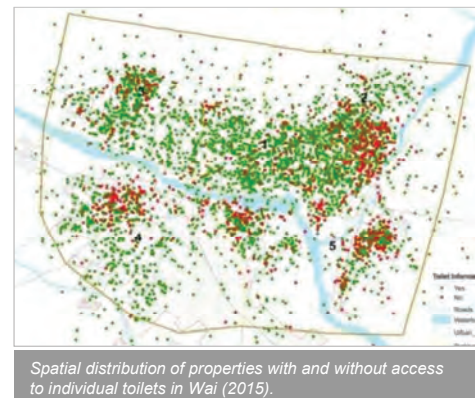


In 2015: > 10,000 properties surveyed in Wai for sanitation baseline assessment with SaniTab

✓ Citywide survey on :

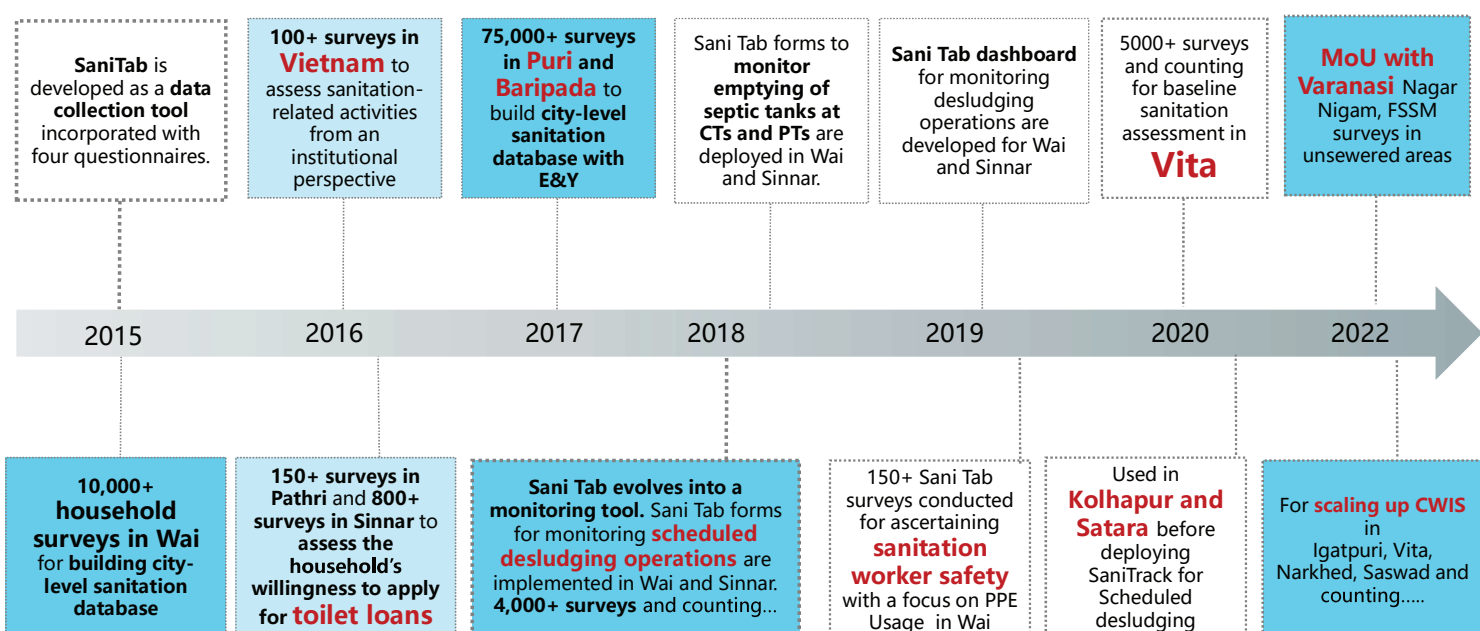
- Toilet availability
- Type of disposal system
- Size and shape of septic tank
- Location of septic tanks
- Accessibility of septic tanks
- Last time septic tank was emptied

✓ Online dashboard for analysis of data



21

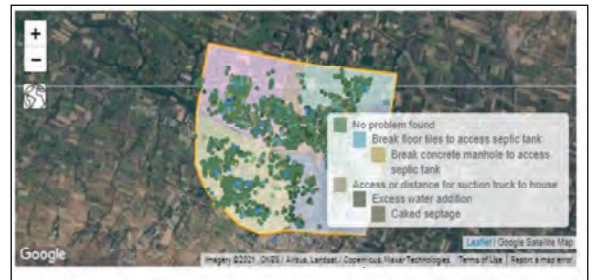
Since then - Use of SaniTab for 1 Lakh+ surveys



22

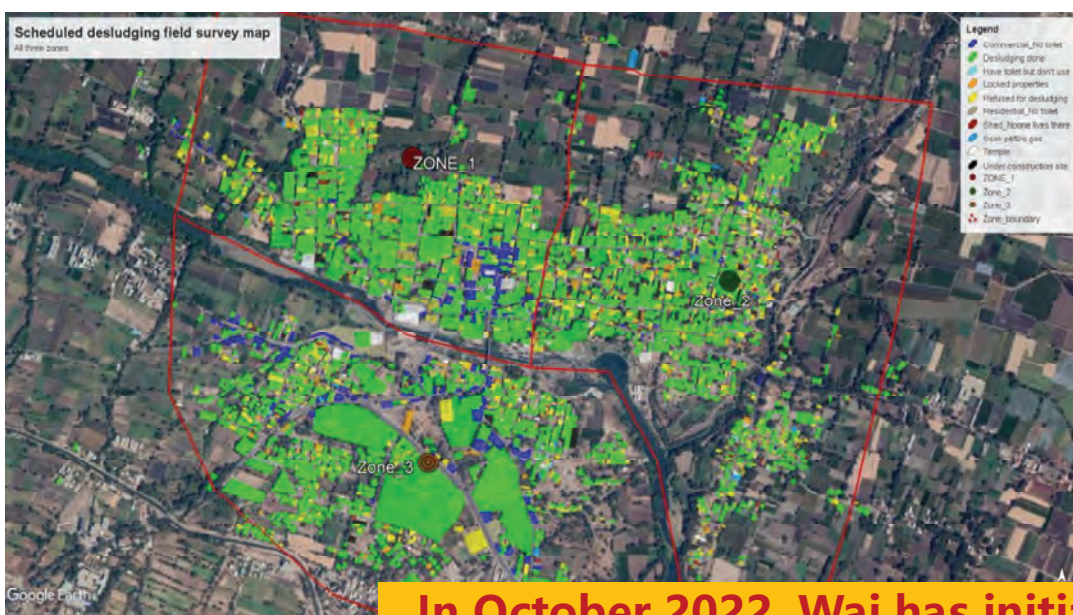
Form for monitoring desludging services + developing a database of onsite systems in Wai

- Customizable app - not only as a data collection tool but also as a **monitoring system**
- **Desludging monitoring form** created for monitoring the performance of the desludging services being provided by the private sector service provider and the ULB truck
- **Dashboard** developed for easy monitoring of the desludging operations.
- Creating a **unique database of onsite systems** – Added questions about septic tanks and CWIS perspective
- If all tanks are to be visited in 3 years – use this opportunity to create a database!



23

In January 2022, Wai successfully completed its first 3-year cycle of scheduled desludging



3600+
Septic tanks served

6800+
Properties covered

95%
Acceptance rate of services

19 million
Liters of septage treated

In October 2022, Wai has initiated second cycle after another tendering process

Awareness generation a key feature for success of high uptake of FSSM services . . .

Paintings / banners in the city by WMC



Household visits by desludger with info. leaflets



Cities circulated small videos



Intimation through SMS

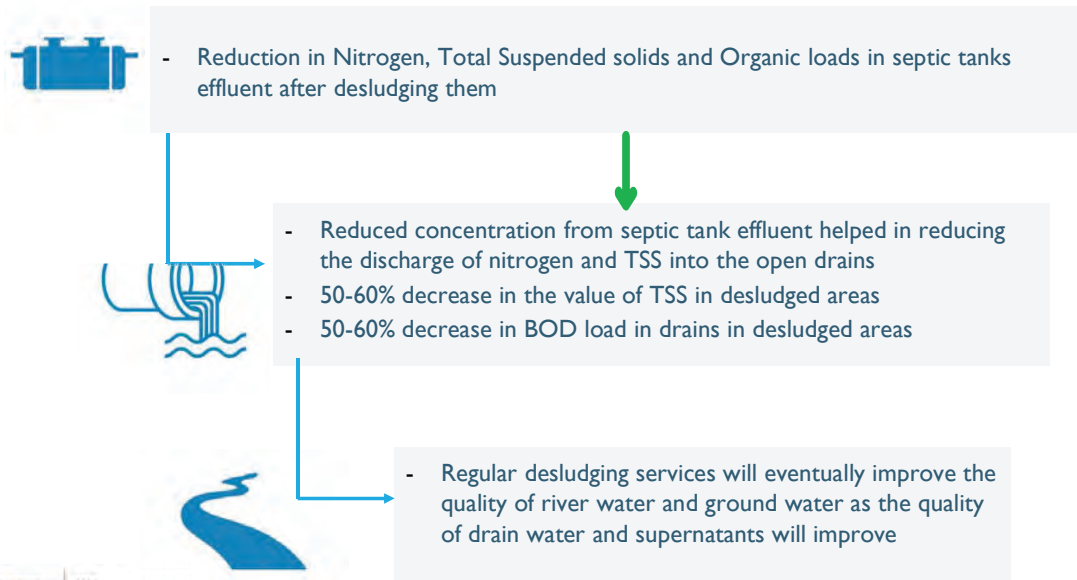


Some glimpses of scheduled desludging



Improvement in groundwater and river water quality due to scheduled desludging

Improved performance of septic tanks after desludging resulting in improved drain water quality flowing into river



Summary - Key factors for successful implementation of Scheduled Desludging . . .



Providing scheduled desludging service as a Municipal Service

- Like provision of SWM door to door collection service
- Promote supply driven approach and not demand driven.
- The onus of desludging the septic tank must not be on the HHs



Higher degree of desludging acceptance rate linked to indirect cost recovery

- Avoid/ user chargers based model (Based on international experiences)
- Should promote indirect cost recovery mechanism such as sanitation tax or sewerage tax as percentage of property tax.



Proper monitoring and IEC campaigns

- Involving various stakeholders for Awareness generations i.e. Citizens, NGOs, ULB officials, SHGs, etc.
- Paper based or IT based monitoring systems

Sinnar FSTP – Water reuse, Urban Forest and Resource center



- 70 kilo litres daily capacity
- USAB - Up flow-Anaerobic Sludge Blanket Reactor
- ABR - Anaerobic Baffled Reactor
- SDB - Sludge Drying Beds
- Carbon filters



- Resource centre for visitors
- Fully self sufficient with solar energy
- FSTP built with city's own funds



- Landscaping and urban forest
- Oasis in the midst of barren land!



- Urban forest - 8000 square metres
- FSTP end products reused here – dried sludge and treated water
- Diverse species of plants for strong ecosystem
- Thriving and attracting bird species



- Women's Self Help Group engaged by Municipality for maintenance



- Online monitoring system for treatment quality parameters

Empowering women for inclusive FSSM service delivery . . .

- **Building capacities of Elected Women Representatives (EVRs)** for effective functioning and participation in local governance focusing on FSSM.
- **Celebrating Women Sanitation champions** in the city and acknowledging their participation
- **Sensitizing women** at household level regarding the process of desludging



Sanitation workers safety

- Registers for PPE usage and replacement
- SaniTab / SaniTrack dashboard monitors the PPE usage of desludgers on daily basis.
- PPE flyer has been prepared for various sanitation activities and shared with stakeholders
- Training workshop along with a health camp was organized for all Sanitation workers. Also PPEs were distributed during this event.
- Council has introduced clauses related to provision, usage and monitoring of PPEs in all their upcoming contracts for Sanitation based on experience of this scheduled desludging contract



Partnerships and Collaborations

BILL & MELINDA GATES foundation



HSBC



CWAS CENTER FOR WATER AND SANITATION

CRDF CEPT RESEARCH AND DEVELOPMENT FOUNDATION

CEPT UNIVERSITY

NFSSM Alliance

Recognition

Asian Venture Philanthropy Network, Singapore, AVPN Constellations Award in "Climate Action" for work in Wai and Sinnar (2022).



Award at 9th Edition of FICCI Water Award in "Urban Wastewater Management" category for work in Sinnar (2021)



Award from CSR box and Dalmia foundation at 7th CSR Impact Awards 2021 under 'WASH' category for work in Sinnar under HSBC CSR grant (2021)

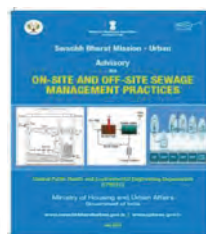


Wai and Sinnar featured in Niti Aayog documentation on FSSM



Scaling up . . . Not just one-off pilots!

Successfully demonstrating in Kolhapur and Satara cities. Exploring in more...



Scaling up lessons across Maharashtra through policies, guidelines and implementation support

Influenced National Policies and guidelines

Tools for training ULBs across India

Model Tenders and SoPs for FSSM used by ULBs

Maharashtra has taken up FSSM in a big way . . .

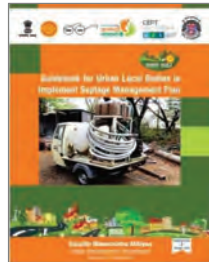
Increased focus on moving cities towards ODF+ /++ (FSSM) after declaring Urban Maharashtra ODF on 2nd Oct. 2017

Government Resolutions

Septage Management Guidelines



Step by Step Guide for ODF+

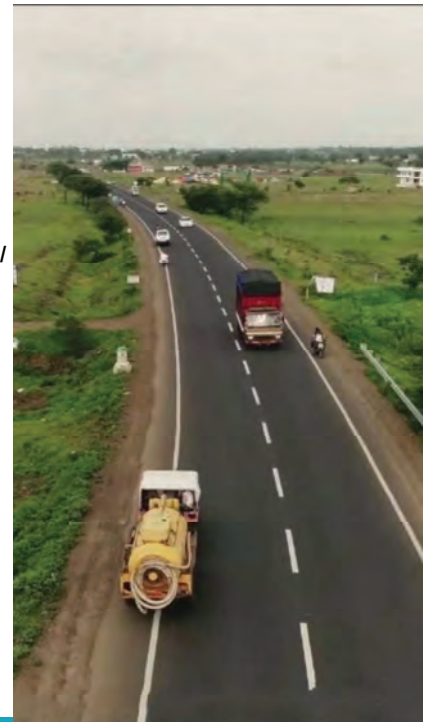


ODF, ODF+ and ODF++ framework

Utilizing Incentive grants and 14th FC funds for sanitation/ ODF+ /++ activities

70+ cities Co-treating of FS at own or nearby STP

311 independent FSTPs Construction



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CRDF

CEPT

Support to Government of Maharashtra for FSSM

Scaling up FSSM and urban sanitation under Swachh Maharashtra Mission



Policy, guidelines and strategic support for implementation



FSSM strategy and scale up plan for safe sanitation



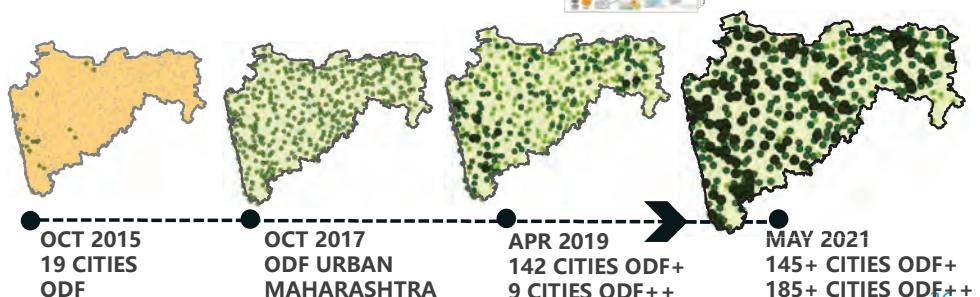
Technical support in day to day operations



Strengthening local government capacity for ODF, ODF+ and ODF++



State become ODF on 1st Oct 2017 and now aspires to become ODF+ /++ with 311 FSTPs under implementation



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A two-pronged approach for scaling up FSSM strategy

Co-treatment at own/near by STP Cities - 70

Independent FSTP Cities - 311

**Category A cities:
ULBs with STPs**

**Category B cities:
Co-treatment at nearby
STPs**

**Category C cities:
Independent FSTPs**

**Co-treatment at own STP and
accept FS from nearby cities**

**Co-treatment at nearby STPs
within 20 km**

**Remaining ULBs will treat septage
at FSTPs**

**Functional/proposed/und
er construction STPs**

Co-treat at nearby STPs

Independent FSTP

35 cities

35 cities

311 cities

CWAS CENTER FOR WATER AND SANITATION

CRDF CENTRAL RURAL DEVELOPMENT FUND

CEPT CENTRE FOR ENVIRONMENTAL PLANNING AND TECHNOLOGY

**70 ULBs practicing co-treatment
and have achieved ODF++**

**210 independent FSTPs are
functional**

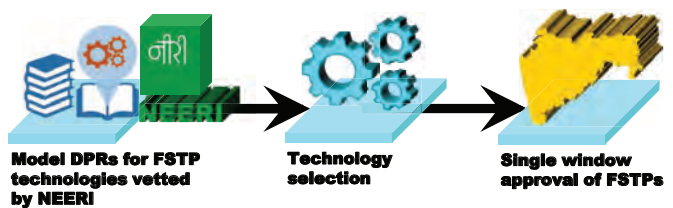
**Government
resolution on co-
treatment of
Septage – Own
STP and Cities
within 20 km of a
nearby STP city**



**Institutionalize FS
co-treatment
through MoU
between sending
and receiving
cities**



**Designated FS
discharge point
(at wet well at
pumping
station/STPs or
maintenance hole)**



**Adoption of cost effective and less
mechanized technology for setting up
faecal sludge treatment facilities**



CWAS CENTER FOR WATER AND SANITATION

CRDF CENTRAL RURAL DEVELOPMENT FUND

Thank you

CWAS CENTER
FOR WATER
AND SANITATION

CRDF CEPT RESEARCH
AND DEVELOPMENT
FOUNDATION

**CEPT
UNIVERSITY**

About us

The Center for Water and Sanitation (CWAS) at CEPT University carries out various activities – action research, training, advocacy to enable state and local governments to improve delivery of services.



cwas.org.in
pas.org.in



cwas@cept.ac.in
tiny.cc/paseneews



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[cwas.cept](https://www.linkedin.com/company/cwas.cept)

Annex 3

Annex D. 1. 7

MEMORANDUM OF UNDERSTANDING

between

Varanasi Nagar Nigam

and

**CEPT Research & Development Foundation (CRDF),
CEPT University**

1 PREAMBLE

CEPT Research and Development Foundation (CRDF)

CEPT Research and Development Foundation (hereinafter referred to as "CRDF") is the research and advisory arm of CEPT University. CEPT University has created a vibrant environment of interdisciplinary collaboration and innovation focused on issues concerning human habitats. Through CRDF, University engages actively in research projects, advisory assignments and capacity building initiatives aimed at solving critical problems in the built environment and improving people's quality of life in towns and cities.

CRDF was established as a Not for Profit company under Section 25 Company under the Indian Companies Act, 1956 with Registered Office located at CEPT University, Kasturbhai Lalbhai Campus, University Road, Navrangpura, Ahmedabad. CRDF operates with an independent board appointed by CEPT University and is organised around thematic centres which specialise around a specific area of expertise. CRDF's mission is to educate, to build thoughtful and competent professionals and undertake research to clarify and deepen our understanding of how we design, plan, build and manage habitats, so that we may improve upon present practices.

The Center for Water and Sanitation (CWAS) is a part of CRDF. CWAS undertakes action-research, implementation support, capacity building and advocacy in the field of urban water and sanitation. Acting as a thought catalyst and facilitator, CWAS works closely with all levels of governments - national, state and local to support them in delivering water and sanitation services in an efficient, effective and equitable manner.

Varanasi Nagar Nigam

Varanasi Nagar Nigam (Municipal Corporation) (hereinafter referred to as "VNN") is the governing body of the city of Varanasi in the Indian state of Uttar Pradesh. The municipal corporation administers the city's infrastructure and public services. Varanasi Municipal Corporation was established on January 24, 1959 as a Nagar Mahapalika under Municipal Corporation Act of the 1959 and in 1994 it was upgraded to Nagar Nigam. With 90 wards and a total area of 82 km² the city has a dense population and witnesses huge inflow of pilgrims and tourists. The Varanasi Municipal Corporation is responsible for the planning, development and upkeep of the city and delivery of civic services to its citizens.



VNN's mission is to make Varanasi a dynamic, vibrant, beautiful, self-reliant and sustainable city with all basic amenities and to provide a better quality of life to its citizens.

CRDF and Varanasi Nagar Nigam are individually referred to as a Party and collectively as Parties.

2 BACKGROUND

Varanasi Nagar Nigam (VNN) is conducting a technical cooperation project, "Comprehensive Improvement of Environmental Sanitation in Varanasi" with the support of the Japan International Cooperation Agency (JICA). Under the project, VNN together with JICA is piloting Faecal Sludge and Septage Management (FSSM) in one of the 84 unsewered villages (namely Kanchanpur) that were newly added to the VNN boundary in 2020. The FSSM activity includes development of an on-site sanitation facilities database, awareness raising of population on periodical desludging of septic tank and training of private desludging operators for provision of improved services, with intention of establishing scheduled desludging in future.

Since CWAS at CRDF-CEPT University has successfully assisted some cities in Maharashtra in introducing scheduled desludging, the JICA expert team (JET) has recommended technical support from CWAS for improving FSSM in Varanasi.

3 NATURE OF COLLABORATION

Both the Parties through this Memorandum of Understanding ("MoU") agree to the following general forms of collaboration and shared interests;

- CWAS team will support VNN for utilization of the SaniTab application in conducting a household sanitation survey in the project area.
- CWAS team will support VNN for developing and deploying a custom survey form on the SaniTab application in consultation with JICA expert team (JET).
- CWAS team will provide technical training for the use of the SaniTab application and the survey questionnaire to VNN and its surveyors. On-field survey will be conducted by VNN.
- On completion of the field survey by VNN, CWAS will provide the extracted database in excel format.
- CWAS team will provide technical advice on awareness raising of population on periodical desludging of septic tank and training of private desludging operators for provision of improved services.



- This support and advice will be provided by CWAS at no cost to VNN.

4 RIGHTS AND OBLIGATIONS OF PARTIES

- 4.1 The Parties will cooperate and support each other in the achievement of their common areas of collaboration and shared interests in the spirit of good partnership. To maintain this spirit, the Parties will promote and disseminate information on each other's activities.
- 4.2 The results of collaborative activities of the Parties will be made open to the public by default unless both Parties agree on and document necessary access restrictions.
- 4.3 The Parties will endeavour to communicate readily and promptly with each other over areas of mutual interest and possible future areas of collaboration.
- 4.4 Where appropriate and beneficial, and to the extent allowed by the organisations' respective due processes, the Parties may establish and support Joint Interest/Working/Task Groups in areas of shared activity.

5 ADMINISTRATIVE PROVISIONS

5.1 TERM

This MoU shall become effective on the date of signing and shall remain in force for one year from the date of signing, unless terminated earlier by either Parties in keeping with the Terms of the MoU. This MoU can be extended up to a period of 12 months based on the mutual agreement of the Parties.

5.2 TERMINATION

Either Party may terminate this MoU with a 30-day written notice to the other Party. Such termination will not affect the commitments already undertaken under this MoU or any other previous contracts. The termination of this MoU, however effectuated, will not affect the parties' rights, duties, and obligations pursuant to confidentiality and intellectual property.

5.3 MODIFICATION

If any exchanges in the above clauses or a modification are intended, then it can be carried out by written mutual consent of both the Parties.

6 NO FINANCIAL OBLIGATIONS



- 6.1 This MoU creates no binding obligation to set apart or commit any financial or other resources or to comply with or respond to any offer or proposal except as may be agreed to in this MoU by the Parties in writing within the scope of this MoU or separately.
- 6.2 No transfer of funds between the Parties is envisaged in connection with this Memorandum of Understanding.
- 6.3 Participation at the events organized by a Party shall be self-financed by the other Party unless otherwise agreed in writing. It is intended that all activities should not be designed for profit for either Party. Each Party is responsible for covering its own costs including staff costs, any overheads, travel and other out of pocket expenses.

7 INTELLECTUAL PROPERTY RIGHTS

- 7.1 The Parties shall consult with each other regarding the Intellectual Property Rights as appropriate relating to any project or benefits derived thereof in respect of activities carried out under a separate legal instrument pursuant to this Memorandum. Any new intellectual property will be managed in a manner consistent with the Parties' policies on intellectual property. Data, code, publications, and analogous output will be accessible by default, according to the principle 'as open as possible, and only as closed as necessary'.
- 7.2 Each Party owns and shall retain all rights, title, and interest in their respective background intellectual property (BIP) that has been made available to each other for the purpose of the execution of the research work. BIP shall mean any know-how or intellectual property which is owned by a Party before entering into this MoU and any know-how and intellectual property which is developed by a Party outside the scope of the MoU (e.g., in cooperation with another partner).
- 7.3 All title, rights, and interests in and relating to any research results, i.e., know-how and intellectual property whether patentable or not, obtained under the cooperation vide this MoU, will be termed as "Joint Intellectual Property" and shall vest in and be jointly owned by the Parties.
- 7.4 Either Party is entitled to use any research results emanating from this MoU, for further research. The Parties will inform each other immediately about any further research results in writing or via e-mail. The use of research results for commercial purposes shall be subject to a specific agreement to be signed between the Parties as and when



such research results are available and are expected to be put to use for commercial purposes.

8 CONFIDENTIALITY

8.1 Each Party shall maintain the confidentiality of this MoU and any information exchanged pursuant to the terms of this MoU, during the term of this agreement and one (01) year after termination or expiration thereof, unless otherwise agreed herein. The obligations on confidentiality shall not apply to any information of a party that

- a. has been approved for release by prior written authorization by the disclosing party and/or;
- b. is already in the public domain at the time of disclosure and/or becomes publicly known through no fault by the receiving party and/or;
- c. is acquired by the receiving party from a third party other than the disclosing party not through a breach of any obligation of confidentiality by such third party and/or;
- d. is already known to the receiving party before the time of disclosure as evidenced by tangible records and/or;
- e. is independently developed by the receiving party without any aid of the disclosing party's information and/or;
- f. must be disclosed due to a court's decision or a public authority.

8.2 In case disclosures become mandatory under Clause 8.1(f), the Party forced to disclose the information shall limit the disclosures to the extent necessary and as mandated under the relevant statute and shall inform the other Party immediately in advance.

9 PUBLICATION

9.1 CRDF, as an institution of research and advisory, engages only in research and advisory that is compatible and beneficial to, and consistent with, its academic role and mission of CEPT University. Therefore, results and methodology of research activities shall be reasonably available to students and researchers for publication.

10 NON-EXCLUSIVITY

10.1 The MoU is not exclusive in nature and each party shall have the right to enter into similar arrangements with any other company, research, or academic institution.



11 WARRANTY AND LIABILITY

- 11.1 Parties acknowledge that neither party has made assurances or guarantees, of any kind, that the areas of collaboration would lead to a particular result, produce any specific data, product or other result, or result in or cause VNN or CRDF to succeed or achieve any specific objectives.
- 11.2 Any liability of the parties and their representatives shall be excluded except for gross negligence and wilful acts or omissions.

12 LANGUAGE OF MEMORANDUM AND CORRESPONDENCE

- 12.1 The present MoU is written in English.
- 12.2 All correspondence regarding this MoU shall be carried in English.
- 12.3 In case of any discrepancies or inconsistencies in the semantic content of the terms, the English language version shall prevail over any other language.

13 SETTLEMENT OF DISPUTES AND CONFLICTS

- 13.1 The Parties will endeavour to resolve by negotiation any and all disputes that may arise from this MoU or with regard to it.
- 13.2 In case the efforts and negotiations do not result in a mutually acceptable resolution, the MoU shall be terminated forthwith.

14 LEGAL EFFECT

- 14.1 This MoU is not intended to impose any legal obligation (save any rights accrued to the parties under Clauses 7 and 8) whatsoever on either party but limited to an obligation to bargain in good faith. The Parties do not intend to be bound by any agreement until both agree to and sign a definitive written contract. Neither party can rely on any promises inconsistent to this paragraph. This paragraph supersedes all other conflicting terms. Governing law shall be the laws of India.

15 CONTACT PERSON

The contact person from CRDF shall be Ms Aditi Dwivedi and the contact email id is aditi.dwivedi@cept.ac.in. The contact person from VNN shall be Mr. Siddharth Kumar, Secretary, JalKal and the contact email id is gmjknvs@gmail.com.



For and on behalf of CEPT Research
and Development Foundation



Darshan Parikh,
Director
Date: 12/09/2022

For and on behalf of Varanasi Nagar
Nigam

नगर आयुक्त
नगर निगम, वाराणसी
Pranay Singh IAS,
Municipal Commissioner Date:

महाप्रबन्धक
नगर निगम
जलकल
वाराणसी
(RASHMIDLA KUMAR)
GENERAL MANAGER
JAL KAL VIDHAG
NAGAR NIGAM VARANASI

“SaniTab” Training for surveyors

in Kanchanpur village

Date – 15 October 2022

CWAS CENTER
FOR WATER
AND SANITATION

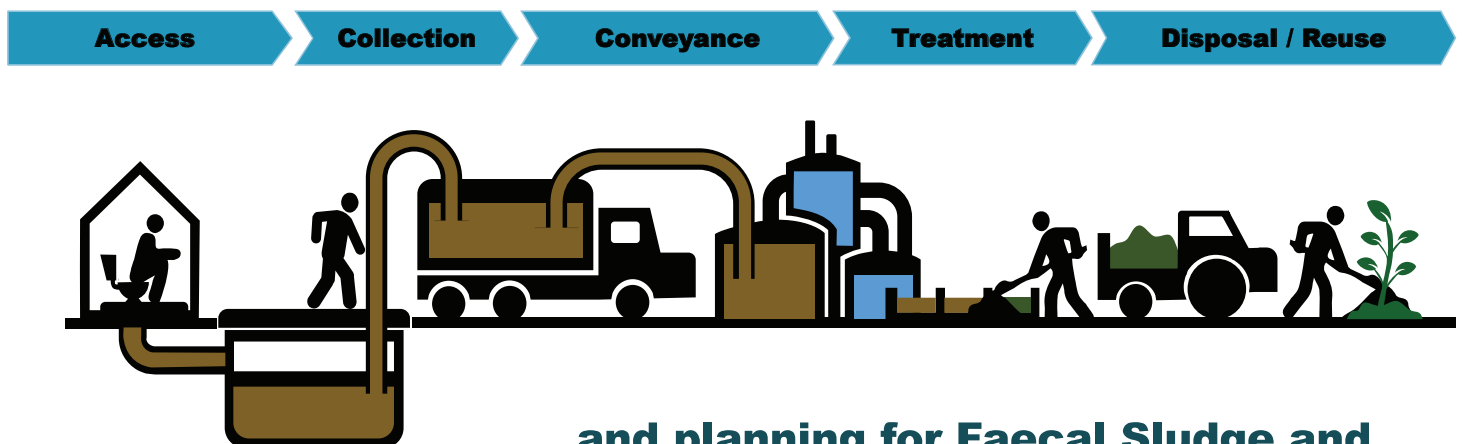
CRDF CEPT RESEARCH
AND DEVELOPMENT
FOUNDATION

CEPT
UNIVERSITY



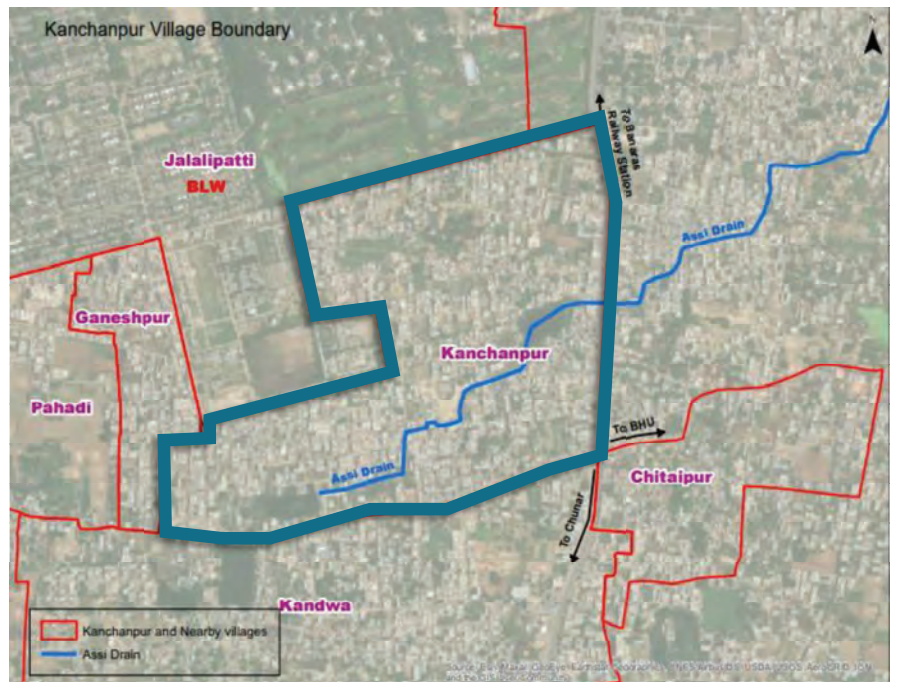
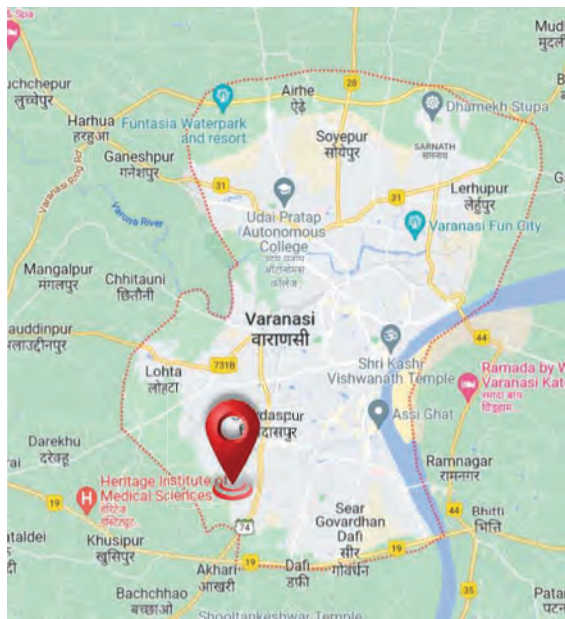
In smaller towns and peri-urban areas, where sewer networks are not available, onsite sanitation systems are required

**Such systems like septic tanks require
desludging by suction trucks**



**...and planning for Faecal Sludge and
Septage Management (FSSM)**

Survey of onsite sanitation systems in Kanchanpur



SaniTab

“**CWAS, CEPT University** has developed a Mobile Application - **“SaniTab”** to create database for Onsite sanitation system

SaniTab – Key Features

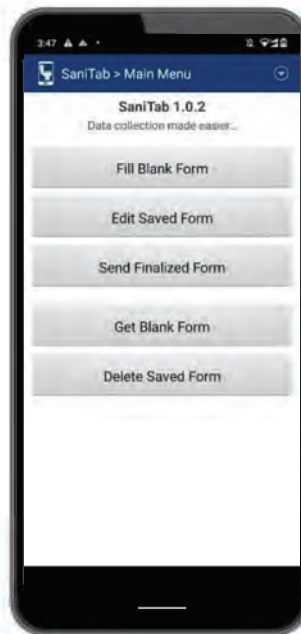


SaniTab

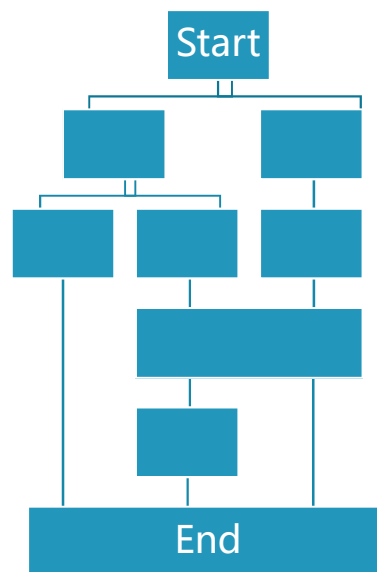
Mobile Interface of SaniTab: the tool includes features such as -

- ✓ Creation of a custom survey form
- ✓ Geo-tagging survey forms
- ✓ Clicking pictures using on-device camera
- ✓ Gathering signature of respondent
- ✓ Validation checks for the data entered
- ✓ The app enables creation of 'branches' within a form.

SaniTab – Screens



Kanchanpur FSSM survey questionnaire



32 Total Questions

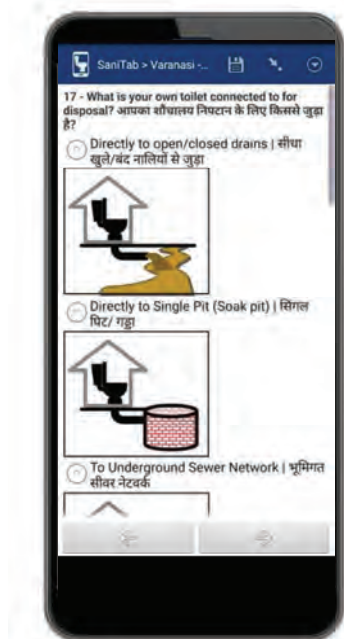
Branching and skipping flows based on answers

Maximum 23 questions and Minimum 6 questions to be answered to complete from at one property location

FSSM questionnaire

Assessment captures the following aspects

- Where is the **toilet connected to**
- **Size and shape** of septic tank
- **Owner details** of septic tanks
- **Accessibility** of septic tanks
- When was the **septic tank last cleaned**.
- **Reasons** for emptying septic tanks



Question 1

Locality name -

SaniTab > Varanasi

1 - What is the name of the locality? क्षेत्र का नाम क्या है?
Please fill the Colony name (in shorter form) (क्षेत्र की छोटी सी नाम भरें) (संक्षिप्त रूप में)

2 - Property number or "House Unique ID" (10 digits) as per Nagar Nigam records। मकान संख्या/पुनिक द्वारा अर्ज. आई. (10 नम्बर)
अनगर "House Unique ID" से केवल का है तो कुल दो नाम डालें (-) अर्थात्। जैसे 12345678-



Questions 3 -7

Q3 - Property Status

SaniTab > Varanasi

3 - Status of property during the survey | सर्वेक्षण के दौरान भवन की स्थिति

☐ Open | खुला हुआ

☐ Locked | लाला बंद

Q4 - Property typology

SaniTab > Varanasi

4 - Property typology | भवन का प्रकार

☐ Residential | आवासीय

☐ Commercial | व्यावसायिक

☐ Institutional/ Public & Semi-Public | संस्थान / सार्वजनिक एवं अर्धसार्वजनिक सुविधाएँ

☐ Mixed | मिश्रित

Q/5/6/7 - Property Sub-typology

SaniTab > Varanasi

6 - Commercial sub-typology | वाणिज्यिक उप प्रकार

☐ Industry | उद्योग

☐ Shop/Mall | दुकान/ मॉल

☐ Hotel / Lodge | होटल / लॉज

☐ Other | अन्य

Questions 8-16

Owner name/number

Property details | भवन संबंधी सवाल

8 - Name of Building/Property | भवन/संपत्ति का नाम

9 - Name of the owner/ respondent | मालिक/प्रतिक्रिादी का नाम

10 - Contact number | संपर्क नंबर

12 - What is the tenure status of this property? इस संपत्ति की भूस्वत्ति की स्थिति क्या है?

☐ Owner occupied | मालिक अधिभूत

☐ Tenant occupied | किरायेदार अधिभूत

13 - How many toilets are there in this property? इस संपत्ति में कितने शौचालय हैं?

Tenure status

Property details | भवन संबंधी सवाल

8 - Name of Building/Property | भवन/संपत्ति का नाम

9 - Name of the owner/ respondent | मालिक/प्रतिक्रिादी का नाम

10 - Contact number | संपर्क नंबर

12 - What is the tenure status of this property? इस संपत्ति की भूस्वत्ति की स्थिति क्या है?

☐ Owner occupied | मालिक अधिभूत

☐ Tenant occupied | किरायेदार अधिभूत

13 - How many toilets are there in this property? इस संपत्ति में कितने शौचालय हैं?

User details

User details | उपयोगकर्ता की जानकारी

14 - How many households are there on this property? इस संपत्ति में कितने परिवार रहते हैं?

16 - How many people are living here? यहाँ कितने व्यक्ति रहते हैं?

Details | विवरण

Children (Less than 6 years) | बच्चे (6 वर्ष से कम)

Male (above 6 years) | पुरुष (6 वर्ष से अधिक)

Female (above 6 years) | महिला (6 वर्ष से ऊपर)

Question 17

Toilet outlet connected to-

17 - What is your own toilet connected to for disposal? आपका शौचालय निपटान के लिए किससे जुड़ा है?

☐ Directly to open/closed drains | सीधा खुले/बंद नालियों से जुड़ा

☐ Directly to Single Pit (Soak pit) | सीधा छिद/गड्ढा

☐ To Underground Sewer Network | भूमिगत सीवर नेटवर्क



Question 17 – possible answers

Toilet outlet connected to-

Directly to open /
closed drain



Directly to single pit /
Soak pit



Underground Sewer
network



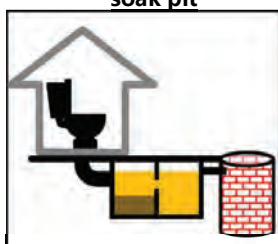
Directly to open land
/ water bodies



Twin pit



Septic tank connected to
soak pit



Septic tank connected to
open/closed drain



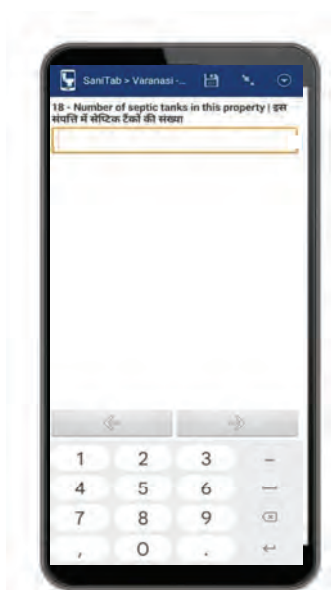
Septic tank connected to
open land/ water bodies



Septic tank connected to
sewer network



Question 18-20



Q- Number of septic tanks in the property ?

1
2
3



1.5
2.5
3.5



Q -Septic tanks sharing status??

Individual /shared

19 - Septic tank sharing status | सेप्टिक टैंक साझा करने की स्थिति

☐ Individual | व्यक्तिगत

☒ Shared | साझा

Q -Septic tanks shared with..

1244566---

Question 21



Shape of septic tank -



Rectangular



Circular

Question 21



Shape of septic tank -



Question 22

Size of septic tank -

SaniTab > Varanasi ...

Septic Tank details | सैप्टिक टैंक की जानकारी (1) > 22 - Septic Tank Dimensions | सैप्टिक टैंक के आकार

Length (in feet) | लंबाई (फुट में)
Please fill the data with two decimal place.

Breadth/Diameter (in feet) | चौड़ाई/व्यास (फुट में)
Please fill the data with two decimal place.

Depth (in feet) | गहराई (फुट में)
Please fill the data with two decimal place.

1 2 3 -
4 5 6 .
7 8 9 $\frac{\square}{\square}$
0 $\frac{\square}{\square}$

Length (in feet)

Breadth/Diameter
(in feet)

Depth (in feet)

Questions 23-25

Last desludging detail

SaniTab > Varanasi ...

23 - When was the septic tank emptied the last time? सैप्टिक टैंक को अंतिम बार कब खाली किया गया था?

☐ Last 6 months | 6 महीने पहले

☐ 6 to 12 months before | 6 से 12 महीने पहले

☐ 12 to 24 months before | 12 से 24 महीने पहले

☐ 24 to 36 months before | 24 से 36 महीने पहले

☐ More than 36 months | 36 महीने से अधिक

☐ Never emptied | कभी खाली नहीं किया

☐ Don't know/ Remember | पता नहीं / याद नहीं

SaniTab > Varanasi ...

24 - Why was the septic tank emptied? सैप्टिक टैंक को क्यों खाली किया गया?

☐ Blocked toilet (Septic tank full) | अवरुद्ध शौचालय (सैप्टिक टैंक भर गया)

☐ Overflow from access hole/ maintenance hole (Septic tank full) | एक्सेस होल/खरखाब छेद से अतिप्रवाह (सैप्टिक टैंक भर गया)

☐ Smell | दुर्गंध

☐ Faecal matter from effluent pipe | एफ्लुएंट पाइप से मल आने लगा

☐ Others | अन्य

☐ Don't know/ Remember | पता नहीं / याद नहीं

SaniTab > Varanasi ...

25 - Were there any problems during emptying of septic tank last time? क्या पिछली बार सैप्टिक टैंक खाली करने के दौरान कोई समस्या हुई?

☐ Access issue or distance from suction truck to house | सक्शन ट्रक से घर तक पहुंच या दूरी

☐ Break floor tiles to access septic tank | सैप्टिक टैंक तक पहुंचने के लिए फर्श की टाइलें तोड़ें

☐ Break concrete manhole to access septic tank | सैप्टिक टैंक तक पहुंचने के लिए कंक्रीट के मैनहोल को तोड़ें

☐ Difficult to locate the septic tank | सैप्टिक टैंक का पता लगाना मुश्किल

☐ Smell during emptying | खाली करने के दौरान गंध

☐ Made a mess / spilled septage | गन्दगी फैला दी

☐ No problem found | कोई समस्या नहीं

☐ Others | अन्य

Questions 26-29

Last desludging detail

Question 26: Name of the service provider that emptied the septic tank the last time? किसी कार सेप्टिक टैंक खाली करने वाले सेवा प्रदाता का नाम?

Question 27: Is the septic tank easily accessible from road by a suction emptier truck? क्या सक्शन एम्प्टीयर ट्रक का उपयोग करके सड़क से सेप्टिक टैंक तक आसानी से पहुँचा जा सकता है?

Question 28: Is there proper access with manholes/ access covers for any of the chambers of septic tank which can be easily opened? क्या सेप्टिक टैंक के किसी भी कमर के लिए मैनहोल/ एक्सेस कवर है जिसे आसानी से खोला जा सकता है?

Question 29: When do you think septic tank should be emptied? आपके विचार से सेप्टिक टैंक को कब खाली करना चाहिए?

When foul odours occur (जब दुर्गंध आती है)

When it overflows (जब यह ओवरफ्लो हो जाता है)

Periodically even without sign of overflowing (औवरफ्लो के संकेत के बिना भी समय-समय पर)

Question 30

Property Location

Wait for GPS location to stabilize before submitting

Step 1: Capture GPS Location of property | संपत्ति का जीपीएस लोकेशन लें

GPS coordinates can only be collected when outside.

Start GeoPoint

Step 2: Loading Location

Please wait. This could take a few minutes.

Save GeoPoint Cancel

Step 3: Capture GPS Location of property | संपत्ति का जीपीएस लोकेशन लें

GPS coordinates can only be collected when outside.

Start GeoPoint

Latitude: N 25°18'43"

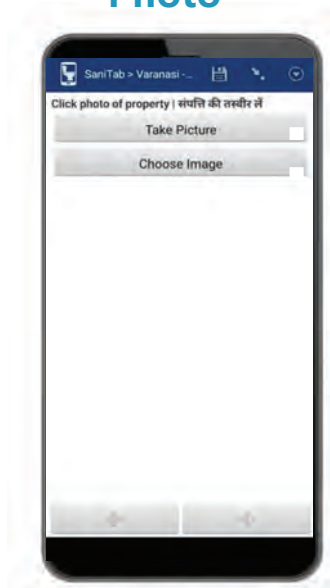
Longitude: E 82°59'16"

Altitude: 32.3m

Accuracy: 87.6m

Question 31

Photo



Things need to be remembered -

- Try to capture properties photo with respondent
- Focus on property photo, not on the respondent



Question 32-33

Signature



Form ID



SaniTab – Don'ts

while conducting survey



Do not Skip any question manually



Do not fill multiple forms for same property



Do not leave any blank field



Download SaniTab apk



SaniTab – Login process



Download app from here –

https://drive.google.com/file/d/16T0k2Je_cY5yGVPxzME61pellk-wEX9R/view

* This app is available only for Android user

Download SaniTab apk



Modify your mobile settings to install app

Setting >> Privacy >>Special permission>>install app
by unknown resource

* This setting may be very phone to phone

Download SaniTab apk



Give the permissions to app –



Camera
permission



Location
permission



File manager
permission



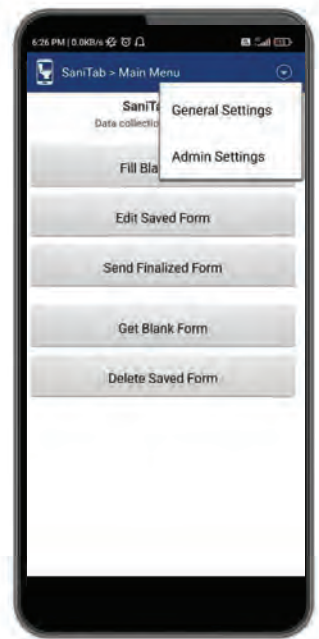
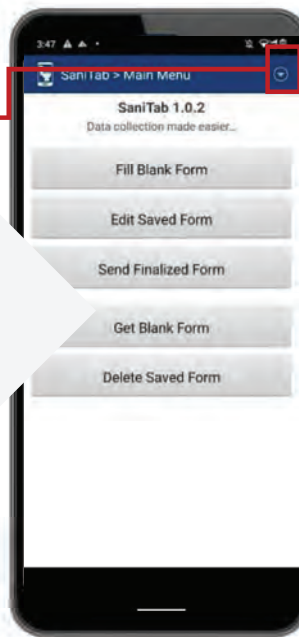
SaniTab – Setup

Over-view of SaniTab App



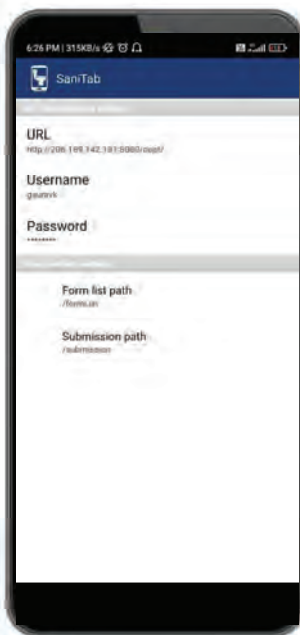
Click here

App Setting

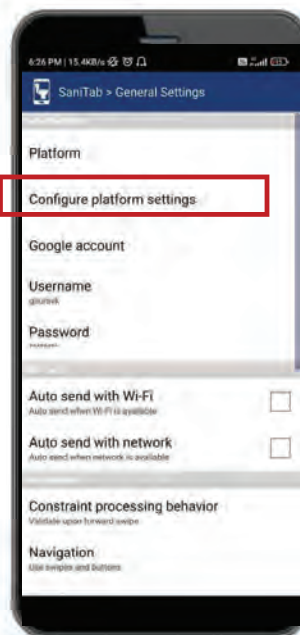


SaniTab – Screens

Over-view of SaniTab App

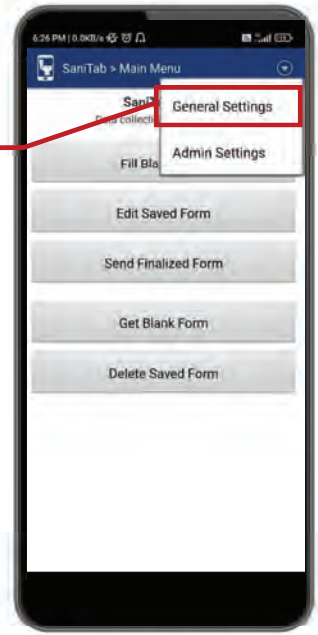


Platform Setting



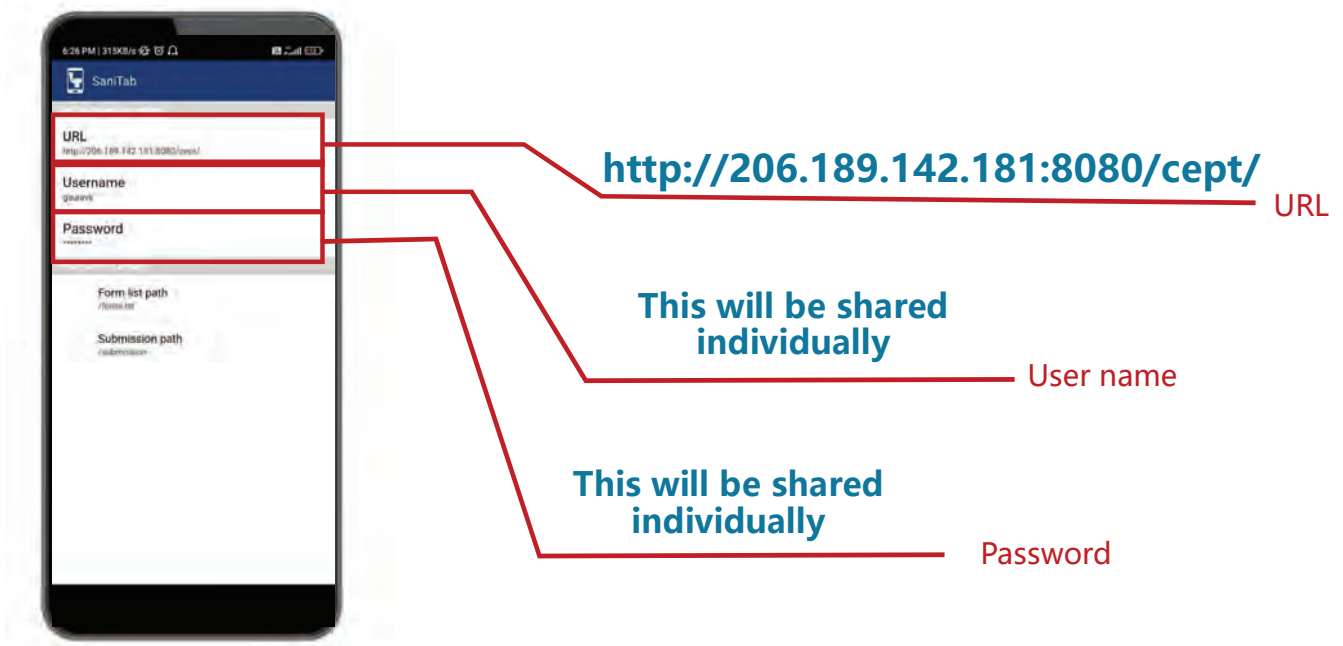
General Setting

Click here

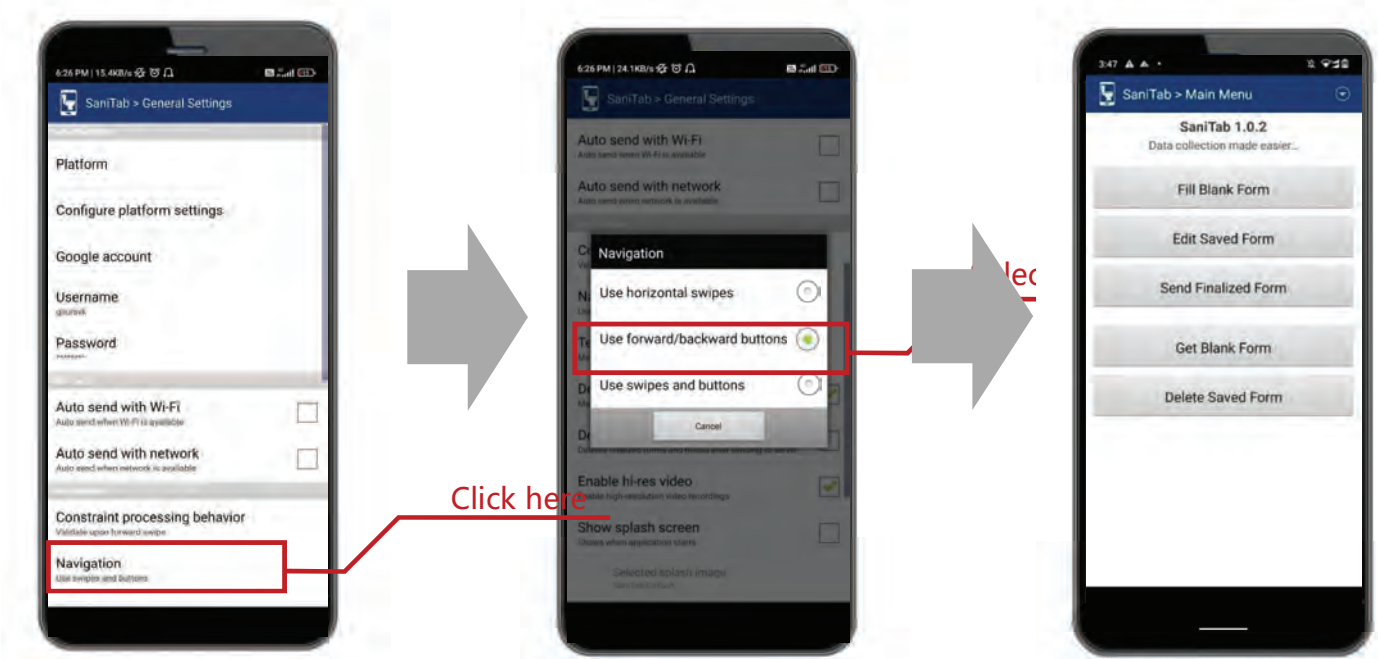


App Setting

SaniTab – Screens



SaniTab – Screens

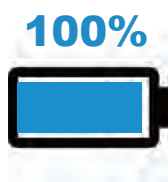


SaniTab – Screens



SaniTab – Do's

Before commencing the survey -



Mobile devices should
be 100% charged



Enable GPS
location in mobile



Make sure SaniTab
is working properly



SaniTab – Don'ts

Do's and Don'ts

Before commencing the survey -



Do not change the App setting



Do not login with other user's id



Do not download multiple forms



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THANK YOU

CWAS

CENTER FOR WATER AND SANITATION

CRDF

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About us

The Center for Water and Sanitation (CWAS) is a part of CEPT Research and Development Foundation (CRDF) at CEPT University. CWAS undertakes action-research, implementation support, capacity building and advocacy in the field of urban water and sanitation. Acting as a thought catalyst and facilitator, CWAS works closely with all levels of governments - national, state and local to support them in delivering water and sanitation services in an efficient, effective and equitable manner.



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स्वच्छ कंचनपुर के लिए : आपका सहयोग महत्वपूर्ण है



लोगों को अपने स्थानीय पर्यावरण से संबंधित प्रमुख चिंताएं हैं?

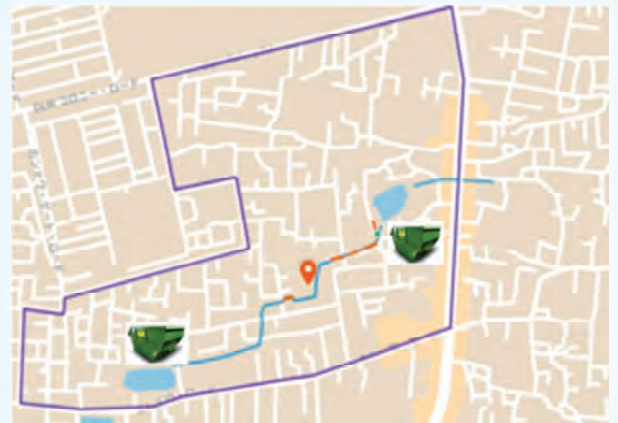
कंचनपुर में घरलू सर्वेक्षण अगस्त 2023 में JICA की तकनीकी सहयोग परियोजना, जिसे वाराणसी में पर्यावरण स्वच्छता के व्यापक सुधार के लिए परियोजना (CIESV) कहा जाता है, के तहत आयोजित किया गया था। सर्वेक्षण के परिणाम से यह स्पष्ट होता है कि निवासियों को कूड़ा प्रबंधन एवं जल निकासी जैसे दो सबसे अधिक महत्वपूर्ण मुद्दों में स्वच्छता और पर्यावरण के संबंध में सुधार करने की आवश्यकता है (अधिक परिणाम पृष्ठ XX में विस्तृत है।)



कंचनपुर के घरों से निकलने वाले कूड़े का उचित प्रबंधन

 कंचनपुर क्षेत्र में निर्दिष्ट स्थान पर कूड़ा संग्रहण एवं नियमित रूप से कूड़ा उठान

नगर निगम ने नवम्बर 2023 में कंचनपुर में चिह्नित दो स्थानों पर कंटेनर रखने और कंटेनर में कचरा संग्रहण शुरू करने की योजना बनाई है। डोर-टू-डोर कलेक्शन शुरू होने से पहले यह एक संक्रमणकालीन व्यवस्था है।



सड़कों या खुली जमीन पर कचरा न फैलाएं, बल्कि कचरे को निकटतम कंटेनरों में लाएं।

अन्यथा, आप निजी कचरा संग्रहकर्ताओं का उपयोग कर सकते हैं। JICA परियोजना टीम द्वारा प्रशिक्षण प्राप्त कचरा संग्रहकर्ताओं के संपर्क नंबर यूआरएल पर पाए जा सकते हैं।



अपने निकटतम कंटेनर की जानकारी के लिए QR कोड को स्कैन करें

जब आप निजी कचरा संग्रहकर्ता का उपयोग करते हैं, तो आपको निम्नलिखित बिन्दुओं पर उनके साथ सहमत होने की सलाह दी जाती है।

1. सप्ताह में कितने दिन कूड़ा लेने आएगा और लेने का समय
2. आप कूड़ा कैसे देना पसंद करते हैं (सीधे किसी संग्रहकर्ता को या घर के गेट से)।
3. भुगतान राशि व भुगतान के तरीके



निजी कूड़ा संग्राहकों की अधिक जानकारी के लिए QR कोड को स्कैन करें



क्या आप 3-R (Reduce, Reuse, Recycle) मॉडल के तहत कूड़ा कम या रीसायकल करना चाहते हैं?

यदि आप अपने क्षेत्र के कचरे में कमी में योगदान देने के लिए प्रेरित हैं, तो आप कूड़े का अलगाव (गीला और सूखा) और पुनर्चक्रण का अभ्यास कर सकते हैं। निम्नलिखित वस्तुओं को, यदि अन्य से अलग किया जाए, तो कबाड़ी वाले को बेचा जा सकता है। ऐसा करके आप कचरे के कमी में बहुत योगदान देंगे।



- समाचारपत्र
- कागज/किताबें/पत्रिकाएं
- काँच
- धातु सामग्री और तार
- प्लास्टिक
- पुराने कपड़े और चिथड़े
- चमड़ा
- रबड़



क्या आप अपने गीले कूड़े से घर पर खाद बनाना चाहते हैं

आप अपने जैविक कचरे से खाद बना सकते हैं और उससे बागवानी का आनंद ले सकते हैं। यदि आप घरेलू खाद बनाने में रुचित रखते हैं।

खाद बनाने के लिए आवश्यक वस्तुएं



खाद बनाने के लिए ध्यान देने योग्य बातें

निर्धारित जगह - हमारा कम्पोस्टर ज्यादा धूप या बारिश वाले जगह में न हो
तापमान - 20 से 42°C
हवा - एरोबिक कम्पोस्टिंग में ये बहुत महत्वपूर्ण है कि हमारा कम्पोस्टर (जिसमें छोटे छोटे छेद बने हो) की जगह हवादार हो
ग्रीन एवं ब्राऊंस - यह खाद की C:N (25-30:1) बैलेंस रखता है (सूखे पत्ते, काँक पिट, पुवाल, कागज, आदि ब्राऊंस की तरह प्रयोग में ले सकते हैं)
नमी - कम्पोस्ट के लिए नमी की मात्रा 50-55% होती है (ज्यादा शुष्क होने पर उसमें हल्का पानी का छिड़काव और ज्यादा नमी पर ब्राऊन मिलायें)
एक्सलेटर/मिक्रोव - खाद बनाने की प्रक्रिया को तेज करता है (गाय का गोबर, छाछ, पुरानी खाद इत्यादि में से कुछ भी प्रयोग कर सकते हैं। हर जैविक लेयर के बाद हलकी मात्रा में इसका छिड़काव करते हैं)

खाद बनाने की प्रक्रिया



पॉट की निचली सतह पर ब्राऊन बिछाइये एवं उसके ऊपर एक लेयर जैविक कूड़ा डालें

खाद बनाने की प्रक्रिया शुरू करने के लिए जैविक कूड़ा के ऊपर ब्राऊंस एवं मिक्रोव के मिश्रण का लेयर बना दें (प्रतिदिन एक लेयर)

ढेर को हर 3-4 दिन में पलट। जब ये भर जाए तो इसे बंद करके दूसरा पॉट का इस्तेमाल में लायें

जब एक खेप खाद तैयार हो जाए तो सूखने को छोड़ दें और दुबारा से पहला चरण का पालन करें



अधिक जानकारी एवं प्रशिक्षण के लिए इस QR को स्कैन करें और Varnasi Home Composting facebook page से जुड़ें



आप अपने निर्माण एवं विध्वंस अपशिष्ट का निस्तारण कैसे करते हैं ?

निर्माण एवं विध्वंस अपशिष्ट (घरों के निर्माण या टूटने से निकलने वाले कचरे) को घर से कूड़ा लेने वाले कचरा संग्रहकर्ताओं, सार्वजनिक कचरा कंटेनरों या किसी अन्य सार्वजनिक स्थानों पर नहीं डाला जा सकता है। इसके लिए वाराणसी नगर निगम द्वारा एक कस्टमर हेल्प लाइन नंबर दिया गया है, जिस पर आप कॉल करके आप अपने घर से निर्माण एवं विध्वंस अपशिष्ट नगर निगम द्वारा एक उचित दर पर उठवाया जाता है।

C & D अपशिष्ट उठाने की दर-₹ 325 प्रति टन

C & D Waste Helpline No.

7233000550

1800-1805567/1533

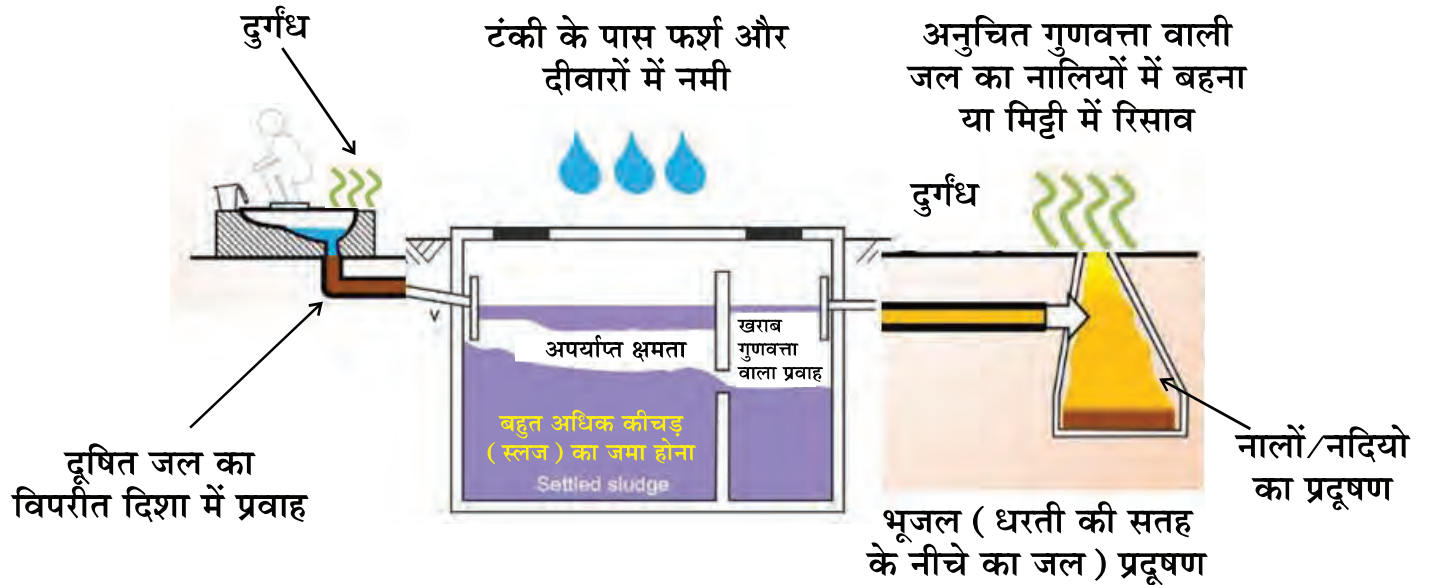
कंचनपुर के घरेलू अपशिष्ट (सीवेज जल) का उचित प्रबंधन

सेप्टिक टैंकों को समय-समय पर खाली करना

कंचनपुर में घरेलू सर्वेक्षण के माध्यम से, यह पता चला है कि कंचनपुर में 80% से अधिक घरों ने अपने सेप्टिक टैंक की सफाई कभी नहीं कराई है। सेप्टिक टैंक की समय-समय पर सफाई न करने से टैंक में बहुत अधिक कीचड़ जमा हो जाता है जो सेप्टिक टैंक के काम करने की क्षमता को कम कर देती है, जिससे कि विभिन्न समस्याओं का सामना करना पड़ता है, जैसा नीचे दिखाया गया है।

 सेप्टिक टैंकों को समय-समय पर खाली करके इन समस्याओं को रोका जा सकता है।

सेप्टिक टैंक को समय-समय पर खाली न करने से होने वाली समस्याएं :



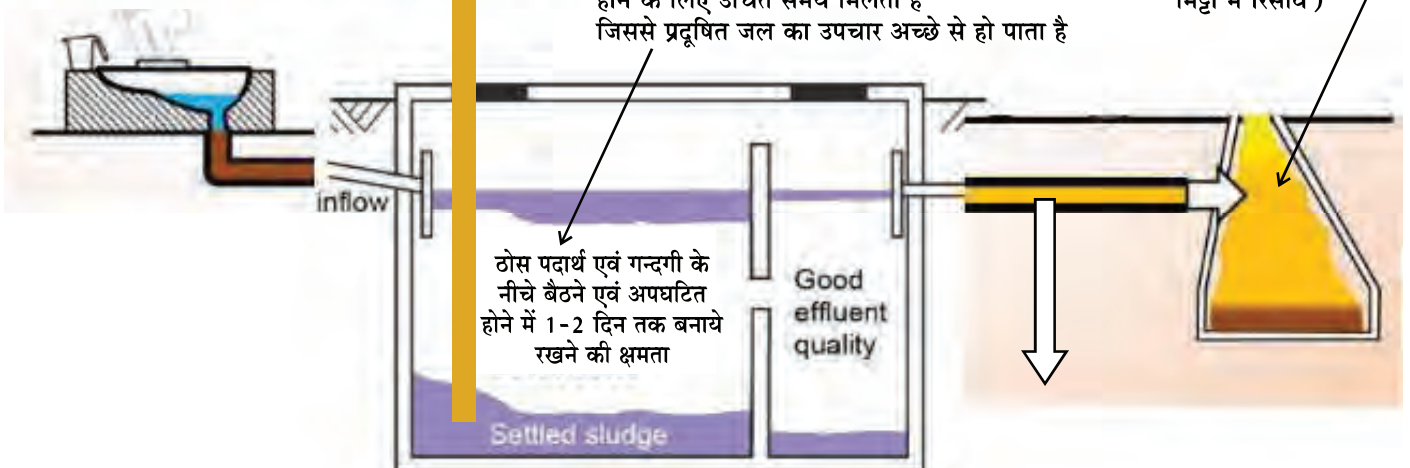
सेप्टिक टैंकों की सफाई समय-समय पर करने से सीवेज के कार्य करने की क्षमता बनी रहती है



केन्द्रीय सार्वजनिक स्वास्थ्य और पर्यावरण इंजीनियरिंग संगठन (CPHEEO) दिशा निर्देश और वाराणसी के मल कीचड़ और सेप्टेज प्रबंधन नीति के अनुसार सेप्टिक टैंक को हर तीन साल में खाली किया जाना चाहिए।

सेप्टिक टैंक की समय-समय पर सफाई करने से दूषित जल (Sewage) के ठोस पदार्थ (स्लज) को नीचे बैठने (Settle) एवं अपघटित होने के लिए उचित समय मिलता है जिससे प्रदूषित जल का उपचार अच्छे से हो पाता है

उचित गुणवत्ता वाली जल का निकास (नालियों में बहना या मिट्टी में रिसाव)



आप समय-समय पर सेप्टिक टैंक को खाली करने के लिए जलकल में पंजीकृत सेप्टिक टैंक सफाई वाले ऑपरेटरों से संपर्क कर सकते हैं।

Prashant Upadhyay
8004700885

Anant Kumar Upadhyay
7348063474

Ajay Kumar
8840101059



सेप्टिक टैंक को खाली करने की फीस

जलकल से घरों की दूरी के आधार पर जलकल विभाग मूल्य तय करता है।

(a) < 5 km	- INR 2000/- per trip
(b) 5-10 km	- INR 2500/- per trip
(c) > 10 km	- INR 3000/- per trip



आपकी घरों में सेप्टिक टैंक की सफाई करने का कार्य

सेप्टिक टैंक के ढक्कन/कवर की पहचान एवं वहां तक सफाई संसाधन जाने की जगह



वैक्यूम टैंकर का आगमन



सेप्टिक टैंक के ढक्कन/कवर को हटाना



सेप्टिक टैंक के ढक्कन/कवर को हटा दिया गया



सेप्टिक टैंक के खाली करने का कार्य प्रारंभ



सेप्टिक टैंक खाली करने का कार्य प्रगति पर है



खाली करने के बाद, ढक्कनों को सील कर दिया जाता है



ढक्कनों/कवरों को सील करने का कार्य पूर्ण



सम्पर्क सूत्र-नगर निगम वाराणसी /CIESV

हेल्पलाइन-0542- 2720005, 2508585, 1800-1805567/1533

सेप्टिक टैंक की सफाई के लिए सम्पर्क करें (जलकल)-14420

@nagarnigamvns, @SBMVaranasi @nagarvikashup/

@nnvns,@SwachhBharatmissionvaranasi



IOS



ANDROID

स्वच्छता सम्बन्धित शिकायत हेतु कृपया QR Code को स्कैन कर स्वच्छता एप डाउनलोड करें।

How to safely empty a septic tank



Gumboots



Safety goggles



Helmet



Mask



Gloves

❖ Inspect the site, break the mortar seal and connect the hose from the truck to the tank.



❖ Park the truck within 25 m from septic tanks. In case of more than 25 m of linear distance and 4 m in elevation gain, intermediate pumping is required.



❖ Break the mortar seal of the septic tank lid. Inspect the tank for cracks or damage before and after the emptying of tank.

❖ Lay out and connect the hoses from the truck to the tank or pit to be emptied.

❖ Increase the vacuum to the proper level to take out faecal sludge out of the tank.

❖ Break up faecal sludge and emptying the septic tanks between 90% and 95% of its contents.



❖ Operators shall leave behind sludge not less than 25 mm in depth in the bottom of the septic tank.



❖ Clean up any spillage using proper sorbent materials. Cover top and the area around is sprayed with 1% of chlorine solution.

❖ Prepare a written report indicating: How much waste was removed; the condition of the tank or pit; any recommendations for repairs.

❖ Replace & seal the cover with plaster.

Use of PPE while emptying septic tank is mandatory. However, based on requirement, appropriate safety equipments should be adopted while emptying septic tanks.

Appendix 20

Technology Book on Decentralized Wastewater Treatment



Technology Book on Decentralized Wastewater Treatment

May 2024

Wastewater Management Sector Team

**The Project for the Comprehensive
Improvement of Environmental Sanitation in
Varanasi (CIESV)**

Preface

In the Wastewater Management Sector of the CIESV Project, a Packaged Sewage Treatment Unit (PSTU or *Johkasou* in Japanese) was installed on a pilot basis for community wastewater treatment and treatment of collected septage by desludging operators.

In order to provide sanitation solution to unsewered areas in the Varanasi City and UP State, it is expected that the pilot project can be replicated. Since *Johkasou* is one of the available technical options for decentralized wastewater treatment in India, comparison with other technologies would be beneficial for UPJN and JalKal officials for deciding on the replication in terms of selecting the most suitable one to local conditions.

As a reference material for supporting the selection, JICA expert team and counterpart engineers of JalKal in the wastewater management sector jointly developed this Technology Book on Decentralized Wastewater management.

This BOOK covers some main technologies that are applied internationally and also in India for both wastewater treatment and treatment of faecal sludge and septage or Faecal Sludge Treatment Plant (FSTP) .

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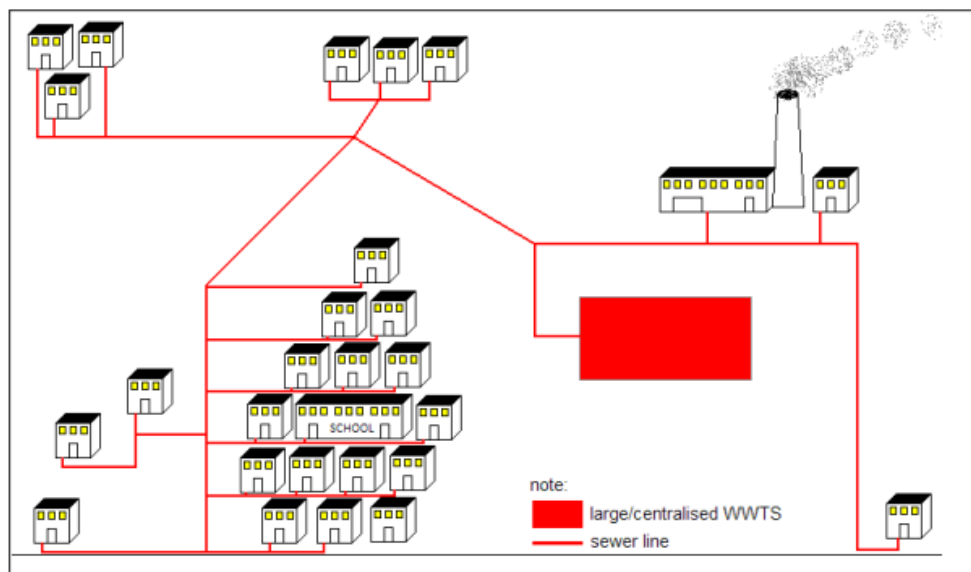
1. Centralized and Decentralized treatment

The figure below shows differences between Centralized Treatment and Decentralized Treatment.

Still, Decentralized treatment can be divided into two categories:

- 1) Treatment facility is attached to individual house/building (on-site treatment)
- 2) Treatment facility is attached to a sewer line to which some houses/buildings connect (decentralized treatment).

Centralised Treatment



Decentralised Wastewater Treatment

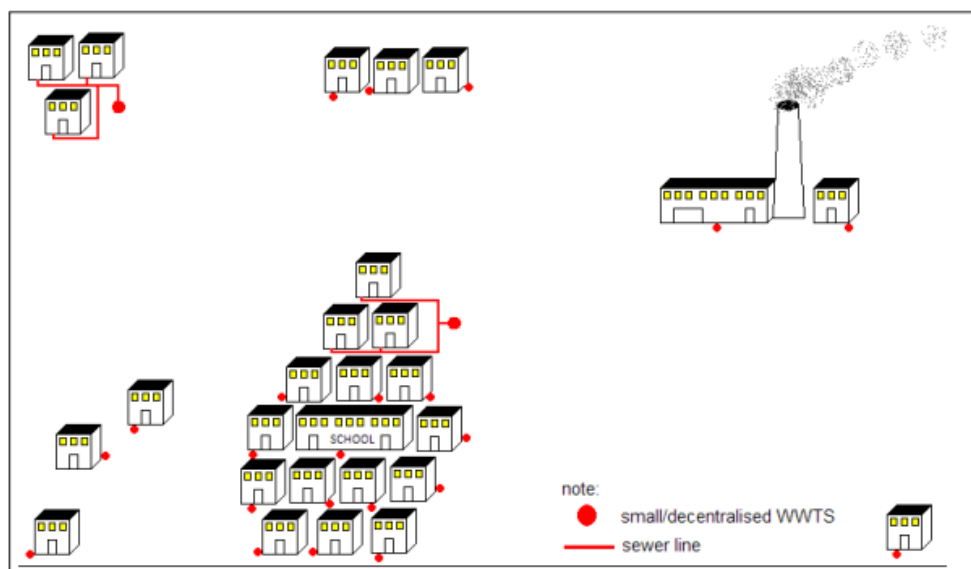


Figure1: Comparison of Centralized and Decentralized Treatments

Source: HANDBOOK ON DECENTRALISED WASTEWATER TREATMENT MODULE, 2017, published by National Institute of Urban Affairs

2. Wastewater treatment and treatment of faecal sludge and septage

- 1) **Wastewater treatment** is for domestic wastewater including both grey (kitchen, washing, bathroom, etc.) and black (toilet) water. This includes individual and community systems as shown in the Figure 2.

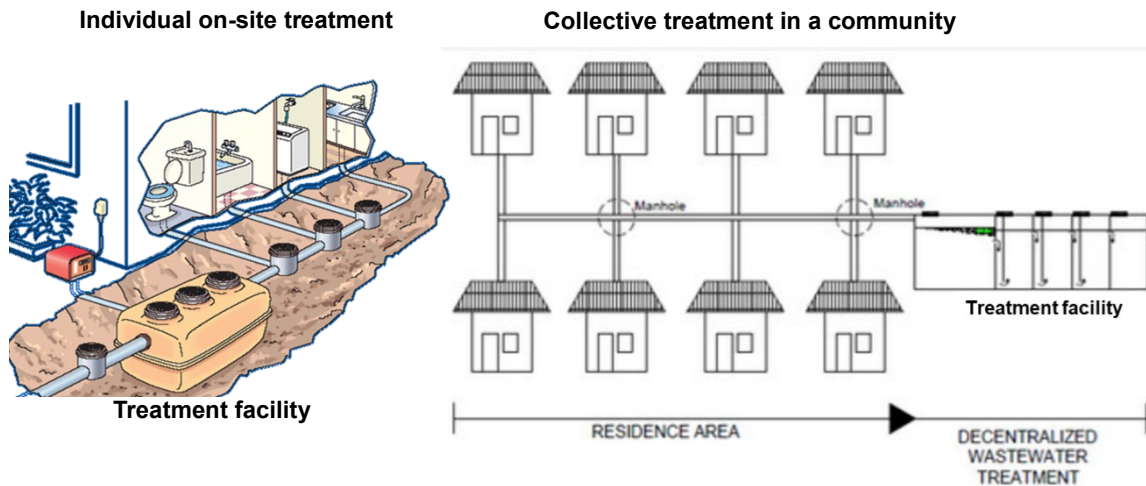


Figure 2: Schematic drawings of decentralized wastewater treatment

- 2) **Treatment of faecal sludge and septage** is for sludge of septic tanks or pit latrines that is collected and transported by vacuum tankers and discharged into a treatment facility. The treatment facility is called Faecal Sludge Treatment Plant (FSTP).

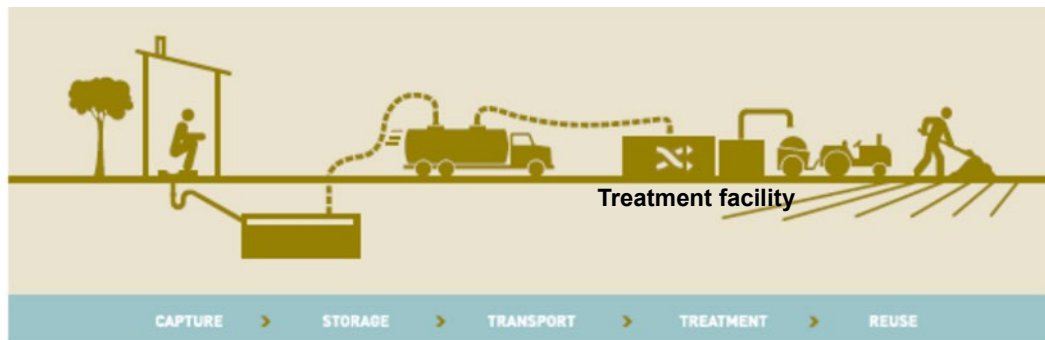


Figure 3: Schematic drawing of faecal sludge and septage treatment

3. Treatment technology for wastewater

(1) Decentralized Wastewater Treatment Systems (DEWATS)

- 1) DEWATS was developed by Bremen Overseas Research and Development Association (BORDA), Germany. More than 400 DEWATS have been implemented In India.
- 2) In DEWATS, wastewater can be treated through aerobic and anaerobic techniques connecting respective modules.
 - Settler
 - The anaerobic modules comprise of anaerobic baffle reactors (ABR) and anaerobic filters (AF).
 - The aerobic modules have horizontal planted gravel filters (HPGF) and polishing ponds.
 - A module for biogas generation (Biogas Reactor) can be attached.
- 3) DEWATS is based on different natural treatment techniques, put together in different combinations of modules according to need. One example of a simple combination of modules is shown in the Figure 4. Detailed drawings of each module are shown in the Figure 5.

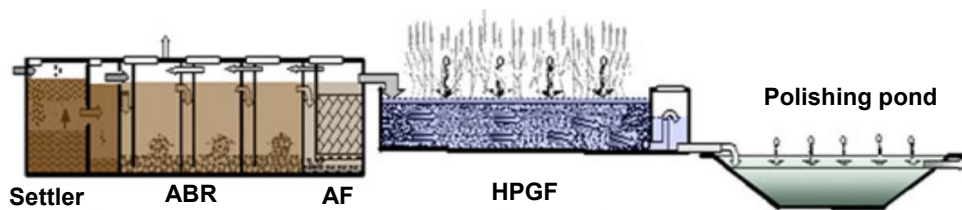


Figure 4: Schematic drawing of DEWATS

Source: Decentralised Wastewater Treatment (DWWT) by Centre for Science and Environment

- 3) Key features of the technology are as follows:
 - A) It is used for recycling both “grey” and “black” domestic wastewater.
 - B) Treatment capacity can vary from 1KLD to 100KLD.
 - C) Electricity is not required if total gravity flow can be applicable due to topography, otherwise pumping arrangement with electricity consumption is necessary.
 - D) Relatively larger land area is required. In general, it requires 15-20m² per 1KL of treatment capacity. It may not be applicable in densely populated area.
 - E) Reasonable removal of TSS, BOD, COD and F.Coliorm is obtainable. However, removal of total nitrogen is limited. Overall, meeting the NGT standards for release of treated effluent into a surface water body (TSS < 20mg/l, BOD < 10mg/l, COD < 50mg/l, TN< 10mg/l) is difficult. See the table below the BOD

removal efficiency in each module.

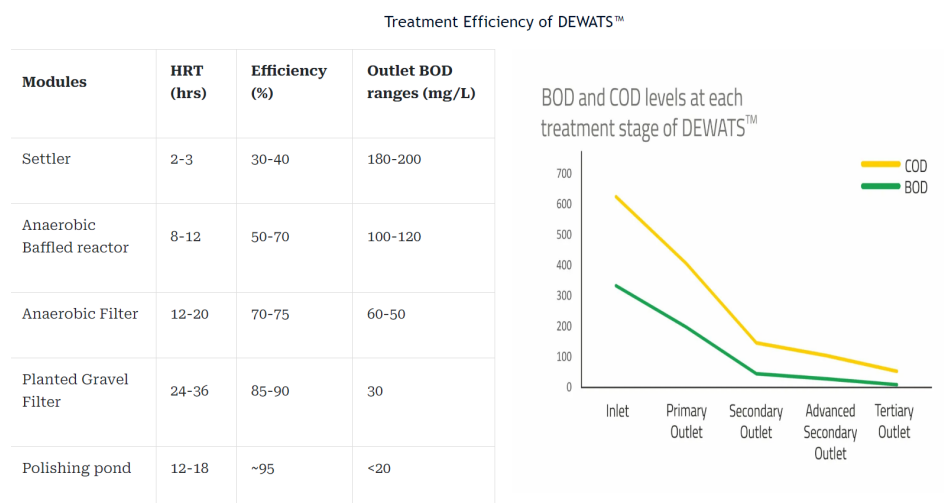


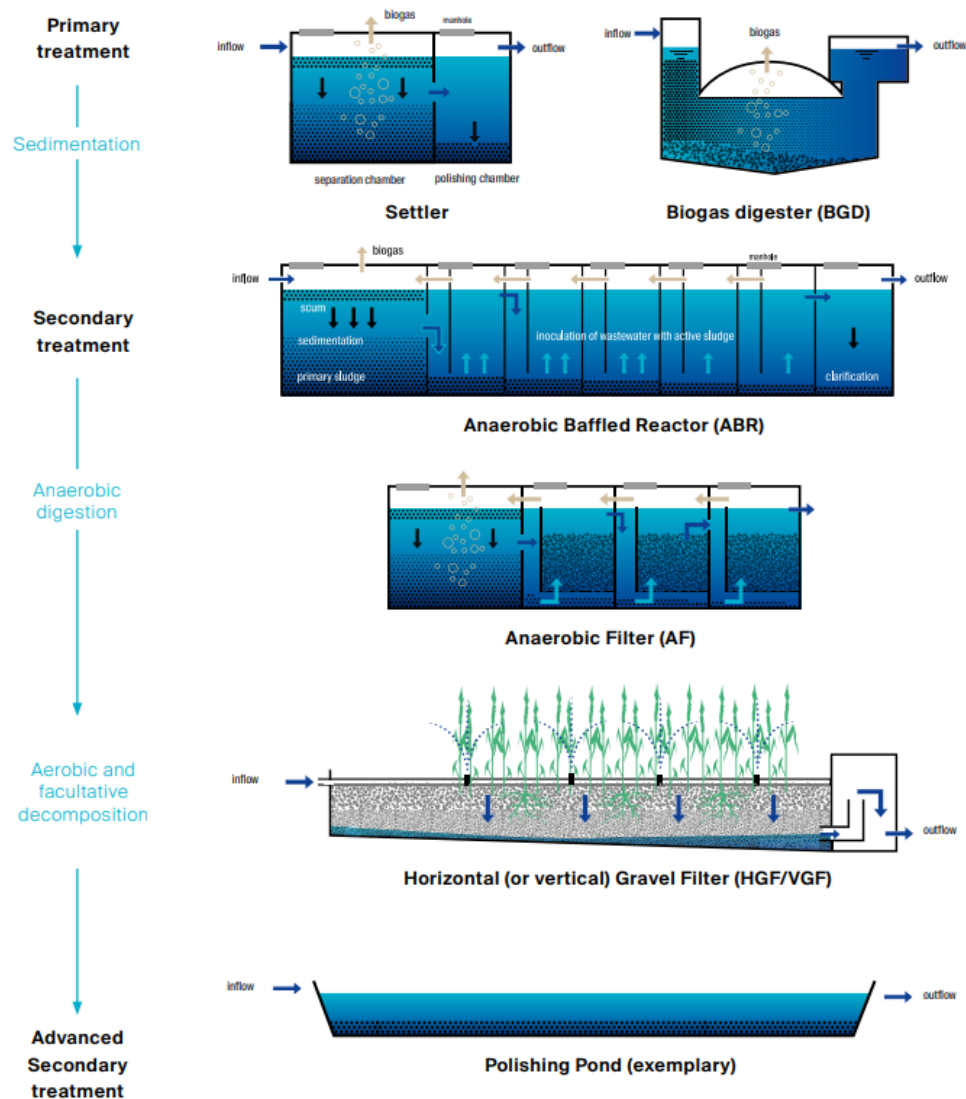
Table 1: BOD removal efficiency in each module of DEWATS

Source: Decentralised Wastewater Treatment System (DEWATS) by Consortium for DEWATS Dissemination Society

- F) Sludge accumulates in all modules of Settler, ABR, AF, HPGF and Polishing pond, periodical desludging is necessary.
 - G) The technology is applied more often in individual institutions such as hospitals and FSTP rather than community wastewater treatment.
- 3) Case of the technology application in India
See section 3. (5).

Figure 5: Detailed drawing of modules of DEWATS

Source: DEWATS implementation by BORDA



(2) Moving Bed Biofilm Reactor (MBBR)

- 1) MBBR is a biological treatment technology that was developed in 1980s in Norway as a more compact Waste Water Treatment Plant compared to the conventional activated sludge STP with improved treatment efficiency. MBBR is currently used in over 50 countries including India.
- 2) In MBBR tanks, microorganisms attached to a constantly moving solid medium (MBBR media) carry out treatment. The movement is made by the air bubbles in the aerobic process or using a mixer for anoxic process.
- 3) MBBR treatment process consists of::
 - Primary clarification as pre-treatment
 - MBBR aerobic tank(s) for BOD/COD removal (see the Figure 6)
 - MBBR anoxic tank can be added for nitrification and denitrification (see the Figure 7)
 - Secondary clarification
 - Tertiary treatment and disinfection

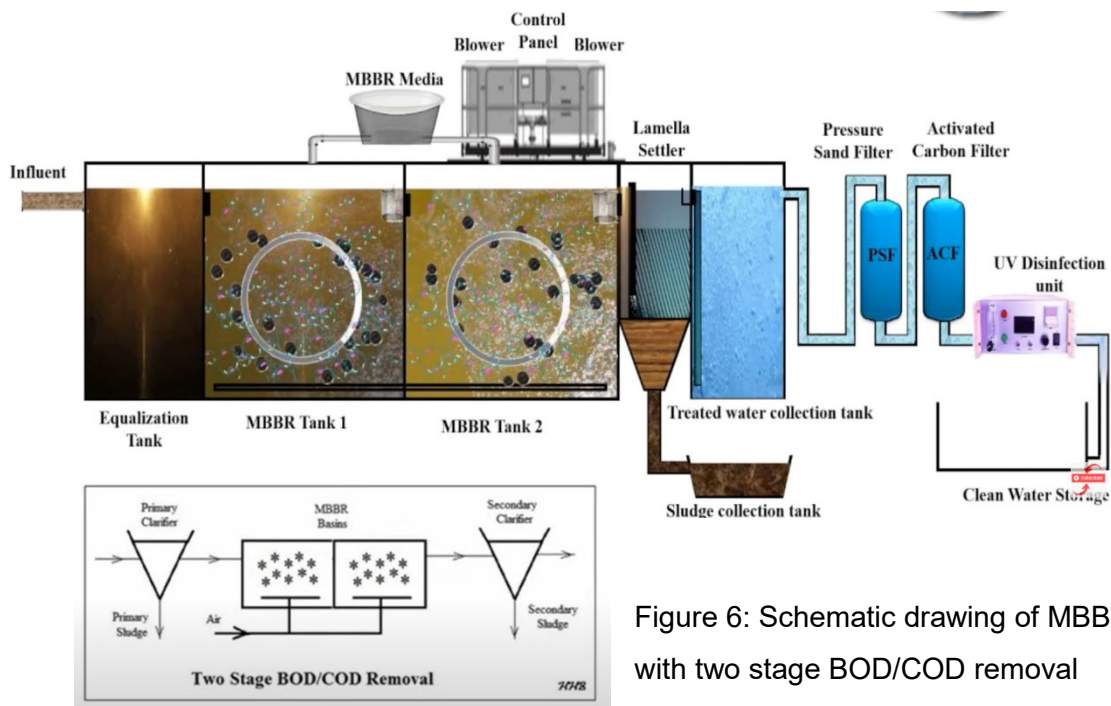
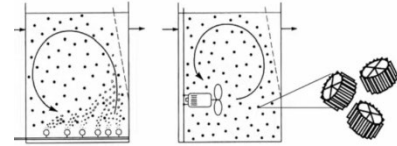


Figure 6: Schematic drawing of MBBR with two stage BOD/COD removal

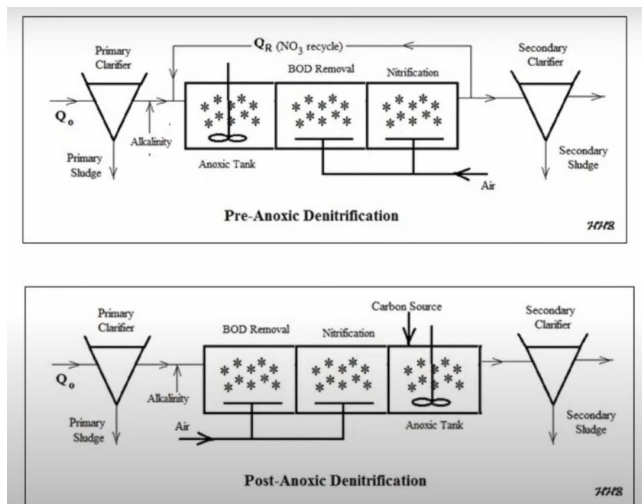


Figure 7: Schematic drawing with addition of anoxic tank for denitrification

Source: MBBR Process Description by Water Academy

- 4) Key features of the technology are as follows:
 - A) As for the activate sludge process, it is used for treatment of both municipal wastewater (grey and black) and industrial wastewater for BOD and COD removal, nitrification, and denitrifications.
 - B) Removal efficiency can be achieved up to 90-95% of BOD and COD removal and 90% of Nitrogen and Phosphorus removal. In order to meet the NGT standards, tertial treatment may be necessary.
 - C) Less space, roughly 1/4 of the conventional activated sludge STP, is required.



Image 1: 50KLD Pre-fabricated MBBR

Source: Greenviro Environmental Solutions

- D) Necessary operation and maintenance include monitoring and operating pumps and blowers, as well as performing routine maintenance on screening, clarifier,

influent equalization, integrated control and sludge removal.

- E) Skilled operator in the field of biological water treatment is necessary so they can properly analyze the media to ensure it's still doing its job of decomposing the waste in the tank.
- F) Non-interrupted supply of electricity is required for keeping the MBBR media moving through aeration. This makes energetic cost relatively high.

(3) Johkasou

- 1) Johkasou is a biological treatment technology developed in Japan in 1950s and has been introduced in 49 countries.
- 2) It is used for treatment of both “grey” and “black” domestic wastewater.
- 3) Treatment process of Johkasou is as follows:

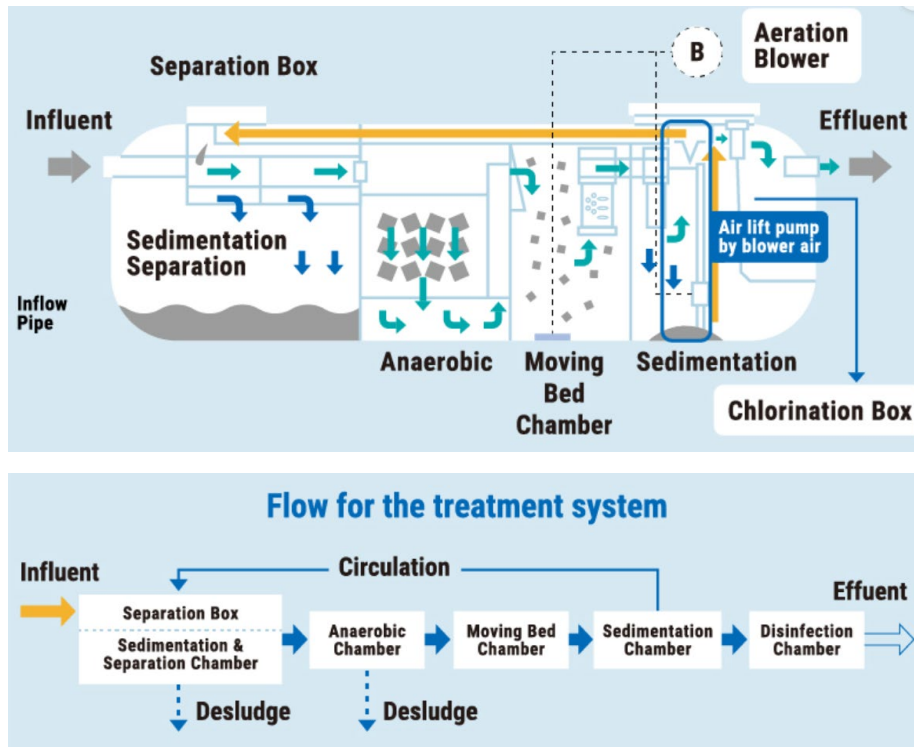


Figure 8: Treatment process of Johkasou

Source: Daiki Axis India

- ① **Separation Box:** Separate solids in wastewater by gravity and prevent the agitation of the excess sludge in Sedimentation & Separation Chamber by influent.
- ② **Separation & Sedimentation Chamber:** Separate solid debris or impurities from water in influent and circulated water and store these sediments in the chamber. Accumulated sludge should be desludged from the tank periodically at least once in 6 – 12 month.
- ③ **Anaerobic Chamber:** It is filled with filter materials, which separate solids and keep anaerobic microorganisms to decompose organic mater.
- ④ **Moving Bed Chamber:** It is filled with mesh cylindrical media, which retain aerobic microorganisms to decompose and remove organic matter from wastewater.
- ⑤ **Sedimentation Chamber:** In order to obtain clear treated water, separate the excess sludge (suspended solids,SS) by gravity. The settled sludge is

constantly returned to the sedimentation & separation chamber by the airlift pump.

- ⑥ **Disinfection Chamber:** Disinfect the treated water to discharge to the river or other water bodies.
- 4) Its most Important function is Re-Circulation system by which nitrification and denitrification process is repeated thereby attaining advanced treatment with higher removal of nitrogen.

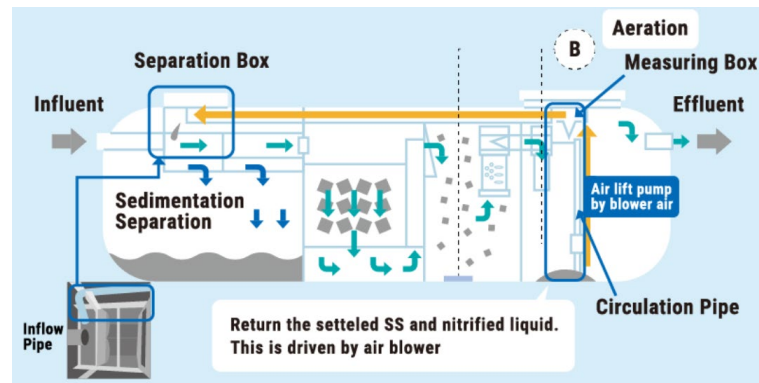


Figure 9: Re-Circulation Process

Source: Daiki Axis India

- 5) Key features of the technology are as follows:
 - A) In a single unit without adding advanced treatment facility, Johkasou can achieve not only BOD and COD removal but also Nitrogen and Phosphorus removal to meet the NGT standards.
 - B) Built in a Fiber Reinforced Plastic (FRP) Package and manufactured in quality-controlled factories, Johkasou is easy to install and start operations.
 - C) As for operation and maintenance:
 - Constant supply of electricity is necessary for blowers, although energy cost can be minimal.
 - Sludge cleaning of the sedimentation and separation chamber is necessary at least once every six months.

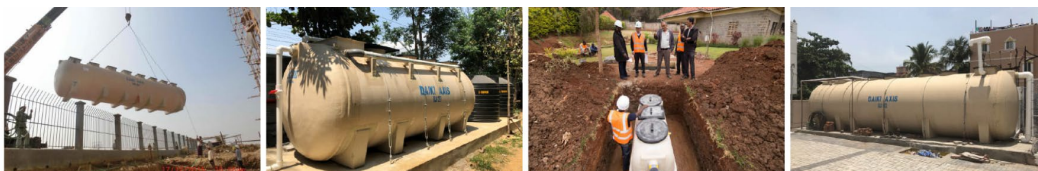


Image 2: Johkasou of FRP package

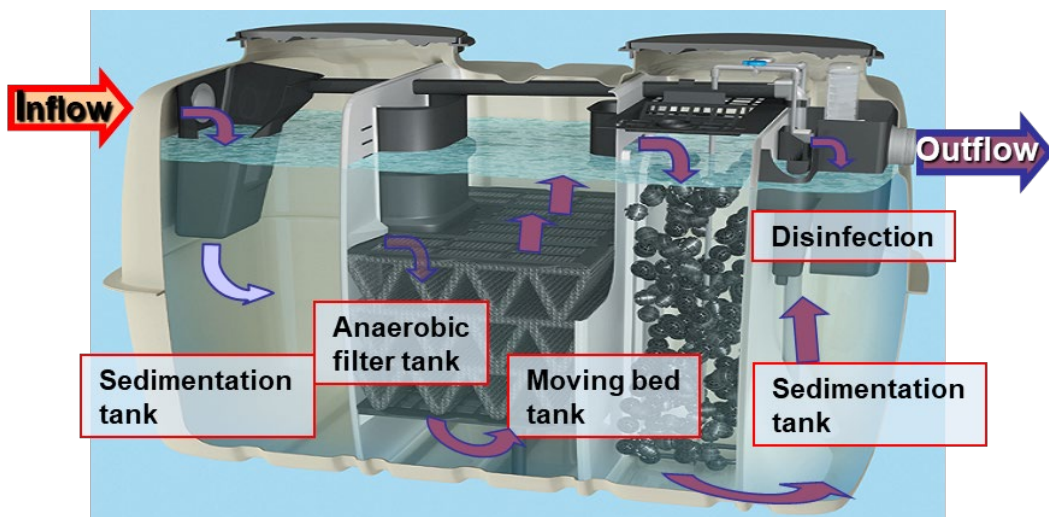
Source: Daiki Axis India

(4) Packaged Sewage Treatment Unit (PSTU)

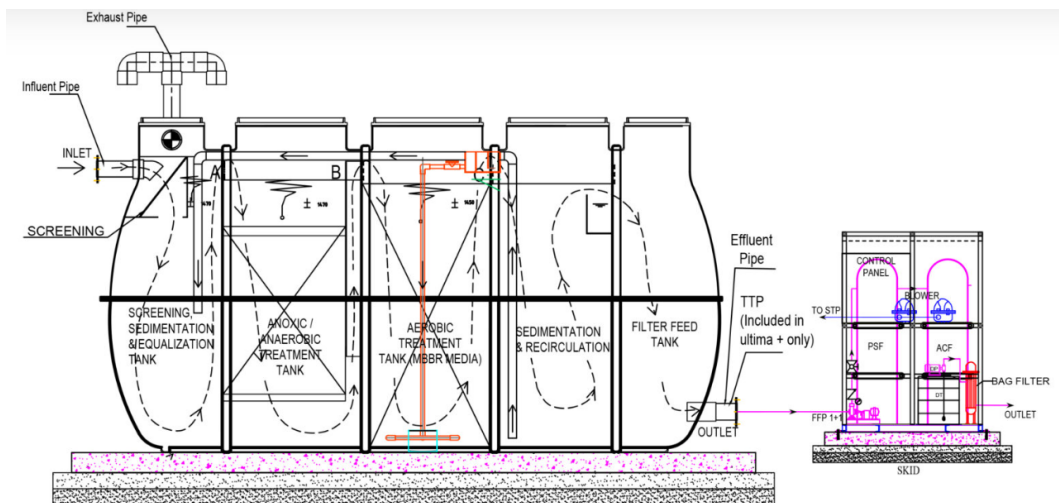
Packaged sewage treatment unit (PSTU) is housed in specially designed and highly durable fiber glass reinforced plastic (FRP) tank. These tanks are compact which can be utilized in a decentralized manner at any location, either it is underground or above the ground. Majority of Johkasou technology is categorized to PSTU but Moving bed biofilm reactor (MBBR) technology is also used in this system.

These technologies are designed to treat municipal sewage water, but, is also used to treat leachate water after solid-liquid separation in a FSTP.

◆ PSTU with Johkasou Technology (Source: Daiki Axis India)



◆ PSTU with MBBR Technology (source: HECS)

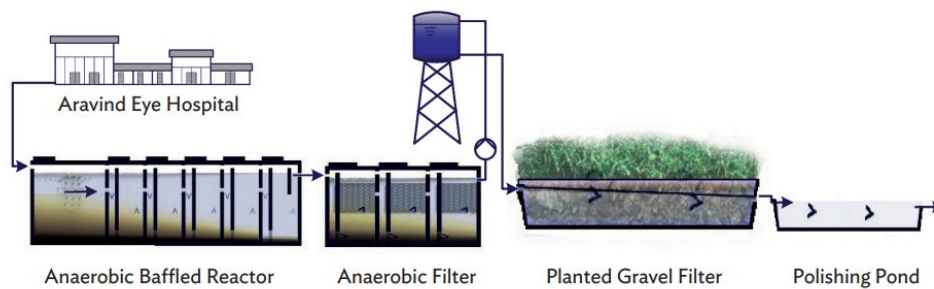


(5) Example of decentralized wastewater treatment - DEWATS at Aravind Eye Hospital, Madurai, TN

1) Key features

- Wastewater type: Domestic wastewater from toilets, bathrooms and kitchen
- Treatment capacity: 307KLD
- Land area required: 1,774m²
- Reuse of treated water: Gardening and toilet flushing

2) Treatment flow:



Source: Decentralized Wastewater and Fecal Sludge Management: Case Studies from India by ADB Institute

- The only visible parts above ground are the PGF and polishing pond, which are aesthetically integrated with the gardens and landscape as seen in the photo. As the wastewater flows through the filter subsurface of the PGF and is oxygenated in the process, there is no odor, flies, or any other nuisance.
- The anaerobic treatment modules such as the settlers, ABR, and anaerobic filter are all below ground.

3) Operation and Maintenance

- Regular maintenance checks of the sewer line systems and regular harvesting of plants in the PGF to clean the filter of organic matter and prevent clogging.
- Sludge in the settler, ABR, and anaerobic filter is removed every 4–5 years.
- Water samples from the polishing pond are tested periodically according to guidelines set by the Pollution Control Board.

4) Treatment Efficiency

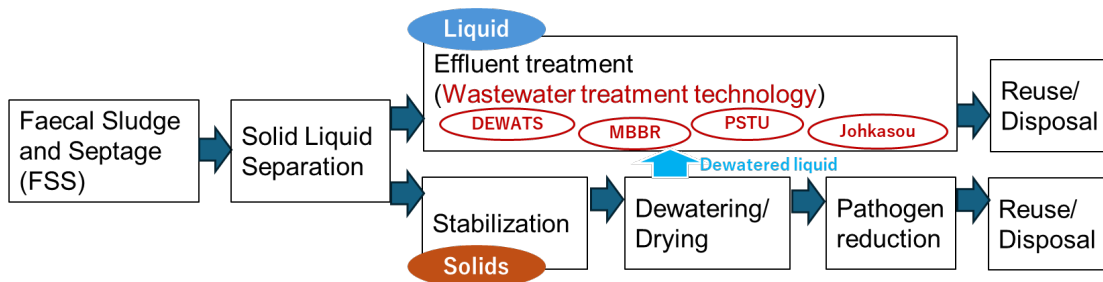
- Treatment efficiency is maintained at an average of 90%–95% BOD removal, with a final BOD of <10 mg/L and a COD of <30 mg/L.
- Nitrates are not removed as these are good for the plants when the treated water is used for gardening.

4. Treatment technology for faecal sludge and septage

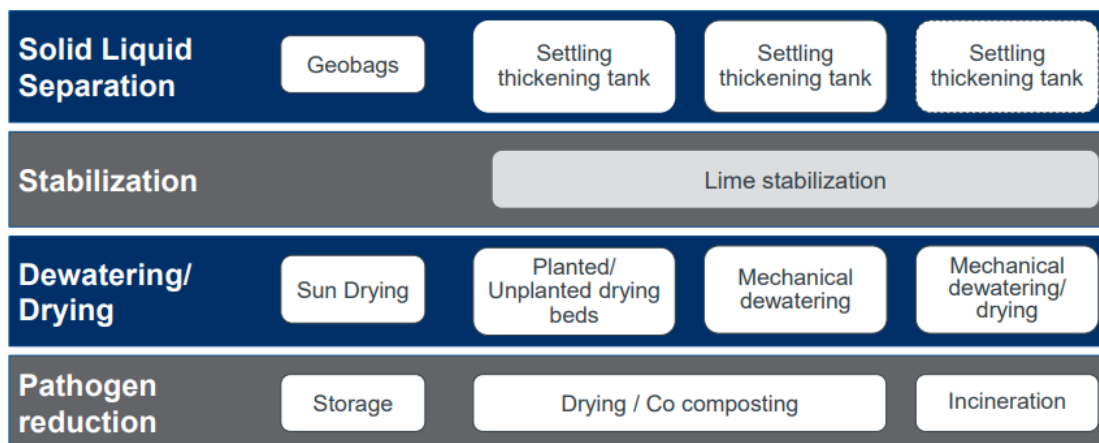
(1) Basic principle: Solid-liquid separation first

Treatment of faecal sludge and septage starts with solid-liquid separation.

After the separation, “liquid” part should be treated by wastewater technologies as presented in 3. above.



(2) Technologies for FSS treatment chains



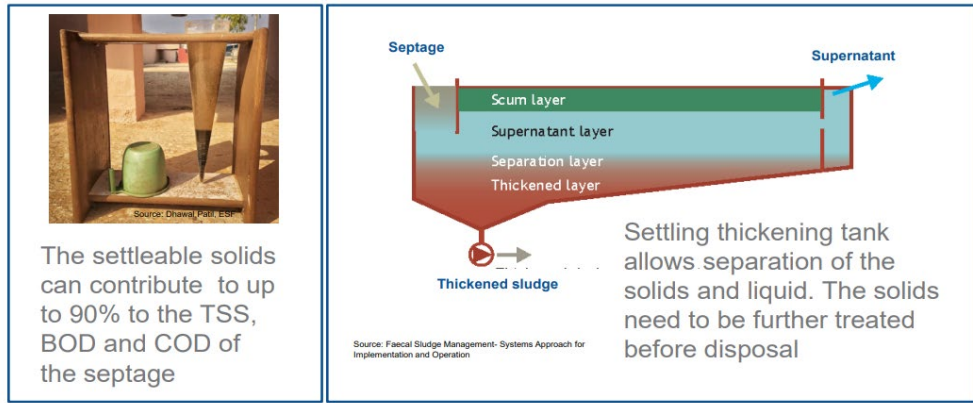
Source: FSSM Orientation Module by National Institute of Urban Affairs

(3) Technologies for “Solid Liquid Separation”

1) Settling thickening tank

- The technology is based on gravitational sedimentation of solids.
- The separation processes take few hours, however for thickening the sludge layer takes few days.
- The solid content of the septage usually is around 1%. The thickened sludge from the settling thickening tank can achieve solid content up to 12% if designed and operated well.

- The reduction of the solid content in the liquid effluent reduced the COD, thus bringing the COD to BOD ratio closer to 2 (domestic sewage has COD to BOD ratio of 2).
- Thus, the liquid effluent from the settling thickening can be treated with wastewater treatment technologies.
- The thickened sludge from the tank is sent for dewatering.



Source: FSSM Orientation Module by National Institute of Urban Affairs

2) Geotube

- Geotubes are made from a specialized woven fabric made out of polypropylene material.
- The fabric has pores of fixed size. When the septage is pumped into the geotube, the solids bigger than the size of the pores is retained inside and the liquid bleeds out of the tube.
- The free water leaves the geo tube immediately, however, the bound water takes seeps out of the tube over a period of day.
- Once the tube is filled and the seepage stops, the bags are cut open for sun drying of solids.

Geo tubes can be used for solid liquid separation. The tubes are one time use only and hence once cut open, needs to be washed and reused for protecting surface from soil erosion or slope stabilization is landslide prone area.

Geotube

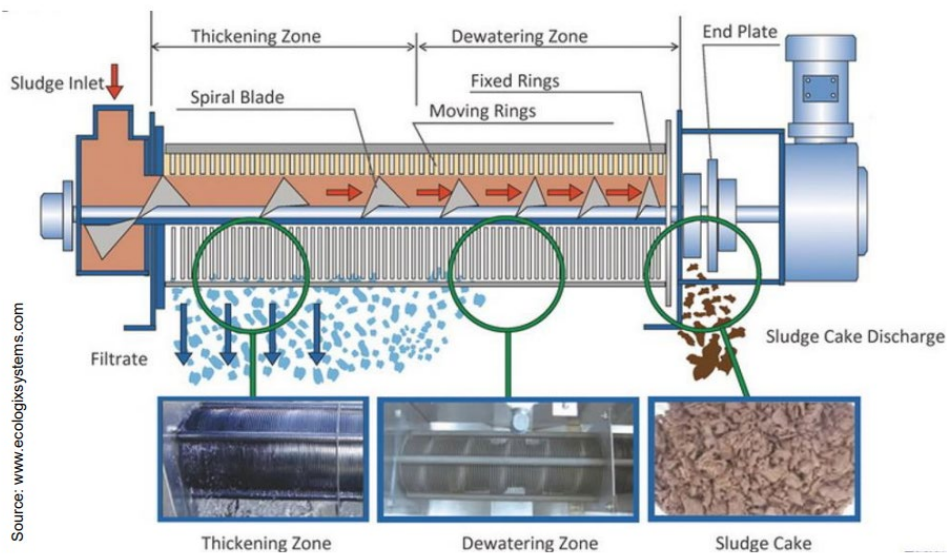


Source: FSSM Orientation Module by National Institute of Urban Affairs

(4) Technologies for Mechanical Dewatering

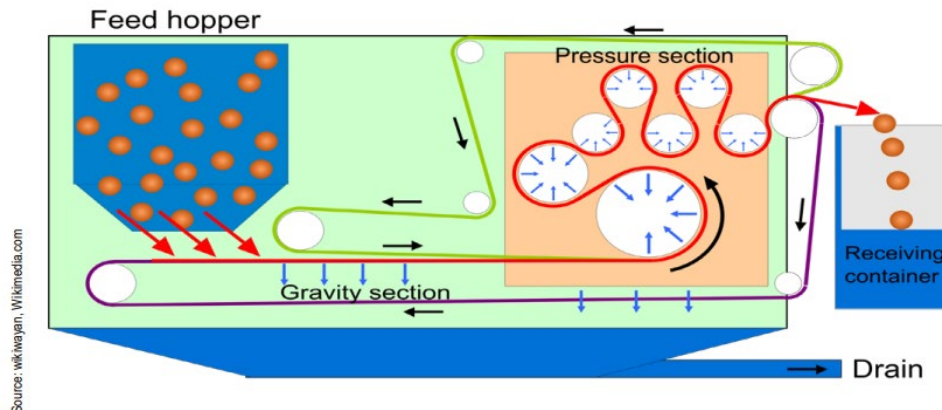
1) Screw Press

- The sludge is loaded at one end and the dewatered solids is discharged at the other end.
- A screw press has two zones, first the thickening zone where free water drains out and the next is dewatering zone. Here the sludge is compacted due to a diminishing distance between the screw and the cylinder, and the liquid that is squeezed out is removed through the pores in the cylinder.
- Although the screw press can operate for varying solid content, it is recommended to operate it at a consistent solid loading rate by conditioning the sludge using polymer before it enters the screw press.
- Typically, a solid content up to 25% can be achieved using screw press.



2) Belt Press

- A belt press consist of belts which squeeze out the water from sludge as it is compressed between two belts.
- The main disadvantages of a belt filter press compared to other mechanical dewatering techniques are the need for skilled maintenance and the difficulty in controlling odours.
- The system consists of:
 - A gravity drainage zone where the flocculated sludge is deposited and conveyed on a porous and mobile belt
 - A compression zone where a second belt is applied on the upper layer of the sludge
 - A zone where the belts are separated and the dewatered sludge is released



Source: FSSM Orientation Module by National Institute of Urban Affairs

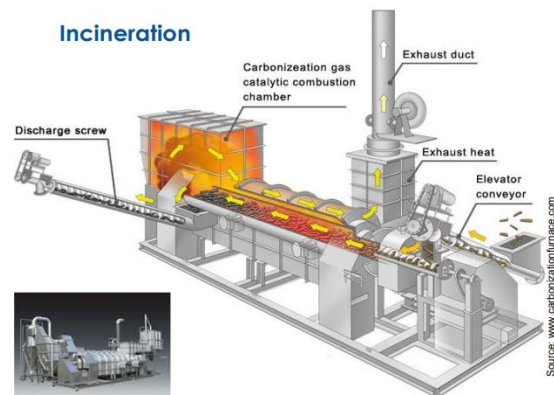
(5) Technologies for reuse or disposal of dewatered sludge

1) Sludge Drying – Heat Treatment

- The dewatered sludge is dried using the hot air from the combustion chamber.
- The dried solids then fall into the combustion chamber. This chamber can be operated as an incinerator or pyrolizer. The operating temperature and supply of oxygen determines of the combustion process.
- The solids are first converted in to carbon (bio char) at a lower temperature (4000 C – 6000 C) and further the bio char burns to produce more heat and higher temperature up to 8000 C – 9000 C.
- The end product such as bio char has good calorific value and can be used in furnaces.

- There is complete elimination of pathogen from the solids and significant volume reduction is also achieved.
- The advantage of the system is it is very compact and gives quite consistent

- Dewatered sludge is dropped onto the conveyor belt
- The sludge is further dried using the exhaust heat
- The dried solids go for dry pyrolysis or incineration
- The by product such as biochar or fly ash is taken out from the combustion chamber
- Exhaust gases to meet discharge standards

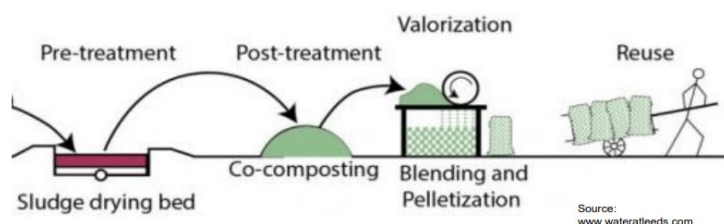


Source: FSSM Orientation Module by National Institute of Urban Affairs

2) Co composting

- Co composting can be performed on the dewatered sludge. Sludge is rich in nitrogen and if mixed with organic solid waste to achieve C:N ratio of 30 then aerobic composting can be done.
- Thermophilic condition is required for pathogen inactivation and hence care needs to be taken to achieve optimum temperature and maintain oxygen concentration between 40% - 60%.
- The advantage of the co composting is that it performs drying and pathogen reduction simultaneously and generates a end product with higher value in the market.
- Limiting factors to practice co composting can be technical and managerial skills along with area required to manage the piles.

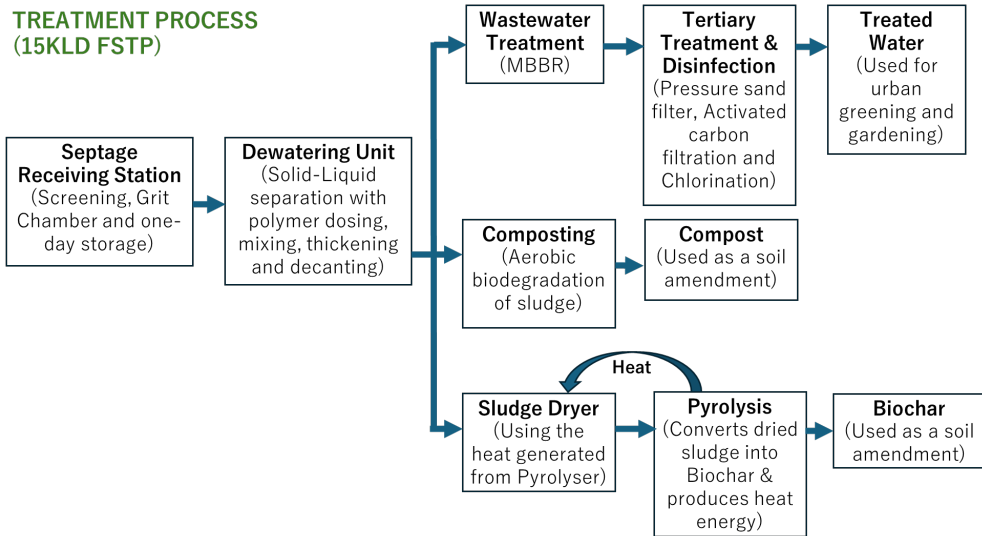
- C:N Ratio = 20-30:1, Oxygen concentration: 40-60%, Particle diameter < 5 cm
- **Advantages:**
Thermophilic condition- Pathogen inactivation
- **Limiting factors:**
Technical and managerial skills



(6) Examples of FSTPs in the State of Telangana

1) 15KLD FSTP in Warangal with technologies of MBBR, Co composting and Pyrolysis

- 15 KLD FSTP using a system based on pyrolysis
- After solid-liquid separation at dewatering unit, effluent is treated through MBBR while part of the solids are co composted to produce compost and remaining is sent to heat treatment to produce biochar.



MBBR Unit



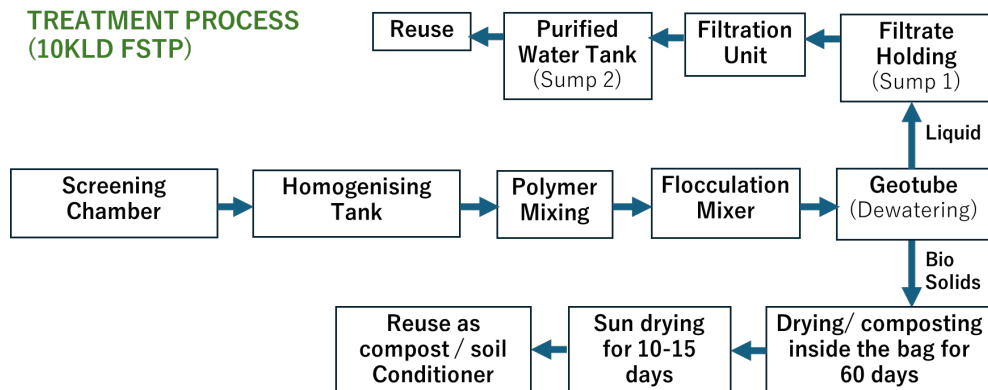
Pyrolysis system



Pyrolysis system

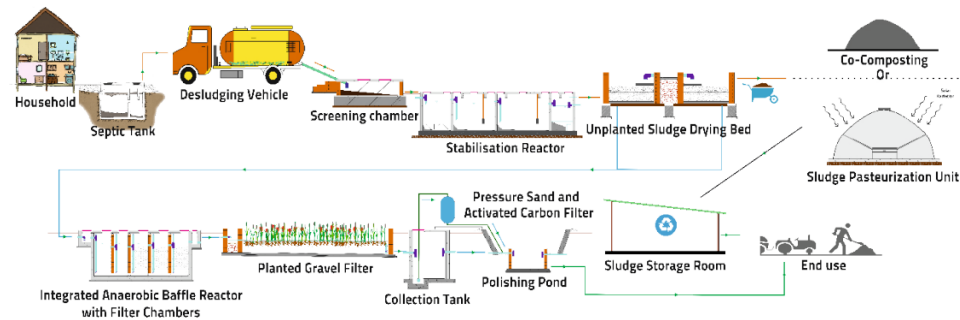
2) 10KLD FSTP in Warangal using the technology of Geotube

TREATMENT PROCESS (10KLD FSTP)



3) 18KLD FSTP in Sircila based on the DEWATS technology

TREATMENT PROCESS



Source: CDD society