



Water audit: A scientific measure and tool to address water scarcity

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CWAS CENTER
FOR WATER
AND SANITATION

CRDF CEPT RESEARCH
AND DEVELOPMENT
FOUNDATION

CEPT
UNIVERSITY

About CWAS

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.

CEPT Research and Development Foundation (CRDF) has been established by the University to manage their research and capacity building activities. There are nine domain-focused centers in the CRDF. The Center for Water and Sanitation (CWAS) is among the first center to be established.

CWAS began its work in 2009 with focus on improving water and sanitation services in India. It carries out activities related to action research and capacity building – working closely with city and state governments, enabling them to improve delivery of services. CWAS is closely engaged with Faculty of Planning at CEPT University. CWAS team teach and guide students of Faculty of Planning.



Global and national focus on WATER

The global annual water loss quantity is predicted to be 126-billion-meter cube, costing over 3900 crore dollars each year.

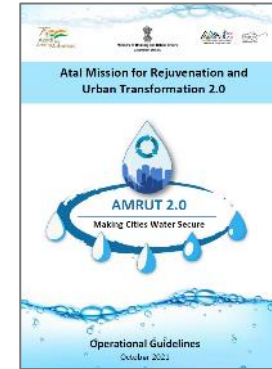


UN-mandated Sustainable Development Goal (SDG) 6 aims to “ensure availability and sustainable management of water and sanitation for all”



WATER is at a central place in the climate talks at COP26

- **Water and Climate Pavilion at COP26**
- **Countries to integrate water and climate agendas at national level**



City Water Balance Plans and City Water Action Plans are one of the key components of AMRUT 2.0

- ✓ **Making Cities Water Secure**
- ✓ **Universal coverage of water supply**

Where will all this extra water come from?



Need ways to measure...

How much water is being lost?

Where are losses occurring?

Why are losses occurring?

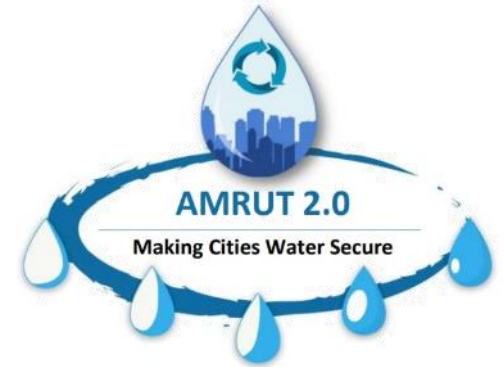
What strategies can be introduced to reduce losses and improve performance?

Source: Water and Sanitation Program of the World Bank

National priority under AMRUT 2.0 to move towards Urban Water Secure Cities

AMRUT 2.0

- Water Security
- Water Audit (Including nonrevenue water or losses audit)
- Making WTPs more energy efficient.



SMART CITIES (Smart Solutions)

- Leakage Identification, Preventive Maintenance

15th Finance Commission performance grant

- 15th FC performance grants link to reduction in non-revenue water

IWA standard water balance chart provides a way to understand and classify losses for improvement actions

System Input Volume (A)	Authorised consumption (B1)	Billed authorised consumption (C1)	Billed meter consumption (D1)	Revenue water (E1)
			Billed un metered consumption (D2)	
		Unbilled authorised consumption (C2)	Unbilled metered consumption (D3)	Non- Revenue Water (NRW) (E2)
		Unbilled unmetered consumption (D4)		
	Water losses (B2)	Apparent losses (C3)	Unauthorised consumption (D5)	
			Metering inaccuracy (D6)	
		Real losses (C4)	Leakages on transmission and/ or distribution mains (D7)	
	Leakages and overflows at Utility's storage tanks (D8)			
	Leakage on services connections up to point of customer metering (D9)			

What is Non-Revenue Water (NRW)?

- **Unbilled authorized consumption (free supply)** - includes water consumption of free connections in parks, government buildings, educational institutes, religious places, public stand posts / tap connections, etc.
- **Apparent losses (commercial losses)** - includes unauthorized (illegal) consumption and all types of meter inaccuracy and data handling error
- **Real losses (physical losses)** - Volumes lost through all types of leaks, bursts and overflows on mains, service reservoirs and service connections, up to the point of customer metering

Unbilled Authorized Consumption



Apparent losses (commercial losses)

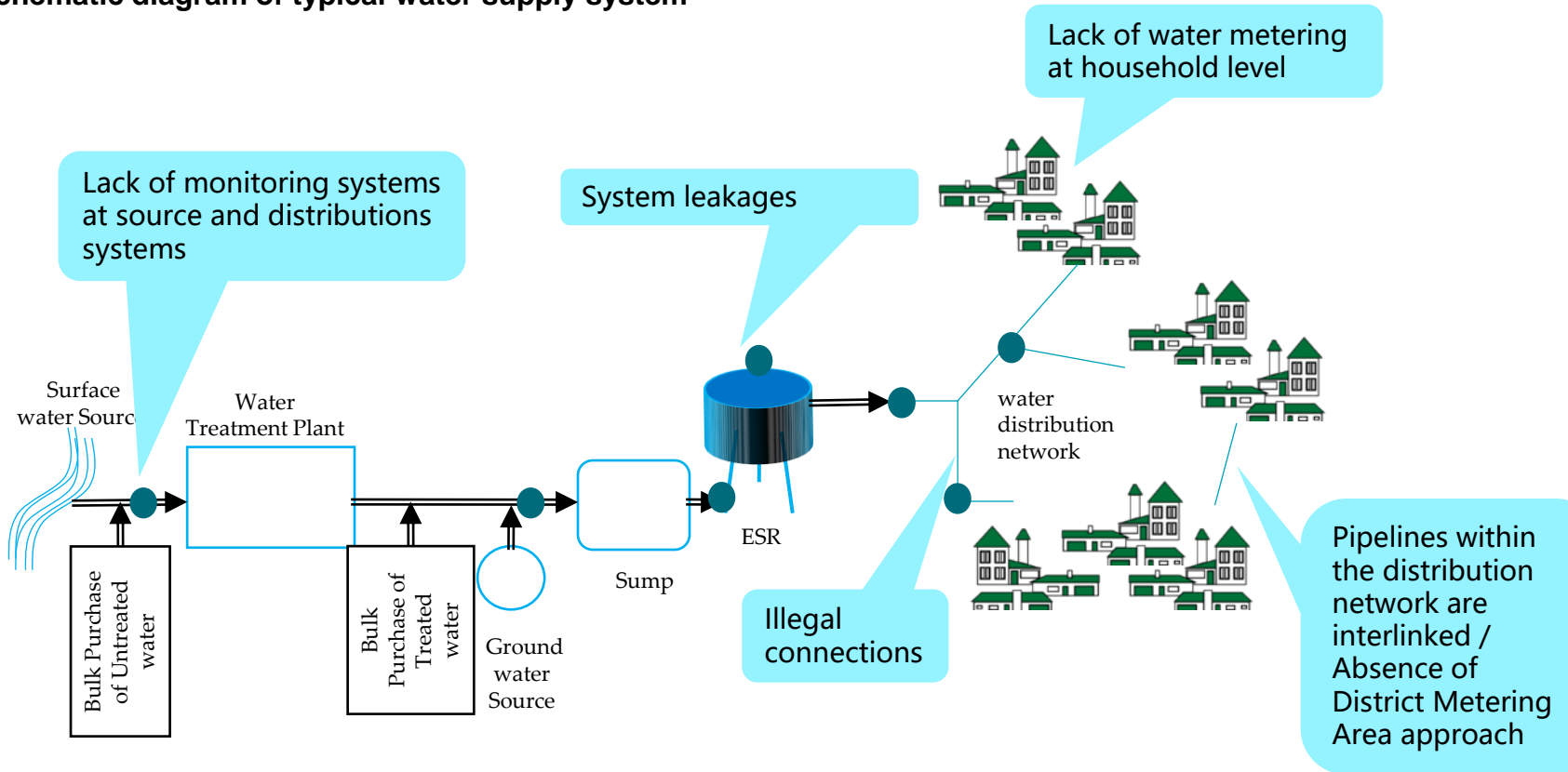


Real Losses (Physical Losses)

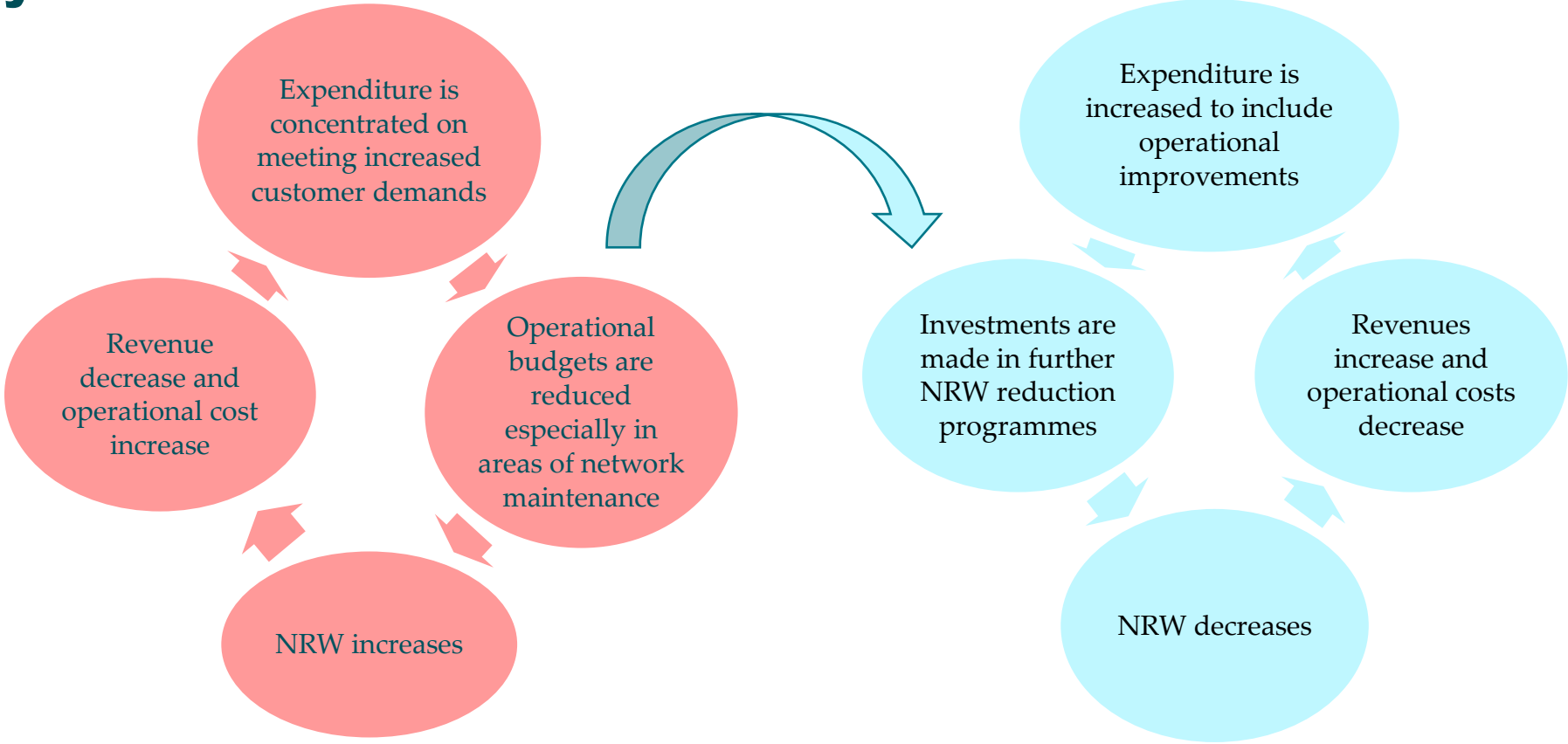


Current scenarios on water supply systems in urban India

Typical Schematic diagram of typical water supply system



To achieve water secure cities, convert vicious to virtuous cycle of NRW



The vicious NRW circle

The virtuous NRW circle

Methods for real losses assessment

The following methods has been used for measuring and estimating losses from identified leaks:

- ✓ **Bucket and stop-watch methods**
- ✓ **Portable Ultrasonic Flow Meter**
- ✓ **Volumetric measurement**
- ✓ **Measurements by partially filled pipe, V-Notch etc.**



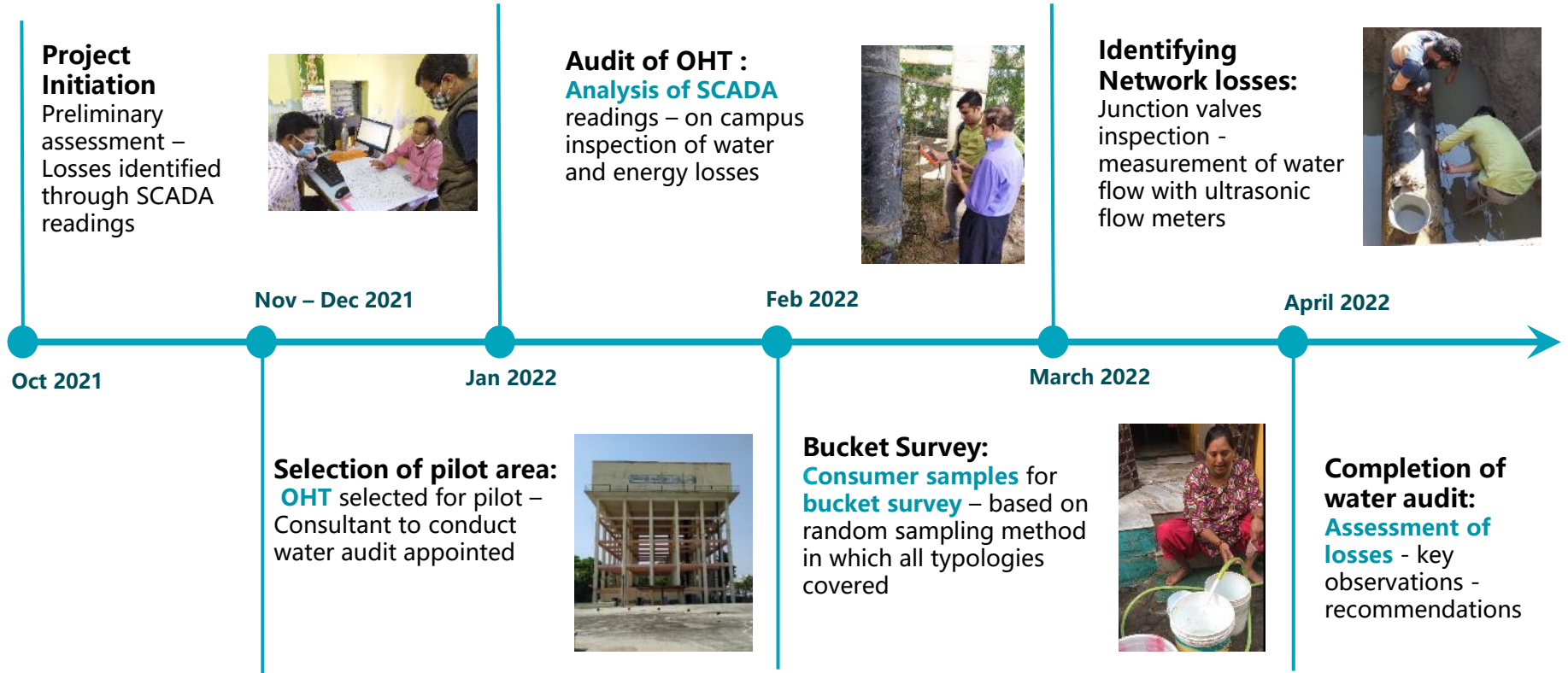
- ✓ **Leaks at raw/treated water transmission lines**
- ✓ **Evaporation losses: Evaporation rate should be measured and with the help of capacity curve, losses should be calculated**
- ✓ **Water treatment losses: Inlet and outlet of treatment plant should be measured**
- ✓ **Leaks/seepage of reservoirs: Drop test should be carried out**
- ✓ **Leaks of distribution mains: Measure inlet and outlet of pipelines**
- ✓ **Leakages from valves and air valves: Can be calculated using bucket and stop-watch method**
- ✓ **Leakages from services connections up to meter: By deducting the mains leakage and storage tank leakage from the total volume of physical losses**



Large scale water audits are expensive and require huge technical capacity usually unavailable to municipalities....

Preliminary Water Audit Methodology by CWAS

Timeline for preliminary water audits that provides rationale for assessment of water losses in the system for selected city



Template for water audit

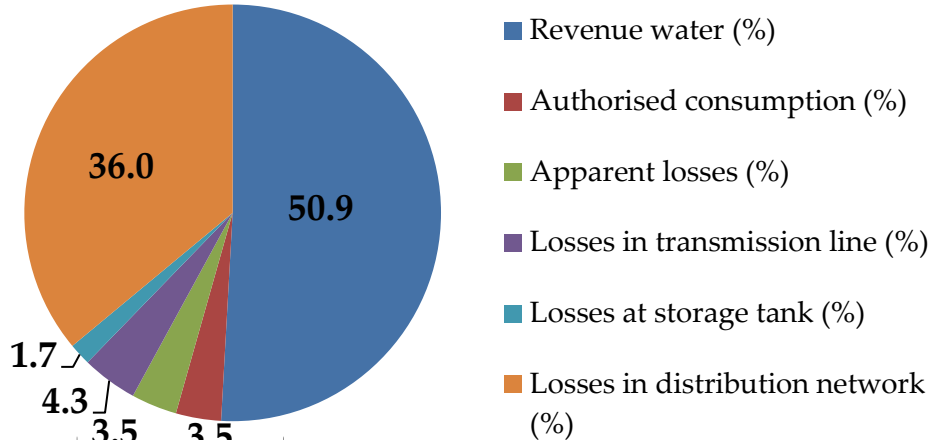
Sr. no.	Item	Water Volume		
		Subtotal (MLD)	Total Consumption (MLD)	Percentage of Total Supply
1	At Head works		14.21	100
2	At Storage Reservoir		13.43	
3	At consumer end			
4	-Domestic -Non-Domestic Total	5.66 0.36	6.02	
5	Corrections- Low flow rate not recorded on meter		1.96	
A	Total corrected water use		7.98	56.16
6	Free water use	1.25		
B	Total authorised water use		1.25	8.80
7	Unauthorised consumption from illegal connections	0.15		
C	Total apparent loss		0.15	1.06
8	Loss of water from Source to GSR (Transmission Loss)	0.78		
9	Loss of water at storage tanks	0.12		
10	Loss of water in distribution system	3.88		
D	Total real loss		4.78	33.64

Case Study

Preliminary water audit exercise in selected cities of Gujarat

- Preliminary water audit study conducted in 10 cities of Gujarat
- NRW value varies from 35% to 77% in these towns
- Results are shared with executive representatives and elected representatives

Breakup of total water supplied



Step 1: Preliminary Visits

Preliminary visits included discussions with city officials, documenting existing water supply system, documenting current system of water quantity estimation, site visits for identifying bulk flow measurement points, etc.



Step 2: Field measurement - At various sources, WTPs and WDSs

Field measurement included bulk flow measurement at various sources, WTPs, WDSs using portable ultrasonic flow meter.



Step 3: Field measurement - At consumer end

Representative sample survey is carried out at consumer end using water meters, water quantity reached at consumer end is measured for the full supply hours in a day



Step 4: Preparation of draft report

Based on the field measurement, amount of losses from sources to WTPs, WTPs to WDSs and WDSs to consumers, free water use and illegal consumption were calculated and strategies were prepared to reduce these losses.



Step 5: Preparation of final report

Results were shared with the elected representatives and councils and their inputs were incorporated in the final report

Case of water audit at WDS level: Bucket survey at consumer end to assess water consumption

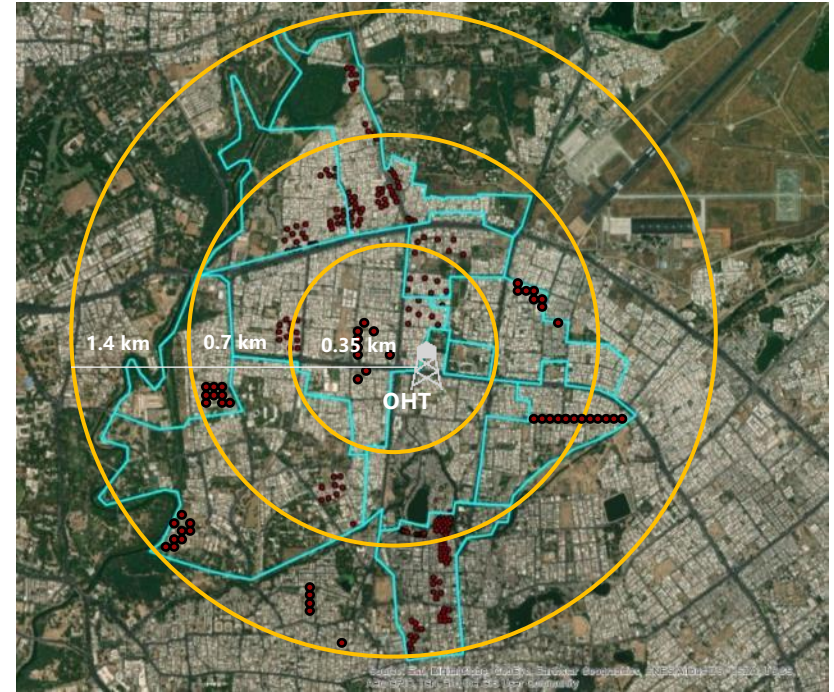
- Total **28,770 water connections** registered in the tax base.
- **No documentation of water connections** OHT/ sub zone-wise. Number of water connections in each sub-zone was analysed and mapped using weighted average method using GIS mapping tool.
- **250 samples** were considered based on **random sampling method** with 90% confidence level.
- **Bucket survey** was carried out in **9 sub-zones (slum HH, non-slum HH and commercial)** of command area during the water supply hours at head and tail of network.
- **Buckets of 15 litres and 20 litres** were used to record volume of water using a stopwatch.



Bucket Survey at consumer end.



20 litres of bucket used for survey



- Command area boundary
- Bucket Survey Samples

Source: VMC; CWAS analysis based on desk research, January 2022

Losses in Distribution station and Overhead tank

- **Flow meter readings** from SCADA were recorded
- **Hourly based readings** were taken from the tank to measure water level. This was done by filling the tank full.
- **Leakages in valves** were observed and detected at the OHT
- **Losses** calculated on an average basis based on the readings.



Survey to capture hourly based readings at OHT



Leakages at the OHT

Losses in valves and pipelines



Leakages in valves in the Karelibaug command area



Water losses in pipelines

Source: Based on water audit by Soham Tech and CWAS team at the Karelibaug OHT, January 2022

Water audit helps in spatial assessment of water supply distribution

Avg. Water supplied per Connection



451
Litres / Connection / Day

HHs with **slum** observes lower per capita water supply



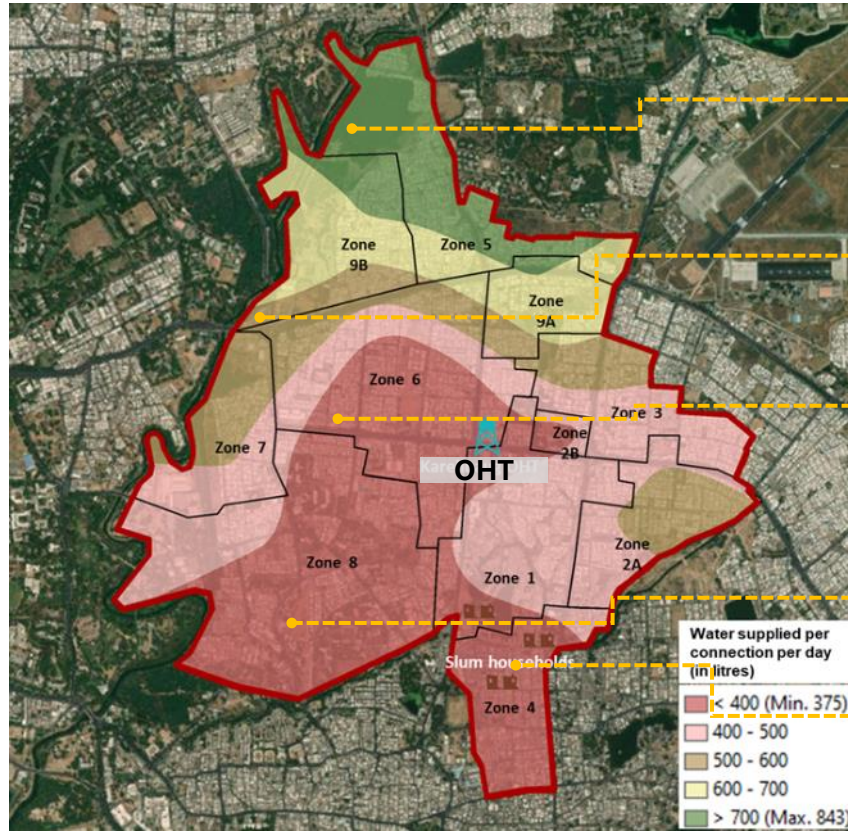
609
Litres / Connection / Day

Wide variation in water supply in **non slum HHs** is noted from survey



851
Litres / Connection / Day

Large sized pipe diameters commercial zones receive higher per capita water supply



Inequity in water supply hours leading to **over consumption** of water in some zones.



Achieve per capita as per standards due to **direct feeder line connections** in the area



Issues related to poor **water pressures** in areas with topographical differences.



Unaccounted water supply from Warasia booster pump in few areas.



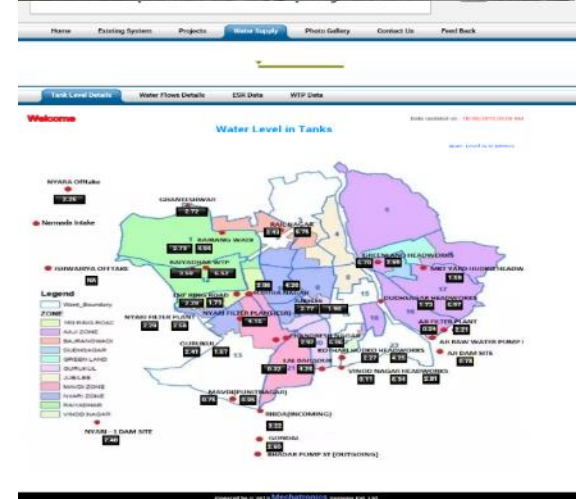
Water theft observed in slum pockets of Hathikhana due to low water pressure.

Inequity in water received at consumer ends

Source: CWAS, CEPT analysis based on results from water audit

Measures to reduce NRW: Case of Rajkot

- There was **no accountability for water losses** in transmission and distribution line due to lack of bulk flow meters at supply side and water meter at consumer end
- **Preliminary water audit study of Rajkot Municipal Corporation** indicated high losses in water supply transmission line. And therefore **RMC installed real time water losses monitoring system** in transmission lines to monitor and reduce water losses.
- After installing this system, it was found that **many illegal connections were directly taken from main transmission line** and there were high leakages in few lines.
- **City officials disconnected the illegal connections** and replace the leaked pipelines to reduce water losses.



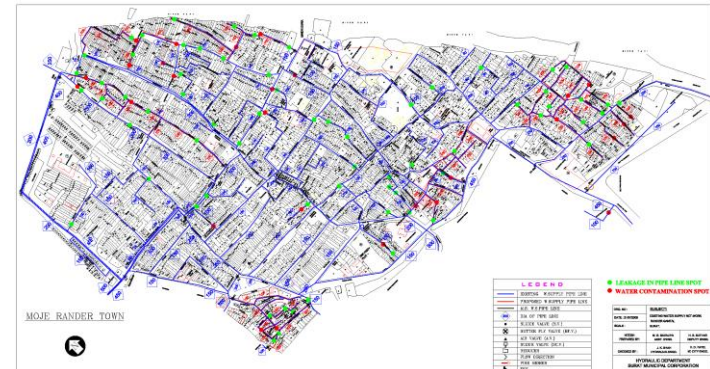
Measures to reduce NRW: Case of Surat

Surat : Formation of NRW Cell & SCADA

- One of the pioneering initiatives of the Surat Municipal Corporation was the setting up of an **NRW cell**.
- Activities in Surat resulted in positive outcomes for creating accountability and early enthusiasm leading to the tangible results of **leakage mapping exercise** carried out by NRW cell of SMC.
- Following the initial leakage mapping exercise, the number of leakages was **reduced by 30% annually in all zones**.

Key Results Achieved

- **Reduction in leakages per km length of pipeline.**
- **Reduction in number of complaints.**
- **Better tracking of complaints**
- **Leak repairs and water savings**



Source : Compendium of good practices urban water supply and sanitation in Indian cities, NIUA

Recommendations: Reduction strategies for NRW



- **Repair leakages** at the OHT, valves and distribution lines.



- **Performance based contract linked with reduction of water losses** for maintenance of distribution network



- **Capacity building of waterworks department of ULBs** for utilization of SCADA data.
- **Training sessions and workshops** to address NRW losses.



- **Regularisation** of unauthorised connections.
- Structured **equivalent** water supply timings



- **Awareness campaigns for consumers** regarding **water conservation**

Thank you

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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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