

# Water and Development Congress & Exhibition 2023

10-14 December 2023 | Kigali, Rwanda

## Reduction of Non-Revenue Water through Preliminary Water Audit for Indian cities

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# Global and national focus on increased access to WATER



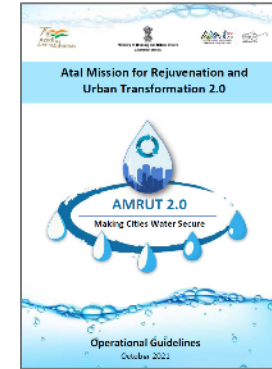
UN-mandated Sustainable Development Goal (SDG) 6 aims to “**ensure availability and sustainable management of water and sanitation for all**”



**WATER** is at a central place in the climate talks at COP talks

Increased access to water as climate adaptation and resilience

Countries to integrate water and climate agendas at national level



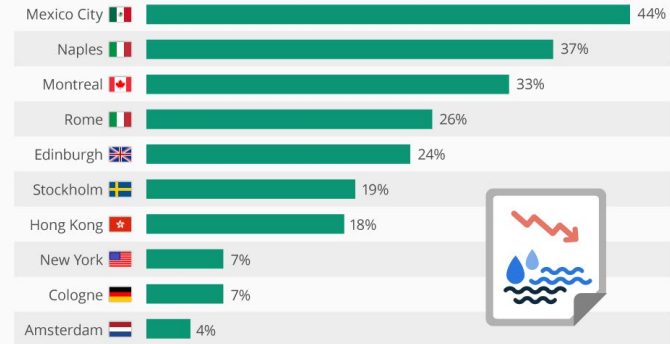
In India, **City Water Balance Plans and City Water Action Plans** are one of the key components of AMRUT 2.0

- ✓ **Making Cities Water Secure**
- ✓ **Universal coverage of water supply**
- ✓ **Har ghar nal. Har ghar nal se jal !(Tap in every home. Water in every tap)**

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

### Some Cities Suffer Enormous Water Losses Every Year

% share of water loss in selected cities in 2012



@StatistaCharts

Source: OECD

statista

Did you know?

If global water losses were reduced by only 30%,

**800 million**

people could be supplied with already treated water!



World Water Loss Day  
4<sup>th</sup> December

# Where will all this extra water come from?



Need ways to measure...

How much water is being lost?

Where are losses occurring?

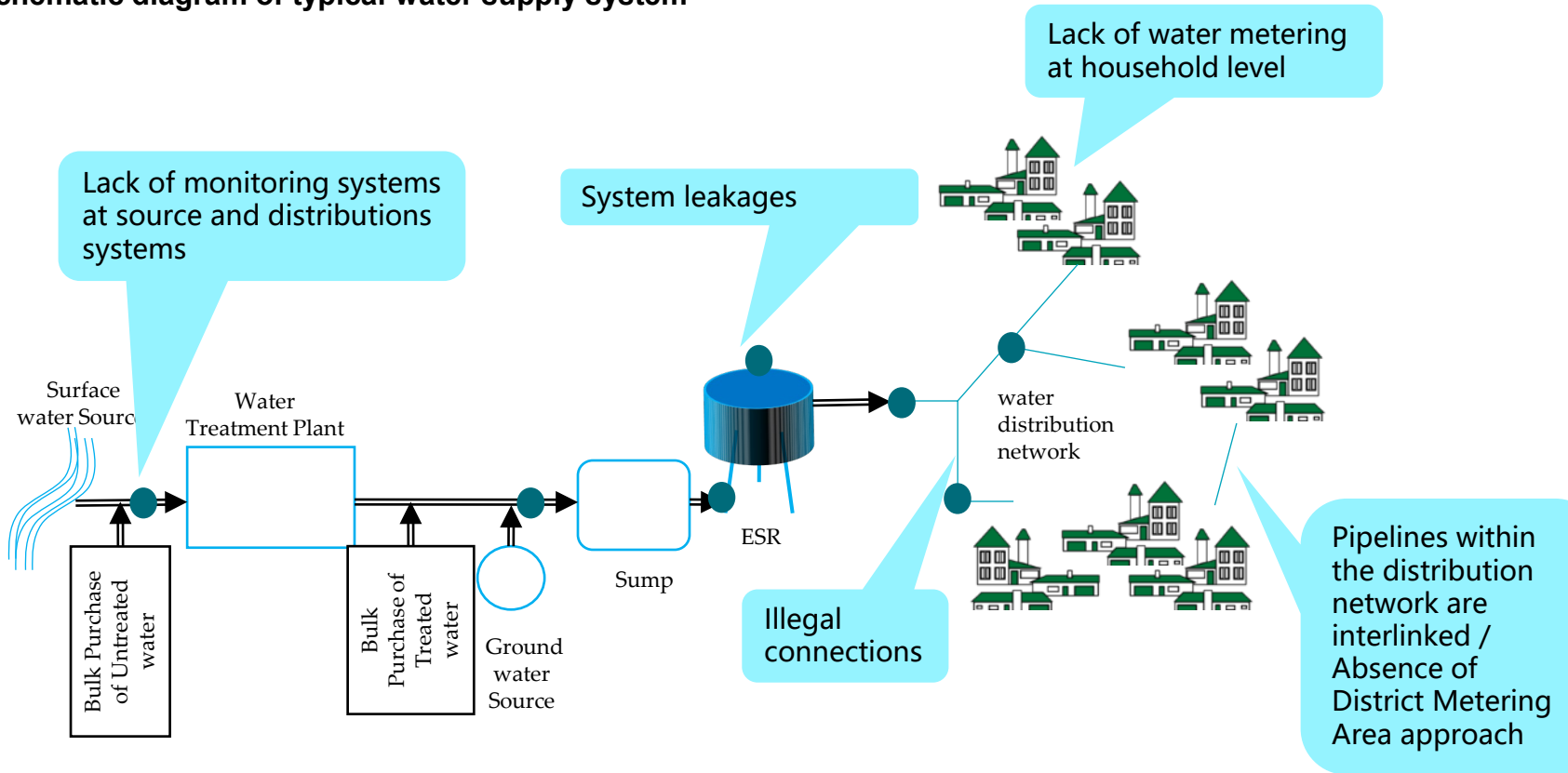
Why are losses occurring?

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

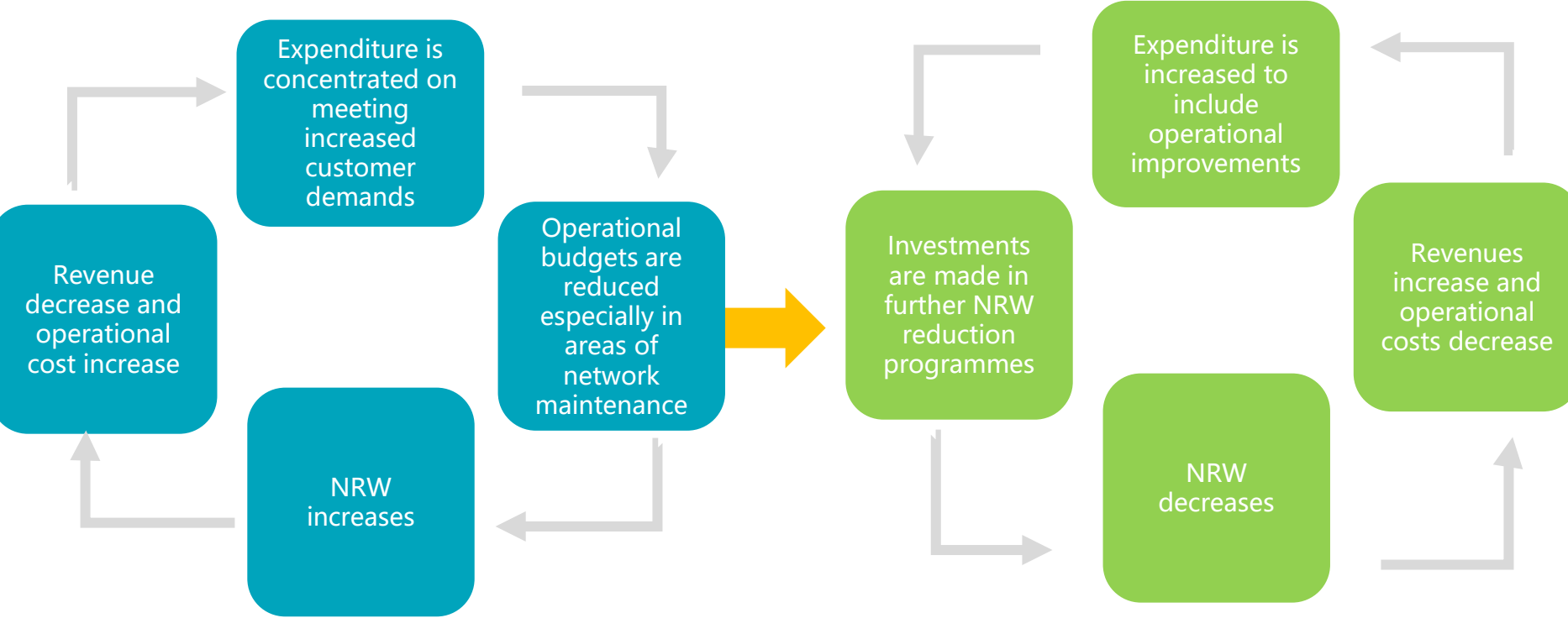
Source: Water and Sanitation Program of the World Bank

# 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



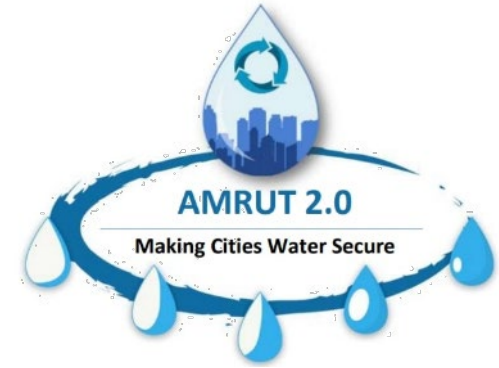
**The vicious NRW cycle**

**The virtuous NRW cycle**

# Indian infrastructure missions focusing on loss reduction

## AMRUT 2.0

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



## SMART CITIES

- Leakage Identification, Preventive Maintenance

## Intergovernmental fund transfers - 15th Finance Commission performance grant

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

# To reduce, first we need to measure !

**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)		
	Apparent losses (C3)	Unauthorised consumption (D5)		
		Metering inaccuracy (D6)		
	Water losses (B2)	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)	

Source: [IPCC](https://www.ipcc.org/); : [IUCN.ORG](https://www.iucn.org/); [UNCCD](https://www.unccd.org/); [WRI, 2019](https://www.wri.org/); [UNESCO, 2023](https://www.unesco.org/)





Absence of metering  
at household level in  
Indian cities ....

Full scale water audits  
become expensive and  
require huge technical  
capacity usually  
unavailable to  
municipalities....

**Preliminary Water  
Audit Methodology  
by CWAS**

# Template for preliminary water audit

	Sr. no.	Item	Water Volume		
			Subtotal (MLD)	Total Consumption (MLD)	Percentage of Total Supply
Flow meters, bulk purchase bills	1	At Head works		14.21	100
	2	At Storage Reservoir		13.43	
	3	At consumer end			
Metered connections, consumer billing, water supply zones , bucket sampling	4	-Domestic	5.66	6.02	
		-Non-Domestic	0.36		
		Total			
free connections in parks, government buildings, educational institutes, religious places, public stand posts / tap connections, etc.	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		
leaks, bursts and overflows on mains, service reservoirs and service connections, up to the point of customer metering	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

# Steps for preliminary water audits

## Project Initiation

Preliminary assessment and data collection



## Audit of WDS and water source :

Flow meters  
Analysis of SCADA data (if available)



## Identifying Network losses:

Junction valves inspection -  
measurement of water flow with ultrasonic flow meters



Field visits to all water sources and supply zones



## Bucket Survey:

Consumer samples for bucket survey – based on random sampling method in which all typologies covered

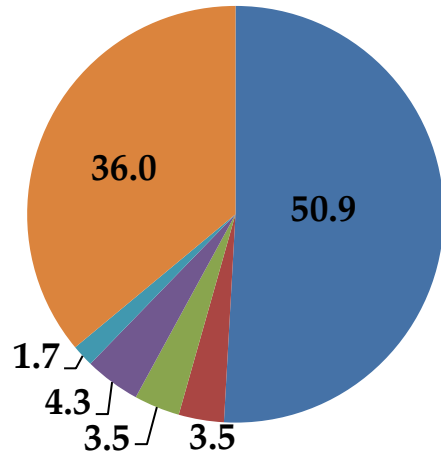


Completion of water audit:  
Assessment of losses - key observations - recommendations

# 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

## Breakup of total water supplied



- Revenue water (%)
- Authorised consumption (%)
- Apparent losses (%)
- Losses in transmission line (%)
- Losses at storage tank (%)
- Losses in distribution network (%)



### 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.

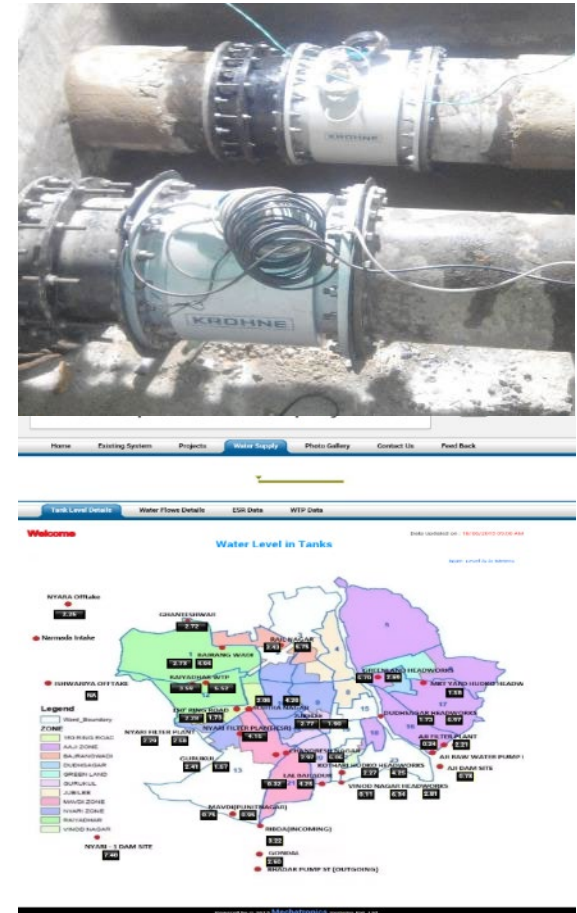


### Step 5: Preparation of final report

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

# 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.



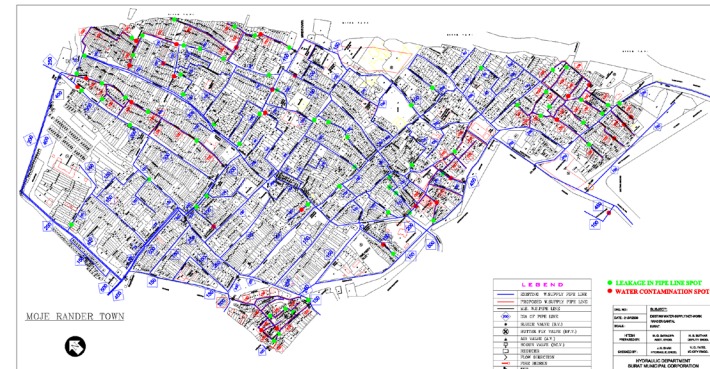
# Measures to reduce NRW: Case of Surat

## 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

# Since then, investments in SCADA systems in many cities ... Still ... Good performance on paper but receiving complaints of inadequate supply



**99%**  
Coverage of individual water supply connections  
Benchmark: 100%



**98%**  
Coverage of individual water supply connections in slums  
Benchmark: 100%



**166 lpcd**  
Per capita supply of water at consumer end  
Benchmark: 135 lpcd



**27%**  
Extent of Non-revenue water  
Benchmark: 20%  
**Estimated**



**7%**  
Extent of functional metering of water supply connections  
Benchmark: 100%



**1 hr/ day**  
Continuity of water supply  
Benchmark: 24 hrs/day

Free water – Low dependency on public stand-posts in the city, due to 98% coverage of individual water connections

Illegal connections regularized by government

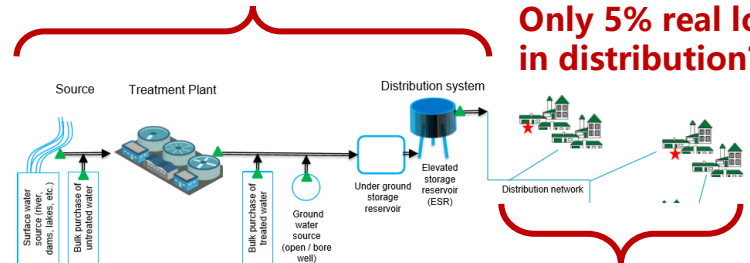
But real losses???

- While SCADA implemented, Water works department **doesn't utilize SCADA readings to monitor water levels** or assess leakages
- Reporting of water levels and other parameters is still done **manually in registers.**
- **Challenges of unintegrated database**

**18% real losses found from source to distribution stations based on SCADA readings**

**3% losses through unauthorized connections**

**Only 5% real loss in distribution???**



# Bucket survey at consumer end to assess water consumption

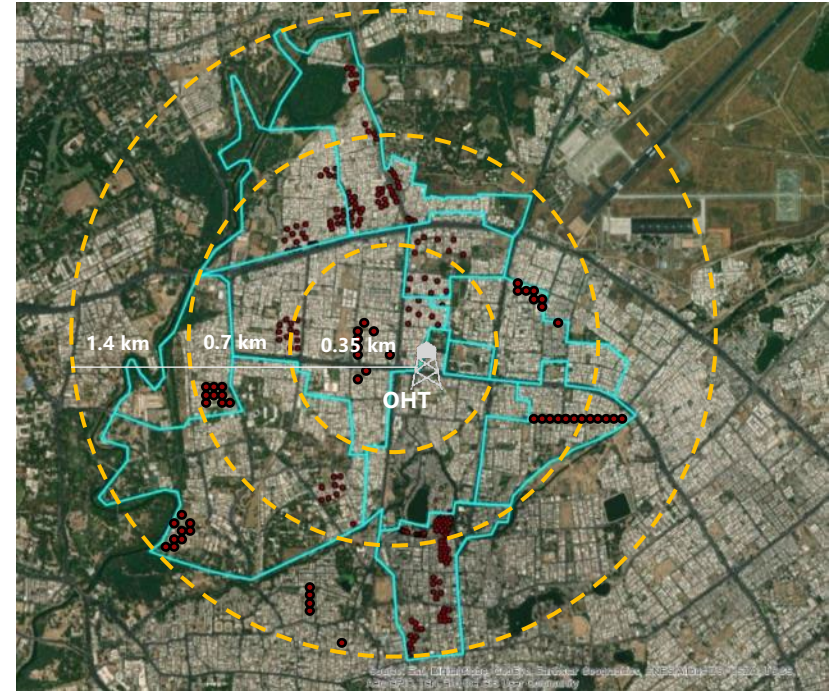
- Total **28,770 water connections** registered in the tax base.
- **No documentation of water connections** OHT/ sub zone-wise - Number of water connections in each sub-zone was analysed and mapped using weighted average method using GIS mapping tool.
- **250 samples** were considered based on **random sampling method**
- **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



# Assessing 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

# Assessing Losses in valves and pipelines



Leakages in valves in the Karelibaug command area



Water losses in pipelines

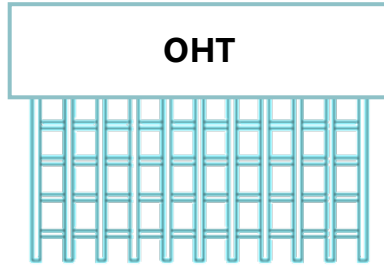
Source: Based on water audit by Soham Tech and CWAS team at the Karelibaug OHT, January 2022

# Results, extrapolated to the city, reflect an annual loss of ~ \$ 8 million to the city government

## Transmission network

Source

**97 MLD**  
Loss in transmission network  
**18%**



**59 MLD**  
Loss at ESR  
**11%**

## Distribution network

**92 MLD**  
Network losses  
(inclusion of valves and pipelines)  
**17%**

**16 MLD**  
Unauthorised consumption  
**3%**



**264 MLD**  
**49%**

# 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

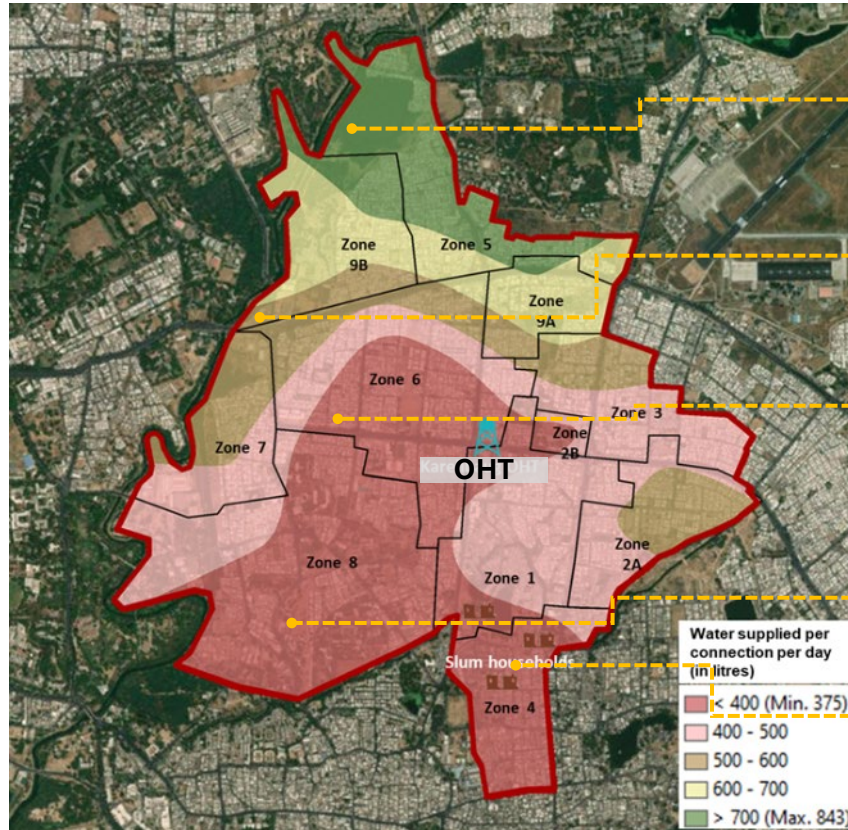
Wide variation in water supply in **non slum HHs** is noted from survey



**851**

Litres / Connection / Day

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



Inequity in water received at consumer ends



**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.

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

# 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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AND SANITATION

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**City Water Audit  
Methodology**



**Kalol Water  
Audit Report**

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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