



## Management of unaccounted for water in India

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THIS PAPER IS presented in three distinct stages. Firstly, an overview of what precisely UFW is, in particular the leakage element, and how it occurs. Secondly, a case study will be presented for Jaipur, the capital city of the State of Rajasthan in India. Finally, an indication will be provided of the lessons that have been learnt from this and how they are being applied to the city of Calcutta, where a project for improvements in the management of the water distribution system is being carried out.

### Stage 1: What is unaccounted for water

Generally speaking, there is confusion over the terms that are used, i.e. Leakage, Unaccounted For Water and Non Revenue Water. It may best be said that leakage is one of the components of UFW, which is in turn part of the NRW. Unaccounted For Water may best be described as the difference between the volume of water supplied to a network and the metered consumption plus the accounted for public use. It is traditionally expressed as a percentage or, more recently, in litres per consumer per hour.

Non Revenue Water is expressed as the difference between the volume of water produced and the volume of water actually billed and paid for by the consumers. As such, UFW forms a major component of this.

Leakage is normally the most major element of UFW and applies to the losses that are experienced in the pipe networks. In our experience throughout the world, visible leaks only account for approximately 20% of the total with the remaining 80% being invisible. These invisible leaks may take any length of time from a month to ten years before they become visible.

The causes of leakage are either referred to as direct or indirect and are outlined as follows:

**INDIRECT:** Aggressive soils; ground movement; road works; construction; and water hammer.

**DIRECT:** Badly laid pipes; pipeline age; manufacturing defects; badly repaired leaks; and sub-standard materials.

In India, in particular, the main causes of leakage may be attributed to badly laid pipes, badly repaired leaks and substandard materials.

In conclusion of this general view of the UFW problem, it may be concluded that the following factors are essential if the utility is to efficiently and effectively address the problem inherent within the system:

- Determine the real level of UFW and the differing components
- Conduct a cost/benefit analysis through Pilot Area investigations
- Define a medium and long-term programme of reduction, monitoring and control & implement reduction measures
- Continue to control at the reduced level.

### Stage 2 : UFW Case Study – Jaipur, Rajasthan, India

This project was entitled “Evaluation and Reduction of Losses and Leakage in the Water Distribution System of the City of Jaipur” and was carried out for the Public Health Engineering Department of the Government of Rajasthan. Initially identified by the French Water Club for Co-operation with India, the study was funded under the Indo-French Protocol to the value of approximately US\$2 million. Although initially intended to be of 18 months duration, the project eventually took three years to complete. The main reasoning behind this excessive time period was the decision by the client to become responsible for all installations and works necessary to be carried out on the distribution system.

Jaipur is the capital city of the State of Rajasthan and is located approximately 250 kms. South of Delhi. It currently has a population of 1.9 million and is the twelfth largest city in India. Rajasthan is a desert region with extremely high temperatures and where 95% of the rainfall is experienced during the monsoon season. Jaipur provides an intermittent supply of water for approximately five hours per day and also had no system of measurement with which to record the flows and pressures in the network, prior to the project.

The main components of the project were as itemised below:

#### **Overall Water Audit :**

Review and analysis of billing RECORDS

Installation of approximately 150 bulk meters at production sites

Site examination of 20,000 customer connections

Serial metering of consumer connections

Workshop testing of domestic consumer meters

Carry out audit of water produced and consumed

**Pilot Area Studies :**

Identification of 5% sample of population, areas to be characteristic of Jaipur

Implementation of District and Waste Metered Areas  
Detailed study to ascertain levels of UFW and its components

Demonstrate UFW reduction by consumer meter replacement and leak repair

**Major Structures/Transmission System :**

UFW levels on existing tubewell network

UFW levels on raw water transmission mains

UFW levels at pumping stations, treatment plants and reservoirs

UFW levels on the inter zonal transfer system

Now, let's take a brief look at some of the results that were achieved from the project.

**Review of the Top 2000 Consumer Connections**

These were initially identified from the existing billing records and mainly based upon the meter size. A review of the type of connection was carried out and the results found were as follows:

Industrial	Non-Domestic	Domestic
15%	39%	46%

It is perhaps surprising to note that 46% of the top 2000 were domestic consumers or, should we say, were registered as domestic consumers, which is a different issue altogether. In addition, having been informed that only 25% of consumer meters were not in working condition, it was found that 48% were not in working condition; 22% had been disconnected; and only 30% were operational.

**Average Meter Error from the Test Bench**

1600 consumer meters were to be tested on a test bench provided under the project. The majority of these meters were of 15 mm. dia. size, the most predominant in the system, and came from a variety of suppliers, approximately 10 in number. 90% of the meters were supplied by local manufacturers. The table below indicates the average error (always an under-reading) found in relation to Indian standards by the testing at each of three differing flow rates:

Type of Flow Rate	Flow Rate (litres per hour)	Average Error of Meters	Indian Standards Permissible Error
Nominal Flow	1500	14%	5%
Transitional Flow	180	24%	10%
Minimal Flow	90	42%	10%

**Public Stand Posts**

Investigations were carried out on a 5% sample to identify the quantity of water wasted through the 615 PSP's. The results obtained from the site surveys were confirmed by selected installation of serial or consumer meters. The results identified that 30% of the water supplied by the PSP's was either being wasted by misuse or lost through leakage. This equated to an annual quantity of water of 110 Ml. It was recommended that this be addressed by a programme of PSP user education, the use of automatic taps and occasional PSP supervision.

**Pilot Area UFW Levels**

Looking at one specific area located inside the old Walled City part of Jaipur containing mainly residential properties, the existing billing records for the area generated an initial assessment of 22% UFW. However, the initial "theoretical" level of UFW from the investigations, prior to any work being carried out, was actually found to be 74%. Zero consumption recorded on a meter was assumed to be just that.

Following the initial monitoring stage, the non-functioning consumer meters and stop taps were replaced and the exercise repeated, demonstrating a reduction in UFW to 40%.

An exercise of leak detection was then carried out mainly using sounding rods (listening sticks), following which the client carried out leak repairs. A further reduction to 26% UFW was achieved. This level of UFW could probably have been lowered even further, but for the limitations of time for further leak detection activities. Due to time constraints, it was not possible to carry out the exercise to determine the level of UFW at target pressure that would result from the construction of the Bisalpur pipeline.

**Results of the Leak Detection Exercise**

From the exercise carried out as part of the Pilot Area Studies to detect and locate the leaks, the distribution of the leaks were found to be as follows:

Location of Leak	Percentage of Total Leaks in System	
	Visible Leaks	Non Visible Leaks
Distribution Main	8%	72%
Service Connection	18%	2%

**UFW Levels in Major Structures / Transmission System**

Investigations were carried out to identify the levels of leakage or UFW in a range of structures and facilities and the results of these investigations are summarised below:

Part of System	% UFW
Tubewell Systems	19%
Distribution Centres (Reservoirs & Pumps)	4%
Inter-Zonal Transfer Mains	8%
Raw Water Transmission System	14%

### Technology Transfer

In order that the lessons and experiences of the project, with the continued utilisation of the equipment may be sustained for the long term benefit of Jaipur, it was essential that Client personnel were fully integrated within the activities and gained the necessary skills and attitudes. This was addressed through:

- Hands-on training to clients study personnel
- Organisation and management
- Knowledge and skills of specialised equipment
- Identify and train clients staff overseas
- Use of UFW Management Information System
- Recommend training needs for client in UFW control and management

### What Was Achieved

- Efficient and continuous measurement system
- Assessment of UFW in selected Pilot Areas
- Audit of water distribution system
- Demonstrate strategy for reduction of UFW
- Implement UFW control and management strategy
- Transfer of technology to clients personnel
- Define economic levels of UFW

### Where Can Jaipur Go From Here?

- Implement UFW control strategy for whole city
- Improve existing practices and procedures
- Carry out planned maintenance procedures
- Set up discrete UFW control unit
- Consider Operation & Maintenance Contract
- Consider Private Sector Participation
- REDUCE UNACCOUNTED FOR WATER

### Lessons Learnt

- Requires greater appreciation at preparatory stage
- Requires greater understanding of implementation procedures
- Requires full understanding of responsibilities for each party
- Responsibility for fulfilling overall project should rest with the Consultant
- Selection of contractors by Consultant in association with Client
- Greater awareness of contractual requirements

### Project Benefits and Considerations

Economic	Social	Environmental
Technical Assistance	Technology Transfer to Client	Water is a Rare Resource
Low Investment	Continuation of Programme	Saves the Precious Resource
Significant Benefits	Water to the People	

### Stage 3 : The Calcutta Project for Improvements in the Management of the Water Distribution System

This project, through the 1998 Indo-French Protocol, takes the lessons from Jaipur and expands the activities beyond a UFW demonstration study. In Calcutta, recent estimates indicated that UFW accounted for 100 Million Gallons out of the daily supply in excess of 250 million. The project control lies clearly with the consultants, Seureca-Space. The inadequate base mapping of the network is being addressed and continuous monitoring systems, utilising GSM telemetry are being installed to feed a tailor made computerised management control centre linked to a GIS system. With these tools, the management of the system will become more efficient, UFW will be considerably reduced and rapid detection of system anomalies and problems will be enabled. Billing system and revenue records will be included, and detailed consumer patterns in a pilot demonstration area will identify possible alternative approaches to tariff systems and levels.

#### Project Objectives for Wards 1 to 100

- Mapping of Primary Water Mains
- Flow & Pressure Equipment Installation
- Consumer Meters on Top 100 ICI Customers
- Implementation of Water Management Software
- Setting Up of Control Centre

#### Project Objectives for Ward 63

- Mapping of all Water Mains & Connections
- Flow & Pressure Equipment Installation
- Consumer Meters on all Connections
- Unaccounted For Water Study
- Customer Survey and Willingness To Pay
- Identification of Sections for Rehabilitation
- Implementation of Water Management Software

#### Benefits to Calcutta

- Accurate Mapping of the Primary Network
- Continuous Flow & Pressure Monitoring Sites
- High Technology / Low Maintenance Systems
- Powerful Water Management Software
- Pipe Location and Leak Detection Equipment
- Automatic Detection of System Anomalies
- Increased Revenue from Consumer Metering
- FULLY TRAINED COUNTERPART STAFF

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