Indo-US
Financial Institutions
Reform and Expansion Project -
Debt Market Component
FIRE(D)

Project Notes

Note No. 23
November
2000

Improving the Operation of Urban Water Supply Systems in India:

A Discussion of Unaccounted for Water

As cities continue to grow, pressuring water utilities to meet increased demand, attention is being given to a commercial orientation in the provision of these services. In India, initial studies indicate that up to 50 to 60 percent of water, treated and pumped by the utility, is "lost," or unaccounted for. Improved management efficiencies in the operation of water systems at the local level, coupled with enabling policy reforms at the state level, can reduce water losses, increase financial viability of the utility, and improve health of residents. The FIRE project assists state and local officials in introducing these changes. This Project Note discusses measures that local officials can take to reduce water losses.

The traditional approach to meeting increased water requirements in India has been augmenting capacity. A lack of commercial orientation has eroded the financial and operationa capacity of most utilities, resulting in under investment in operations and maintenance. Existin assets, created at considerable cost, are allowed t deteriorate even as new investments are made.

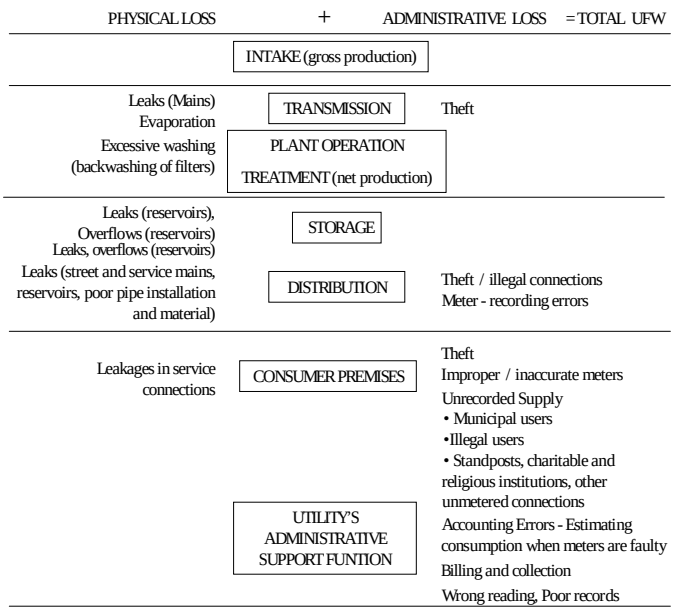
One result is that much water, treated and pumpe at significant cost, is lost. This water could have me the needs of more residents and businesses, an earned revenue for the utility. Moreover, wate leakages are a potential health hazard. An outbrea of hepatitis in West Delhi in August 1999 wa attributed to water contamination at a leaking poin on the distribution pipeline.

Introduction to Unaccounted for Water

Unaccounted for Water (UFW) is defined as th difference between the water produced and supplie to the distribution system, and the water sold. Thi difference may be attributable to physical losses due to leakages and to administrative, non-physical losses due to unrecorded supply. The main sources of UFW for the various components of a water supply system are illustrated in Figure 1.

Figure 1. Sources of Unaccounted for Water

Source: FIRE project, New Delhi, 1999.



Funded by
United States
Agency for
International
Development

Physical losses occur due to leakage or overflow of water in the system. Reasons for leaks include neglect, poor quality of material or workmanship, age and corrosion of the network, leaking joints, lack of suitable appurtenances (pressure vessels, air valves, etc), uneven ground settlement, and vehicular or other pressure on the network. *Administrative losses* result from theft of water or illegal / unregistered connections, faulty meters, unrecorded supply due to poor records, and billing errors as well as public standposts and use by the city and charitable and religious institutions.

Preliminary assessments indicate that the percentage of UFW in Indian cities is very high, in the range of 50 percent. An assessment by Anglian Water International of water utilities in four cities in Karnataka found that the total percent of treated water that is lost ranges from 47 percent to 60 percent . The composition of physical and administrative losses varies. In these four cities, physical losses constituted 34 to 42 percent of the water supplied to the distribution system, while administrative losses were 12 to 18 percent, clearly indicating the need for repair. Moreover, most utilities' ability to identify sources of the losses is constrained because their water distribution systems are not zoned and lack metering and their network maps and consumer databases are inadequate.

Measures to Address UFW

Local officials can address UFW in many ways. The first step is to set up the systems to isolate its specific sources. Once the causes have been identified, appropriate remedial measures can be pursued.

Step 1 - Locating the sources of UFW by:

- measuring water production and consumption accurately;
- conducting a consumer census to identify legal, illegal, and potential connections, and category (domestic / non-domestic);
- conducting a network census (i.e., mapping the network and taking inventory of pipes, valves, and other components that includes their age, material, diameter, and condition);
- installing macro metering of all major supply zones to measure and monitor flows;
- installing or improving micro metering of consumers (i.e., database should include type, age, accuracy of meters, and consumption patterns); and
- conducting surveys to measure normal velocity and flow pressure in the distribution network since abnormal flows could indicate leaks.

Step 2 (A) - Addressing physical losses by:

- increasing consumer awareness;
- detecting and controlling leaks, and regulating flows to consumers;
- building up an asset inventory and leak history and patterns;
- planning for maintenance and repairs emphasizing preventive maintenance (including a specific program of activities, personnel to carry them out, supply of repair parts and materials, up-to-date records);
- improving service connections and ensuring quality control (selecting standard pipe material for distribution mains and service connections, following standard procedures for new works, repairs and replacements); and
- training personnel.

Step 2 (B) - Addressing administrative losses by:

- increasing consumer awareness;
- building up and monitoring an accurate database on connections, meters, consumption, billing and collection;
- addressing water theft;
- measuring and monitoring unrecorded supply (e.g., municipal uses, standposts, religious and charitable institutions);
- regularizing illegal connections;
- installing and repairing meters;
- improved consumption-based billing; and
- training personnel.

Key Principles for Resolving the UFW Problem

Local officials' efforts have a greater chance of success if state policies support them. State level policy changes, recommended by the FIRE project and others, should encourage local utilities to:

- set appropriate tariffs that link water prices to consumption and cover production costs;
- establish incentives to improve efficiencies;
- require that public and private utilities be commercially oriented in their approach to system management and improve customer satisfaction;
- replace hidden subsidies with targeted and transparent subsidies, providing life-line services affordable to the disadvantaged (who often pay a high price for non-treated water); and
- develop consumer awareness programs and seek consumer feedback and suggestions on conservation, effective use and optimal cost.

One key measure that city managers can take to address UFW is to introduce a commercial orientation in the delivery of the service, whether executed by a public utility or private firm. This will help city officials recognize the importance of targeted programs, sustained over time. The improvement due to such

programs can be dramatic. For example, Macao decreased its UFW from 40 to 11 percent through targeted initiatives. Singapore's success in reducing UFW from 10.6 percent in 1989 to 6.2 percent in 1995 is attributed primarily to the sustained efforts adopted by the public utility.

Cities may find an ally in the private sector. Local bodies in India have traditionally outsourced leak detection studies to private consultants and awarded contracts to private firms for construction, repair and replacement works. However, cities can improve their performance by expanding private sector participation. Mechanisms range from short-term service contracts to long-term concessions. The private sector's greater financial and managerial autonomy and accountability help achieve greater efficiency and effectiveness. Local bodies should develop agreements to include incentives to attract and motivate the private party to solve the problem quickly and efficiently, for example, by linking payment to results. The length of the contract should also be appropriate – a short period may lead to under-investment in the leakage control infrastructure.

Service contracts are generally for one to two years. These are fee-based and are typically for specific components of the service, such as meter reading and billing and operations. *Operations and Maintenance (O&M) contracts* usually are for five to seven years. Payments are fixed fee plus incentives linked to reduction in losses. The city retains responsibility for capital investment required for repair and replacement works. *Lease agreements* are generally for eight to 15 years. Under this arrangement the private party makes required routine investments for operations and maintenance, however the responsibility for financing and planning major investments lies with the government. In *concession agreements* the private party finances and owns the facilities for a period of 20 to 30 years (time to depreciate investments and provide a reasonable return to the equity investors). Since payments are linked to direct collection of water charges, the private party benefits from reduction in UFW due to operation efficiencies and system rehabilitation.

Two Initiatives to Address UFW in India

The first initiative demonstrates a comprehensive approach to reduce UFW taken by the metropolitan water and sewerage board in a large city, Hyderabad, with World Bank financing. Capital of the state of Andhra Pradesh, it has a population of more than 4.5 million. The second illustrates a public utility's taking the first step to address UFW using its own resources, with technical assistance by the FIRE project. Kolhapur is a mid-sized city of approximately one-half million in the state of Maharashtra.

Hyderabad Metropolitan Water Supply and Sewerage Board (HMWSSB). In 1992, HMWSSB commissioned Tata Consulting Engineers to carry out a *Water Conservation, Leakage Control and Use Management* study. The study found that 14 percent of water was lost to physical leakages in the transmission system and 140 liters per connection per hour at 10 meters pressure were lost in the distribution system. Administrative losses were estimated at 12 percent. The Board initiated a four-year program in 1995, implemented with World Bank support, that aims to reduce leakages in the transmission system to five percent, losses in the distribution system to 10 liters per connection per hour at 10 meters pressure, and administrative losses to four percent.

The key remedial measure to stem physical losses was to install bulk flow meters to monitor production of water, distribution to O&M divisions, and leakage on the transmission network. From 1996 to 1998, the Board repaired 474 of 615 leaks identified on 408 kilometers of transmission main. It is repairing the remaining leaks on the transmission system by caulking joints with lead, steel collars, cement, and chemical sealants.

The study determined that nearly 70 percent of the estimated loss in the distribution system was from leaks at tapping points and in service connection pipes. Reasons included that the water authority did not own the consumer connections and meters; pipe material and service tap materials were substandard; and distribution main and service connections were not mapped properly. The utility is replacing all old, damaged leaking pipes and service connection pipes.

The main causes of administrative losses, the study found, were that 82 percent of domestic meters and 92 percent of bulk consumer meters were not working. So, the Board installed 60,000 new domestic meters, 590 non-domestic and 126 bulk consumer meters from 1996 through 1998. In addition, the board announced a general amnesty in 1996 and regularized more than 6,000 illegal connections by levying a small penalty.

Other remedial measures included training staff on leak detection equipment and surveys, system mapping, creating consumer data, and repairing leak detection equipment. The Board also conducted an extensive public education program on water use and conservation. As a result of all these measures, the Board estimated that UFW in the entire system has been reduced by approximately eight percent.

Kolhapur Municipal Corporation (KMC). In 1999, the KMC initiated several activities, with assistance from the FIRE project, to reduce UFW. Disturbed by in-house estimates that UFW was about 40 percent, the

corporation undertook a pilot leak detection study. A stretch of 6.2 kilometers of the main trunk line was selected because of its history of leaks and high number of service joints. Conducted with a local academic institution, and using leak-sounding instruments, the study located 17 leaks. The KMC repaired the first leak in early 2000, but lacks funds to repair the others.

To deal with administrative losses, the corporation aimed to improve collection of water charges. First, it identified major defaulters and sent notices to 461 customers who had not paid water bills since 1992. It also identified and regularized, upon payment of a fine, 200 illegal connections. Revenue increased, due to these measures combined with a tariff increase. The corporation periodically issues press releases to increase public awareness and support these measures.

The Way Forward

To reduce UFW, utilities must first identify resources to conduct the pilot studies as well as the projects based on them. These projects include leakage identification and monitoring, repairs, system rehabilitation, and installation of mechanisms to monitor and address physical and administrative losses. Also, utilities must introduce incentives for improved operations and maintenance of water systems. States could develop performance indicators for service levels and parameters for monitoring them statewide.

The private sector has a significant role in improving operational efficiencies and reducing losses. Cities could assign private consultants to conduct pilot studies and design service contracts to outsource meter reading and billing. Public-private partnerships – via O&M contracts, lease agreements and concession agreements – will help introduce a commercial orientation in system management.

Consumers must be educated regarding the city water system, service delivery, and water use and conservation. Not only would this help create a demand for more efficient systems, but also it would help consumers make informed decisions regarding city priorities in participatory processes increasingly required by decentralization.

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This *Project Note* was written by Kirti Devi, Project Development Specialist of the FIRE project. Information based on presentations at a workshop on *Improved Management Systems for Urban Water Supply and Sanitation Services in Maharashtra*, organized jointly by the Government of Maharashtra, Maharashtra Jeevan Pradhikaran, and Indo-US FIRE project at Nashik in December 1998.

The mission of the Indo-US FIRE(D) project is to institutionalize the delivery of commercially viable urban environmental infrastructure and services at the local, state and national levels. Since 1994, the project has been working to support the development of demonstration projects and of a sustainable urban infrastructure finance system. Now, the project is also pursuing this mission through:

- Expansion of the roles of the private sector, NGOs and CBOs in the development, delivery, operation and maintenance of urban environmental infrastructure;
- Increased efficiency in the operation and maintenance of existing water supply and sewerage systems;
- Strengthened financial management systems at the local level;
- Development of regulatory frameworks at the state level;
- Continued implementation of the 74th Constitutional Amendment; and
- Capacity-building through the development of an Urban Management Training Network.

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Funded under USAID Contract
#386-C-00-99-00071-00

The *Project Notes* series is edited by Kathy Desmond.