

# Are You Leaking Water or Data?

Tracing the movement of non-revenue water.

BY GRAHAM SYMMONDS

**WATER LOSS AND REDUCTIONS IN NON-REVENUE WATER** (NRW)—that is, the difference between water pumped, treated, and supplied to the distribution system versus water that actually reaches customers—are emerging as key water resources management themes in the new millennium. And for good reason: water lost is revenue lost. In addition, lost water, even when found, cannot be easily billed. In some jurisdictions, statutory limits exist on recovery, while in other situations, the public relations repercussions are too severe.

## The costs of non-revenue water

The economic and environmental costs of NRW are staggering. For developed countries, non-revenue water often represents 20 per cent of the total water withdrawn from the environment. In developing nations, non-revenue water can account for as much as 50 per cent due to distribution system leaks, theft, and poor measurement techniques. The World Bank estimates that the total cost to water utilities caused by NRW worldwide can be conservatively estimated at \$141 billion per year. In developing countries, about 45 million cubic metres are lost daily through water leakage in the distribution networks—that's enough to serve nearly 200 million people.

Often it is assumed that water leaks—visible or invisible—are the sole culprit. In fact, leaks are only one of a myriad of

causes of NRW, the majority of which are data or measurement related:

- Water theft from jumpering meters
- Unauthorized connections
- Metering degradation and inaccuracy due to meter age or physical damage
- Metering degradation due to water quality or particulate precipitation
- Meter programming inaccuracy, such as meters programmed to read in thousand gallons, but entered into the billing record as reading in gallons
- Meter losses, such as meters missing from the billing inventory
- Meter installation errors
- Improperly sized or specified meters
- Data transcription errors, such as meters not correctly mapped to customer information
- Incorrect billing codes in the billing platform
- Human errors, such as meter reading mistakes or estimates

## Meter accuracy

The typical response to NRW is to deploy teams of distribution system technicians to track down, find and repair the leaks. However, what if the problem is not really attributable to leakage? What if at least some of the water is actually staying in the pipes, but is not being measured? In that case, the water is leaking not from

our pipes, but from our data.

Many people outside the water business do not understand that large meters can represent a significant volume of the water delivered to consumers. In Global Water's Santa Cruz Water Company, 10 of the 17,500 meters in the community consume 23 per cent of the entire delivered volume. In fact, one meter represents over four per cent of the annual consumption. It's clear that ensuring the accuracy, precision and reliability of these large meters can have a significant impact on revenue.

A recent survey of 50 commercial meters in Global Water's Santa Cruz Water Company system found the following (Figure 1):

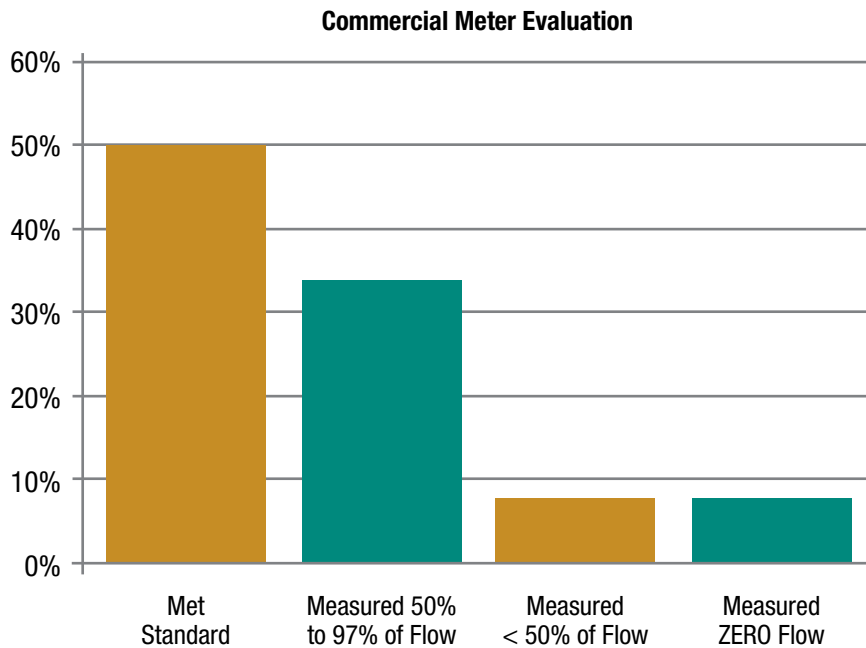
- 50 per cent of commercial meters tested failed to meet the AWWA meter accuracy standard.
- 16 per cent of the tested meters registered less than 50 per cent of the actual volume passing through them.
- Eight per cent of the meters in the survey group registered zero volume.
- The annualized revenue loss from the survey group amounted to \$280,000.
- The annualized water loss from the survey group amounted to 53,000,000 gallons (or 200,626,825 litres).

Extrapolated to the entire commercial meter population (approximately 300 meters), metering inaccuracies represent six per cent of the total water deliveries, and over \$1 million in revenue.

The U.S. Geological Survey estimates that water lost from

U.S. water distribution systems is **1.7 trillion gallons per year**  
at a national cost of **\$2.6 billion per year.**

**Figure 1: Results of commercial meter audit in Global Water – Santa Cruz Water Company**



## Meter issues

Meter accuracy and precision can be impacted by a spectrum of influences:

- 1 Installation problems (including improper piping configurations, meter location)
- 2 Incorrect meter specification (size and type based on usage: turbine versus positive displacement versus magnetic versus compound)
- 3 Billing system multiplier errors (incorrect coding of meter information into the billing system)
- 4 Mechanical meter degradation (including wear, water quality impacts, physical damage, et cetera)
- 5 Automatic Meter Reading/Automated Metering Infrastructure (AMR/AMI) failures

Global Water – Santa Cruz Water Company's recently completed audit found instances of all these issues. While installation problems and billing system



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errors can be addressed with robust quality control and quality assurance programs, the gradual—or even abrupt—failure of the measuring systems cannot easily be predicted, especially when one considers the vast number of meters in a utility, and the varying volumes they read.

**Mechanical meter degradation**

Without question, mechanical metering components degrade over time. Their accuracy and precision fade—often to the point of being a significant drag on utility revenue. While all meters leaving the manufacturer’s warehouse can be shown to meet the AWWA standards for accuracy, the in-service combination of installation, specification, mechanical wear, water quality issues (scaling, precipitation) and the severe operating environment can quickly and materially degrade performance.

As noted above, a significant volume of the utility’s water may be delivered through these meters, and often no thought is given to their ongoing calibration, maintenance and repair. In order to address this, a comprehensive meter audit program must be instituted—validating the specification, accuracy, and precision of commercial meters. Such a program needs to include the age and passed volume of the meters, but must also consider the effects of water quality, the location of the meter, and its operating profile.

**AMR/AMI: a tool for remote monitoring**

With the transition from mechanically-based reading systems (meters and registers) to a combination of mechanical and electronic systems (AMR/AMI infrastructure), the modes of failure are becoming far easier to recognize.

Fortunately, with information from a smart grid for water installation, the data environment is becoming rich enough to allow for meter diagnostics to be performed without actually visiting the meter. That is, we have the opportunity to use statistical methods to evaluate the integrity of metering systems.

From a systems perspective, complex systems can be monitored by studying

their variability. This is particularly useful in systems that enjoy relative stability in output such as commercial meters. In these systems, the variability of the data can be considered to be low—assuming that the consumption patterns fluctuate only with large scale, seasonal effects. In short, the daily variation is negligible.

Borrowing from the study of large-scale networks (ecology, power distribution, et cetera), the concept of “critical slowing down” can be applied to AMI installations. Critical slowing down reduces the ability of the system to respond to increasingly variable inputs, such as erratic readings from component failures. Statistically, this can be represented as an increase in the variance of the data.

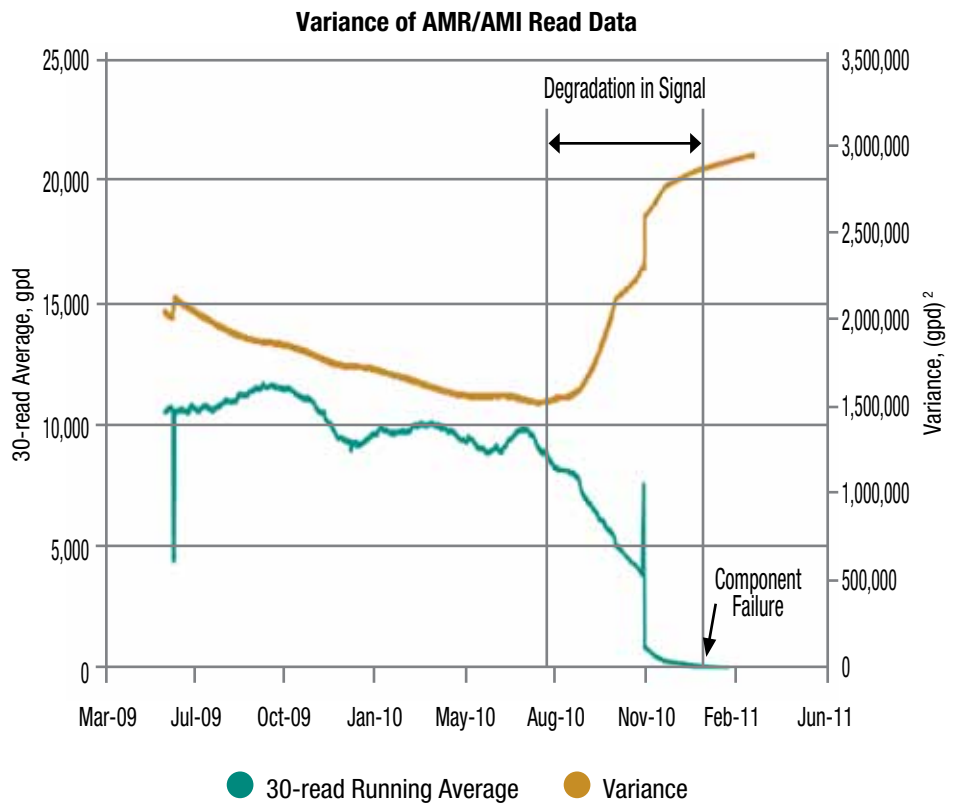
The result is that we can use this data to proactively identify impending failures of metering systems without knowing the actual condition (see Figure 2).

**The smart grid for water and NRW**

Increasingly, the first step to reducing NRW is improving the temporal and spatial quality of the data. For example, by combining highly granular consumption data with historic usage from the Customer Information System and geo-referenced spatial data, unusual consumption patterns can be identified rapidly and visually, alerting the customer and utility staff to take action. In fact, the increase in data density is a key driver for the adoption of the smart grid for water. Further, the analysis that can be performed on this high-density data set offers significant advantages to the water manager.

The goal of achieving zero NRW is critical for utilities going forward. While much of the attention has been focused on physical leaks, there is a large—and potentially unaccountable—variable that is not being considered in these analyses: the accuracy and precision of large-scale meters.

**Figure 2: Example variance in read data for a commercial meter in Global Water – Santa Cruz Water Company**



The U.S. Government Accountability Office has estimated that municipalities are facing the challenge of broad-scale infrastructure replacement at a cost of \$300 billion to \$1 trillion. In order to be most cost effective with those

ensure we are “measuring all the drops.” Until we know that our meters aren’t stealing our water, we should not be embarking on wholesale infrastructure replacement.

In fact, it may be significantly more cost effective to implement a Read Management program. The infrastructure is in a known location, the tests are simple, and the rectification can happen instantaneously, generating a significant increase in revenue.

The first step to reducing NRW is improving the temporal and spatial quality of the data.

infrastructure replacement dollars, we need to ensure that we replace only what needs replacing. While systems with large leaks must address those directly, broad-scale water system replacement deployed under the auspices of reductions in NRW may be not be necessary—we need to first

At a time when municipalities are facing severe financial constraints, investing in a commercial meter program integrated with AMI and state-of-the-art read management analytics will almost certainly lead to immediate increases in revenue, minimizing the need to raise

rates. In many cases, the found-revenue can completely pay for the systems necessary to transform the utility into a smart grid for water utility, which provides the critical data collection and analysis functionality to find the other half of your non-revenue water. WC



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