Non-Revenue Water reduction
Contracts and illustrated examples

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The global volume of Non-Revenue Water (NRW) has recently been conservatively estimated at 50 billion cubic meters/year, and valued at US$15 billion. These figures highlight the problems that many water utilities experience in attempting to reduce NRW. Performance based contracts (PBCs) offer these utilities an alternative approach to reducing NRW. This paper details the benefits of using PBCs to reduce NRW and provides several examples of successful contracts undertaken over recent years.

One of the major challenges facing water utilities around the world is the high level of water losses, either through real (physical) losses or apparent (commercial) losses (customer meter under-registration and theft of water in various forms). The difference between the amount of water put into the distribution system and the amount of water billed to customers is known as "Non-Revenue Water" (NRW).

This article considers the benefits to utilities of using performance-based service contracting, a relatively new and flexible approach to the challenge of reducing NRW. Under a Performance Based Contract (PBC), a private firm is contracted to implement an NRW reduction program and contract payments are (to a certain extent) linked to performance achievements.

Why Reduce Non-Revenue Water?

Many water utilities are facing increasing supply/demand problems as demands from cities grow and finite water resources are becoming increasingly difficult and expensive to develop. For utilities facing these problems, sustainably reducing the real loss component of NRW provides by far the cheapest "new" water resource for the utility, however it is surprising how often real loss reduction is not considered as an option for making additional water available for supply.

Reducing NRW can also help water utilities ensure their financial viability and avoid a spiral of financial decline: Reducing the apparent loss component of NRW to the economic level minimizes the volume of water supplied to customers that is not paid for, thereby maximizing revenues, whilst reducing the real loss component of NRW to the economic level minimizes overall operating costs.

There are other benefits gained from reducing NRW. For example, it helps the utility improve the levels of service provided to customers and it helps the utility distribution staff develop a better understanding of the operation of the distribution system.

Scale of the NRW Problem

In a recent World Bank publication an attempt was made to quantify the worldwide water loss problem and the figures are startling. The global annual volume of NRW was (conservatively) estimated to be approaching 50 billion cubic metres (**Error! Reference source not found.**) – and the total cost to water utilities caused by higher production cost and lost revenues was estimated to be approaching US $15 billion per year (**Error! Reference source not found.**). From these figures it can be seen that many utilities are not managing NRW effectively.

Why is NRW Not Managed Well?

A high NRW level indicates a poorly run water utility that lacks the governance, autonomy, accountability and the technical and managerial skills necessary to provide reliable service.

The benefits of NRW reduction are clear and the methodologies and technologies for reducing NRW are well developed, but decades of work on the subject has not delivered much improvement in the public sector in many countries. Why is this? There are many answers to this question, some of which are outlined below:

The volume and causes of NRW are often not properly quantified or understood by senior management. Because the true volume of NRW is not known, the true cost to the utility of this volume of NRW is also unknown. For these reasons, NRW reduction does not receive the senior management support that it essential for a successful implementation and it is not allocated the priority and funding required to deliver good results.

NRW reduction is not simple to implement, because it is necessary to adopt new technical methodologies to correctly quantify NRW volumes and develop the correct NRW reduction strategy. It is often necessary to make institutional changes to implement a successful NRW reduction strategy because most departments of the utility have a part to play. There is also is a lack of the technical and managerial expertise required to adopt the new technologies and make the institutional changes required.

NRW reduction is also not politically attractive. There are no ribbons to cut to open an NRW reduction program, so publicity conscious politicians tend to favour the development of new resource development projects which they can open over NRW reduction programs.

Although an NRW reduction program will be self financing in the longer term, funding is required in the short term to implement an NRW reduction program and there is often a shortage of funds for new activities.

It is also difficult for public utilities to incentivise NRW reduction staff by, for example, paying performance bonuses, or paying additional allowances for the night work required to find leaks in areas that are difficult to sound during normal working hours.

It may be seen that there are many reasons why utilities struggle to reduce NRW, but underestimation of the complexity of NRW management and the underestimation of potential benefits are probably the two main reasons.

The Benefits of Performance Based NRW Reduction

One alternative to attempting to reduce NRW using in-house staff is to employ a specialist NRW reduction contractor to undertake this work under a performance based contract (PBC). This approach is increasingly being seen internationally as the most reliable means of delivering significant reductions in NRW. The World Bank and other donors have already become interested in this approach (a first World Bank funded PBC is currently in progress in Ho Chi Minh City) and it is anticipated that the market for PBCs will move from niche to mainstream over the next few years. There are many benefits to using this approach, which are detailed below:

A specialist NRW reduction contractor will provide the specialist technical and managerial know-how required to successfully deliver an NRW reduction project. The contractor will select the most appropriate and effective new technology for the particular operating conditions within the utility and has the know-how to use it efficiently. At the end of the contract, the technology installed and used during the contract will be handed over to the utility, together with the infrastructure created during the course of the contract such as district meter areas (DMAs), pressure zones, telemetry etc.

If the PBC contract is drawn up correctly, the contractor will be incentivised to utilize creative solutions in the design and implementation of the project to deliver the desired NRW reduction performance and sustain the NRW reduction achieved for the life of the contract. The contractor is also able to align staff incentives with the performance objectives of the contract and has the labour flexibility to employee staff when they are most effective (e.g. night leak detection crews).

Under the right conditions, the contractor can also arrange funding for some or all of the project costs, with the investment made recovered from a portion of the savings achieved over the life of the contract. For this type of public private partnership to work, it is important that risk is shared fairly between the public and private sectors.

In addition to the benefits discussed above, a PBC NRW reduction contract will also provide the utility with other less obvious benefits:

Improved GIS data – it is not possible to successfully deliver an NRW reduction project without developing accurate distribution network records and correcting errors and omissions in the utility GIS data.

Improved hydraulic network models – the contractor will most likely use hydraulic network models to design the DMAs and pressure zones and the wealth of network performance data collected from the monitored zones can be used to calibrate these models, which should be handed over to the utility at the end of the contract.

Improved asset management planning – the contractor will need to built up a database of leaks found and details of the repairs undertaken, with locations. This data can be used for asset management planning to identify and prioritize mains and service line replacement projects.

Improved understanding by utility staff and management of the work required to implement a successful NRW reduction program. The contact should ensure

that utility staff receive both formal training programs and in-depth on the job training, working with the contractor's staff, so that at the end of the contract, the utility is able to take over and sustain the NRW reduction achieved.
It may be seen from the above that there are many benefits to using a PBC, at least for the initial reduction in NRW which many utilities struggle to achieve.

Examples of Successful PBCs

New Providence, Bahamas

The Bahamas Water & Sewerage Corporation (WSC) contracted Consolidated Water (Bahamas) Ltd. (CWBL) to build and operate the Blue Hills Road Reverse Osmosis Plant on New Providence island. As a part of this contract, CWBL was required to reduce the average daily NRW in the New Providence distribution system by 1 million imperial gallons per day.
The required reduction would be achieved when it was demonstrated that NRW losses were reduced by 365 million gallons (MG) over a period of one year as confirmed through the IWA annual water balance. Until the reduction was achieved, CWBL was required to provide WSC with 1 million gallons a day of free water from the Blue Hills plant. The baseline water balance showed that the annual system input was 3,307.0 MG, of which NRW accounted for 1,777.7 MG.
The NRW reduction strategy adopted on this project included controlling transients by using variable speed controls or pump control valves, pressure management in order to control excessive pressures, particularly during the minimum demand periods, district metering, active leak detection and repair and a large revenue meter improvement program.
By March 2007, system input had been reduced to 3,150.9 MG, despite the addition of several very large customers and NRW had been reduced to 1,334.1 MG, an annual reduction of 431.8 MG, significantly exceeding the target.

York Region Leakage Reduction Program, Canada

In 1998, the York Region of Ontaria, Canada awarded an 8 year PBC to Veritec Consulting Inc., a Miya Group company, to reduce leakage in the 9 municipalities comprising the region, covering 2,500km of mains network. This contract was targeted to save 5.96 Megalitres/day (Mld) and required the establishment, use and maintenance of 65 temporary DMAs, the design, implementation and maintenance of 10 flow modulated pressure management areas and leak detection and repair. The contract included a 6 year maintenance period during which it was necessary to maintain the leakage savings achieved during the first two years.
The 65 DMAs were successfully established, flow profiled and each was maintained 3 times during the contract period and the 10 flow modulated areas were established using Technolog Modulo electronic controllers and ClaVal pressure reducing valves (PRVs). The savings achieved were determined using pre and post repair profiling of the DMAs to confirm savings.

Selangor State, Malaysia

In 1997 the State of Selangor, including the capital, Kuala Lumpur experienced a serious water crisis caused by an El Niño event. This event provided the trigger for the State Government to start dealing with the high level of NRW that had affected the water utility for many years. An estimated 40 percent of the water produced was not invoiced. Leakage was estimated at 25 % of system input, or around 0.5 million m3/day. Reducing real losses by 50% would provide sufficient water to serve the equivalent of an additional 1.5 million people and avert the water shortage in Kuala Lumpur.

The State Waterworks Department accepted an unsolicited proposal from a consortium led by a local firm, in joint venture with Bristol Water Services Ltd (share since sold to the local contractor). The consortium was committed to reduce NRW by 200,000 m3/day over a 10 year period for an agreed lump-sum payment. The contract includes a penalty for non-compliance of up to 5 percent of the total lump sum and the consortium had to take out a performance guarantee of 10 percent of the contract value.

In this PBC, the contractor is free to choose how to achieve target and in particular the split between real loss and apparent loss improvement. The consortium is using an NRW reduction strategy that includes selective customer revenue meter replacement, the identification of illegal connections, DMAs with pressure management installed on every DMA, leak detection and repair and service line renewal where appropriate. The contract has not yet been completed, but the contractor fully expects to achieve the contract target.

Bangkok, Thailand

The city of Bangkok has been suffering from a rapidly growing population which has strained the water supply and distribution system. During the 1990s the system's supply increased from 3.0 to 4.5 million m3/day to meet demand, however NRW also rose dramatically, to a peak in 1997 of 1.9 million m3/day, presumably caused by supply improvements and pressure increases. The system input was then reduced to below 4 million m3/day, and NRW consequently decreased and stabilised in 1999 at 1.5 million m3/day.

In 2000, three 4 year PBCs were let to reduce real losses in 3 of 14 service branches (each around 100,000 connections). Contract payments comprised three elements: performance-based management fee to cover overhead, profits, and foreign specialist staff; a fixed fee covering cost of local labour; and reimbursable payments for all outsourced services, work, and materials performed in the field.

By the end of these contracts, real losses had been reduced by 165,000 m3/day, which is enough water to serve 0.5 million inhabitants, NRW was reduced to 1.3 million m3/day while system input had increased to 4.2 million m3/day.

Sao Paulo, Brazil

SABESP has traditionally undertaken customer metering and billing, including identifying and replacing under-registering meters in-house, however in 2004 SABESP was incurring daily revenue losses equivalent to 1million m3/day. At this time, SABESP decided to experiment with PBCs to improve revenue recovery.

Industrial and large commercial customers and large condominium buildings account for a 28% of SABESP's total billed metered consumption and 34% of total revenue, even though these customers only represent 2% of SABESP's customers.

SABESP therefore let a series of turnkey contracts for meter optimization. Five 3 year contracts were let to replace the meters of 27,000 large accounts identified by SABESP. The contractors were responsible for flow profiling, analysis and sizing, engineering and design and the supply and installation of new meters. The contractor's payments were based on the average increase in billed volume.

Over the three year period of the contracts, metered consumption increased by 45 million m3 and SABESP's revenues increased by US$72 million. The five contractors cost a total of US$18 million, so SABESP's net revenue increased by US$54 million as a result of these PBCs.

Conclusions

Many water utilities struggle to reduce NRW even though the benefits of NRW reduction are clear and the methodologies and technologies for reducing NRW are well developed. There are many reasons for this but underestimation of the complexity of NRW management and the underestimation of potential benefits are probably the two main reasons.

Performance-based NRW reduction contracts offer water utilities struggling to reduce NRW an alternative approach that can help them sustainably reduce NRW, improve revenues and break the spiral of decline that years of poor NRW management creates. Because the NRW reductions are sustainable, water utilities can use the real loss savings as a reliable "new" water resource. PBCs also offer water utilities a number of other benefits.

Care is needed in developing appropriate contract designed with the correct performance incentives to achieve the objectives the utility desires. Prior to tendering a PBC, it is important to determine a detailed and accurate baseline. If the contractor is required to provide funding, a long contract period may be required to recover the investment from the savings achieved.

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Reference

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217 – Table 1
218 – Table 2
252, 253, 254, 255: Some steps by Bahamas case
256, 257, 258, 259, 260, 261, 262, 263: Some steps by York case