PPIAF

Enabling Infrastructure Investment

USING PERFORMANCE-BASED CONTRACTS TO

REDUCE NON-REVENUE WATER

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PPIAF, a multi-donor trust fund housed and managed by the World Bank, provides technical assistance to governments in developing countries. PPIAF's main goal is to create enabling environments through high-impact partnerships that facilitate private investment in infrastructure.

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Abbreviations

B/C	Benefit/cost
BOQ	Bill of Quantities
BZ$	Belize dollar
CAPEX	Capital expenditure
DMA	District Metering Areas
EAAB	Empresa de Acueducto, Alcantarillado y Aseo de Bogota (Water and Sewer Company of Bogota, Colombia)
GIS	Geographic Information System
IDB	Inter-American Development Bank
IFC	International Finance Corporation
IWA	International Water Association
kWh	Kilowatt Hour
m^3	Cubic meters
NRW	Non-revenue water
ONEA	Office National de l'Eau et de l'Assainissement in Burkina Faso
OPEX	Operating expenditure
PBCs	Performance-based contracts
PPIAF	Public Private Infrastructure Advisory Facility
PPP	Public-private partnership
PV	Present value
R$	Brazilian Real
SABESP	Companhia de Saneamento Basico do Estado de Sao Paulo (Sao Paulo Water and Waste Management Company)
VND	Vietnamese Dong

1. Non-Revenue Water: Benefits of Reduction and Control

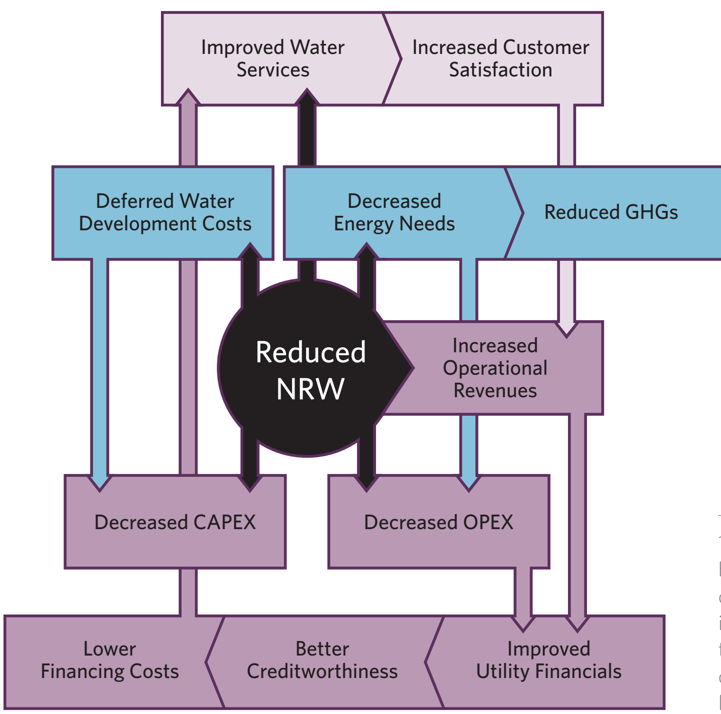
The benefits of non-revenue water (NRW) reduction and control are many and interlinked. Non-revenue water is water that is placed into a water distribution system but not billed to customers.[1] Table 1 shows the different components making up NRW, including examples, indicators, and their financial values.

NRW represents an opportunity cost not only for the concerned service provider, but also for cities, the environment and the broader economy. Some of the benefits are shown in Figure 1 and described in the paragraphs below.

TABLE 1: Characteristics of Components of NRW

Component	Examples	Indicators	Value of Reduced NRW	
			When short-term demand is met	When saved water can be sold
Unbilled authorized consumption	Unbilled government, fire-fighting; pipeline flushing; and some public uses, such as mosques	• Liters/connection/day • Unbilled authorized consumption/ billed consumption	Retail price of water (and sewer)	Retail price of water (and sewer)
Apparent (Commercial) losses	Meter under-registration; un-authorized water use; billing errors	• Liters/connection/day • Commercial loss/billed consumption	Retail price of water (and sewer)	Retail price of water (and sewer)
Real (Physical) losses	Leakage from distribution mains and service connections, tank overflows, etc.	• Liters/connection/day • m^3/day or m^3/km/day • Value of physical losses/ operating cost	Variable operating cost of water production	Retail price of water (and sewer)

FIGURE 1: Inter-Related Benefits of NRW Management



NRW directly improves various parameters (black arrows). At the same time, there is an ongoing cycle where these parameters contribute to the improvement of other parameters.

1 Commercial losses, or apparent losses, include water that is consumed but not paid for by the user. Water that is billed, but not paid for, is not considered part of NRW by IWA convention. Therefore improving billings is an NRW reduction activity, but improving collections is not, despite the financial importance of actual revenue collections. Physical losses, otherwise known as real losses or leakage, are the total volume of water losses minus commercial losses.

Water Resource Efficiency and Deferred Investments in Costly Supply Augmentation

A program to reduce NRW in large, growing cities can hold down raw water withdrawals and the need for new source development. In the East Zone of Manila, water production remained mostly constant from 2001 to 2014, even though the number of connections increased at an average rate of 6.7 percent per year and consumption rose by 4.75 percent per year; this is because NRW fell by 11.7 percent per year. In a water-constrained environment or in cases where drinking water supply competes with other important uses of water, reducing NRW is often more cost effective than increasing the water supply. Reductions in capital expenditures (CAPEX) can come from downsizing or delaying additional water production. In the case of Lusaka, Zambia, financial studies showed that the cost of reducing NRW over the long term to an internationally accepted target would fully meet the water needs of un-served users and cost approximately $66 per capita, whereas investment in a new water-treatment plant would cost approximately $165 per capita.[I]

Energy Savings and Climate Resilience

Conserving water resources creates a buffer in the face of increasing climate variability and can be a cost-effective adaptation measure.

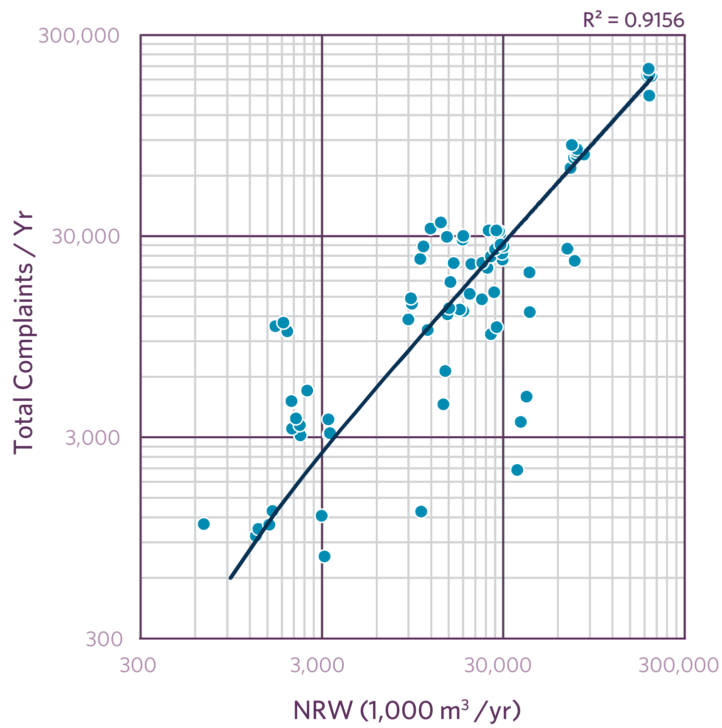
An IDB study in the drought-stricken areas of Jujuy, Argentina compared two climate-change adaptation measures—reducing urban leakage and improving on-farm irrigation efficiency. The results showed that while larger water savings could come from irrigation improvements across the entire province, the present value (PV) cost of controlling urban water leakage was much lower—$0.023/m^3 compared to a range of $0.041/m^3 to $0.075/m^3, depending on the crop involved, for irrigation efficiency.[II]

Additionally, when physical losses are reduced and supply is not needed for underserved customers, pumping could decrease. This would save energy and decrease greenhouse gas emissions if power production involves carbon-based fuels. The energy savings can be large. For example, in Brazil, the estimated average energy use for pumping is 0.75 kWh/m^3 of water produced.[III] For a town with 100,000 connections, a real loss reduction of 250 liters/connection/day would save 6.8 million kWh per year, which is worth nearly $1 million per year. In Abu Dhabi, due to the extensive use of desalination, the energy component of potable water is about 4.0 kWh/m^3, so energy savings from NRW reduction in such areas could be very high.[IV]

Improved Quality of Service and Customer Satisfaction

In general, reducing NRW leads to fewer service interruptions, more continuous supply, higher pressures, and cleaner water.[V]

FIGURE 2: NRW and Customer Complaints in Chile

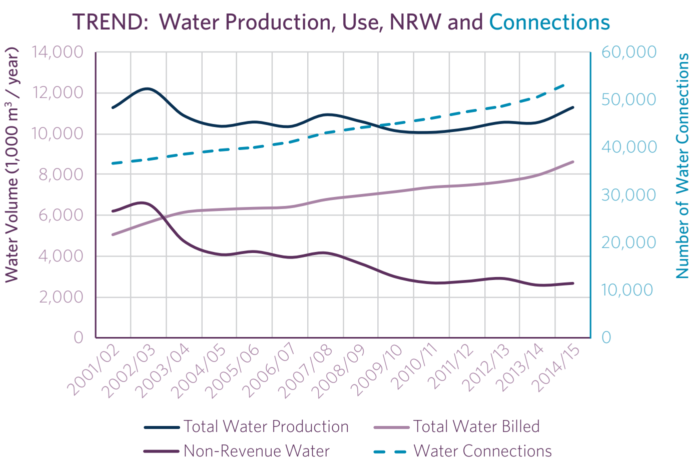


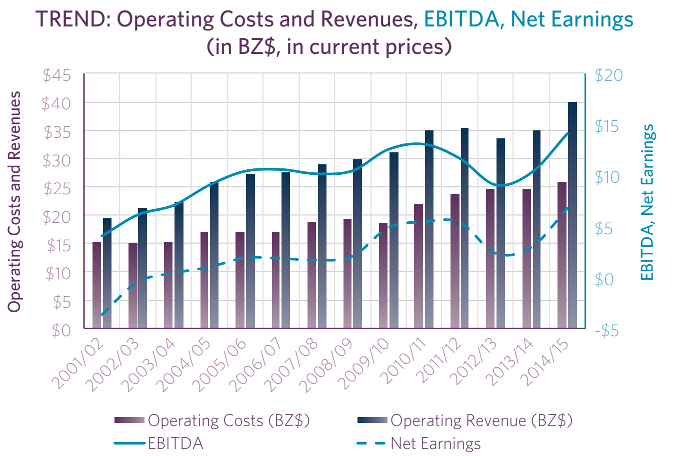
As a result, customers are generally more satisfied with the service they receive, leading to more prompt and consistent bill payment and fewer illegal connections. Figure 2 shows a clear link between NRW and customer complaints in 17 Chilean utilities from 2009 to 2013.

Improved Utility Financial Viability

The reduction of commercial and physical losses can increase operating revenues through the sale of saved water and reduce operating costs linked to producing and pumping water. For utilities under financial stress, the impact can be substantial and translates into less need for subsidies. Figure 3 shows the NRW and financial trends for the Belize Water Services after the system was placed under a concession with an international operator in 2000. From the concession period (2000 to 2005) through the period following the sale of the concession back to the Government of Belize (2005 to present), despite an increase in connections and overall consumption, water production declined due to lower NRW. As a result, water production and operating costs remained relatively stable even as revenues and earnings rose substantially.[VI] Reducing losses is an important step to achieving long-term financial sustainability of water utilities. An efficient utility is likely to get competitive financing that will also improve its ability to meet capital expansion plans and service quality targets in the long run.

FIGURE 3: Belize Water Services: Utility Financial Improvement





2. Private-Sector Involvement with Performance-Based Contracts

A water provider's NRW level is a good indicator of the state of its internal management and operations and is symptomatic of the policy and incentive environment in which it operates. Unfortunately, in publicly managed services, there are few incentives for efficiency—often price does not reflect the cost of delivery; public expenditures are rarely scrutinized; and utility management and staff are neither rewarded for avoiding waste nor penalized for creating it. Water-service providers are also up against many constraints, such as chronic under-funding. This is why water-service providers struggle to manage NRW, despite the clear and significant benefits of doing so. Therefore, although investing in NRW management makes financial sense in most cases, it may nevertheless not happen, because rehabilitating networks, setting up monitoring and control systems, installing billing and accounting programs, etc., all require motivation, know-how and funds that may not be immediately available to utilities.

Utilities could turn to consultants or outsource leak detection, but these arrangements bestow on the utility the burden of action and risk of performance—often regarding a topic on which they have little expertise. It is possible to seek private-sector participation and to transfer performance risks through concession, rehabilitate-operate and transfer, or hybrid operating/lease contracts, but these require the utility to give up a significant amount of responsibility and require much greater upfront transaction preparations.

The fact that NRW-reduction programs can "pay for themselves" has allowed an increasing number of water-service providers to engage specialized private-sector contractors in performance-based contracts (PBCs) for NRW management, wherein the private party takes some of the performance risk of achieving NRW reductions for a share of the upside. The payment structure of a PBC is generally split into two components: a performance-based fee, which varies according to the level of achievement against performance specifications in the contract, and a fixed component, which reimburses the contractor's costs. Annex 1 shows the variety of NRW PBCs and their payment mixes.

PBCs are essentially a form of outsourcing for a mix of technical services and civil works, but with three primary distinguishing features that create incentives for efficient, high-quality work:

- Payment to the contractor is based on achieving results rather than on the cost of inputs;
- The contractor ideally has flexibility and discretion regarding how the results will be achieved, including the organization of teams and technology; and
- The contractor ideally has a stake in the upside that would come from exceeding the targets.

PBCs for NRW management do not typically involve taking over the operations of a utility or a public workforce by the private sector and so avoid the challenges, complexity and transition costs of other types of public-private partnership (PPP) contracts. On the other hand, the principal advantages of PBCs over utility-implemented projects are:

- Utilities can achieve a more rapid reduction of NRW;
- There is a lower risk of the project not achieving its NRW targets;
- Utilities and their staff can learn new practices and gain practical NRW experience if the contractor and utility work in partnership; and
- Utilities can address specific problems (or locations) without having to expand their permanent staff.

In other words, NRW PBCs can help utilities get over a "hump" of high NRW and achieve more efficient operations.

Annex 1 features a list of utilities that have used NRW PBCs.

3. Design Considerations for Non-Revenue Water Management Programs and Performance-Based Contracts

In general, an NRW management program has two phases: the reduction phase and the maintenance phase (also called the sustainability phase). The reduction phase aims to drive down the levels of NRW by reducing real (physical) losses and apparent (commercial) losses. The reduction phase targets the backlog of losses caused by deferred maintenance and weak commercial systems. The reduction phase typically calls for the establishment or updating of the customer cadaster and records by conducting customer surveys, regularizing illegal customers, and testing, calibrating or replacing meters. On the other hand, real (physical) losses are controlled through the establishment of network monitoring sectors, called District Metering Areas (DMAs)[2] that improve the speed of identifying leaks, carrying out leak repairs, and managing pressure—the typical activities conducted at each stage. Real loss reduction will also usually require the replacement or rehabilitation of parts of the network, especially customer connections.

The maintenance phase aims to continue many of these practices to keep the level of NRW low or stable, and to move towards an even lower, optimal NRW level. The maintenance phase can take place during a period when the granting authority considers it will be able to develop the know-how to manage the system by itself, or it can coincide with the payback period of the investment, particularly if the private contractor is also responsible for the up-front financing of the NRW program.

Whereas PBCs for NRW management are more commonly used today, they are by no means simple to structure. Figure 5 illustrates the stages of an NRW PBC transaction and the typical activities conducted in each stage. This section discusses selected issues that can arise and lessons that have been learned in recent years that are relevant to the design of an NRW program and the structuring of a PBC.

2 The size of the network dictates how many DMAs will need to be established and affects the length of the reduction phase. In general, a DMA will be established for every 1,000 to 5,000 connections.

FIGURE 5: Stages of NRW PBC Transaction Development and Implementation

	Stage	Objectives	Activities Typically Undertaken
Preparation	Early Assessment	• Gauge stakeholder commitments • Compile data and attempt a water balance • Identify value drivers and deal breakers • Develop broad scope and estimate costs	• Desk review and analysis of available data • Inspection of network • Discussions with stakeholders
Preparation	Baseline and Diagnostics	• Establish the level of leakage according to International Water Association Water Balance • Identify root causes, realistic reduction targets and key actions	• Night flow and pressure tests • Inspection of network and records • In certain cases, establishment of temporary district metering areas • Customer surveys • Assessment of metering accuracy • Assessment of administrative processes for recording and billing
Preparation	Non-Revenue Water Program Development & Investment Planning	• Expand key actions into specific plans: outputs and inputs required and timing • Develop the budget for the program	• Review of options for action • Definition of actions, outputs and required resources • Financial analysis of costs and benefit of plan and components
Preparation	Transaction Design & Tender	• Define target and scope within the broader NRW program and investment plan to assign the private contractor • Define risk allocation and payment structure • Develop design criteria and minimum standards • Develop cost estimation for bid reference • Develop bidding strategy • Develop contract documents	• Develop business case and assess value for money • Technical and legal due diligence • Conduct financial projections • Market sounding • Tender, evaluate, negotiate and award contract
Implementation	Reduction Phase	• Implement commercial loss-reduction program • Implement physical loss-reduction program: · Establish DMAs · Active leak detection & management · Pressure management • Establish control systems	• Customer surveys, regularization of illegal customers, collection of arrears • Meter replacement or installation • Establish DMA • Set up active leak-detection systems/protocols • Rehabilitation/refurbishment of network and additional works (e.g., reservoirs) • Develop GIS
Implementation	Maintenance/ Sustainability Phase	• Maintain reduced NRW or drive towards lower economic leakage levels	• Regularization of NRW effort into utility organization • Regularization of leak monitoring, leak-detection, and management practices • Regularization of commercial loss-reduction practices • Hands-on training specific functions • Asset management
Implementation	National Scale Up	• Strengthen regulation systems for NRW • Strengthen public sector-side incentives for NRW management	Potential activities could include: • Build capacity for regulators and utilities to establish economic levels of leakage • Develop national NRW program • Establish NRW performance incentive fund

Data Dilemmas in Diagnostics

From a contracting perspective, because the essence of a PBC is to link payments to the degree to which results are achieved or exceeded, it poses a financial risk to the contractor that must be taken account in the pricing. The utility, on the other hand, will be concerned that payments to the contractor be outweighed by the benefits of achieving or exceeding those targets and maximizing value for money. In order to even begin to understand the desirability (from a cost-benefit perspective) of a PBC, a utility would need to have a reasonably accurate sense of realistic loss reductions (the target) and their associated costs (means). However, utilities that have high NRW levels and need assistance through a PBC are also more likely to have trouble making such determinations.

Some early transactions followed a traditional procurement approach whereby the granting authority commissioned a detailed feasibility and design study lasting one to two years to assess the situation, plan the program of works and prepare the PBC tender. But experiences in Ho Chi Minh, Vietnam and Kingston, Jamaica have shown that by the time the subsequent PBC begins, baseline conditions have changed and the PBC contractor can end up working against an inaccurate baseline, or using an inflexible design, or they must redo the diagnostic planning phase. All this costs money, but just as importantly, tends to consume time that could be devoted to the loss-reduction effort itself.

BOX 1: Value Drivers for NRW PBCs

- Utility leadership keen to make rapid progress in reducing NRW
- Major constraints on water resource availability, currently or expected in the future
- High level of NRW, especially in combination with scarcity, low coverage and poor service with intermittent water supply, suggesting that outside expertise is needed to address the issues
- Political or fiscal pressure to rapidly improve NRW, water service and utility financial condition
- High water production cost, such as through the use of desalination or high energy cost
- Limited or low utility expertise in NRW planning and reduction
- Utility cannot expand staff to reduce NRW and then scale back staff to maintain low NRW

Early Assessment and Options Development: An early assessment and options development exercise, conducted with the help of an NRW management expert with experience in performance-based contract design, could overcome some of these constraints. The process aims to:

- Determine the commitment of utility managers and owners to implementing an NRW management program through a PBC and under what constraints (whether technical, financial or political);
- Assess whether a minimum level of information is available to develop a baseline water balance and how to overcome data challenges; and
- Table some options on the scope of the NRW Management Program and the PBC, as well as how performance will be measured.

It is critical, but often overlooked, that the value drivers which contribute to making the PBC option cost-benefit positive and acceptable to stakeholders are identified upfront. Identifying potential deal breakers could also be helpful—for example, where there are no additional (external) sources of funding and tariffs are below cost, then OPEX savings may not sufficiently translate into a sustainable payment stream for the contractor. Box 1 illustrates key value drivers.

The assessment will also evaluate whether utility records and available information, as well as the current level of metering and network sectorization, yield sufficiently accurate information to allow the development of a baseline for the transaction design, without needing an extended baseline step. The goal is to be able to assemble information that can go into a water-balance analysis using the International Water Association method.[VII] This type of analysis allows a utility to determine the level of losses and identify the key root causes and priorities for action. Assessment activities include: an NRW trend analysis; a top-down water balance with water-balance uncertainty analysis; and an NRW practices survey. The information generated from these activities helps determine the baseline, target and scope for the NRW management program in general and the PBC specifically.

Considering the constraints discovered during the exercise, the early assessment should arrive at options for the scope of the program, the potential target, and the cost. This information can be used to engage different stakeholders, including potential funders, such as development financial institutions. The assessment can also begin to identify unknowns and risks that will require further investigation or consideration during the next stages. Some of these unknowns and risks can be dealt with through an extended baseline or in the way that the contract is structured (see section on Flexibility in Scope and Managing Uncertainty). The assessment concludes with a decision regarding whether or not to proceed with the next stages, and whether an extended baseline step is necessary.

Extended Baseline: If the early assessment finds the level of information lacking—for example, if source metering is unreliable or inaccurate, or customer records and other accounts are extremely unreliable—then project managers may decide that an extended baseline is necessary.

This would involve source-meter testing, customer-meter testing (sampling basis), night-flow testing (if continuous water supply can be arranged for test periods), and real-loss component analysis, if burst records are available. The extended baseline sometimes requires that pilot or temporary DMAs are established. DMAs are sections of a water distribution network whose boundaries are closed off by valves and fitted with a meter at the point of inflow in order to manage the monitoring of leakage. Temporary DMAs could be established by using portable, clamp-on meters and closing off boundaries temporarily in order to execute field tests on different aspects of the water balance, such as meter accuracy, illegal connections, pressure, consumption patterns and night-time consumption, in order to reduce the uncertainty of the estimates of the magnitudes of the different components of NRW.

Because the capacity to conduct such a baseline and diagnostic requires specialized technical skills and funds that may not be available to the utility, the baseline and diagnostic stage can also be incorporated in the PBC contract itself. Even if the baseline is finally set during contract implementation, it is important that an initial target is set to ensure consistency in the bidding stage even if the targets may be adjusted after contract award. (See discussions below regarding the scope.)

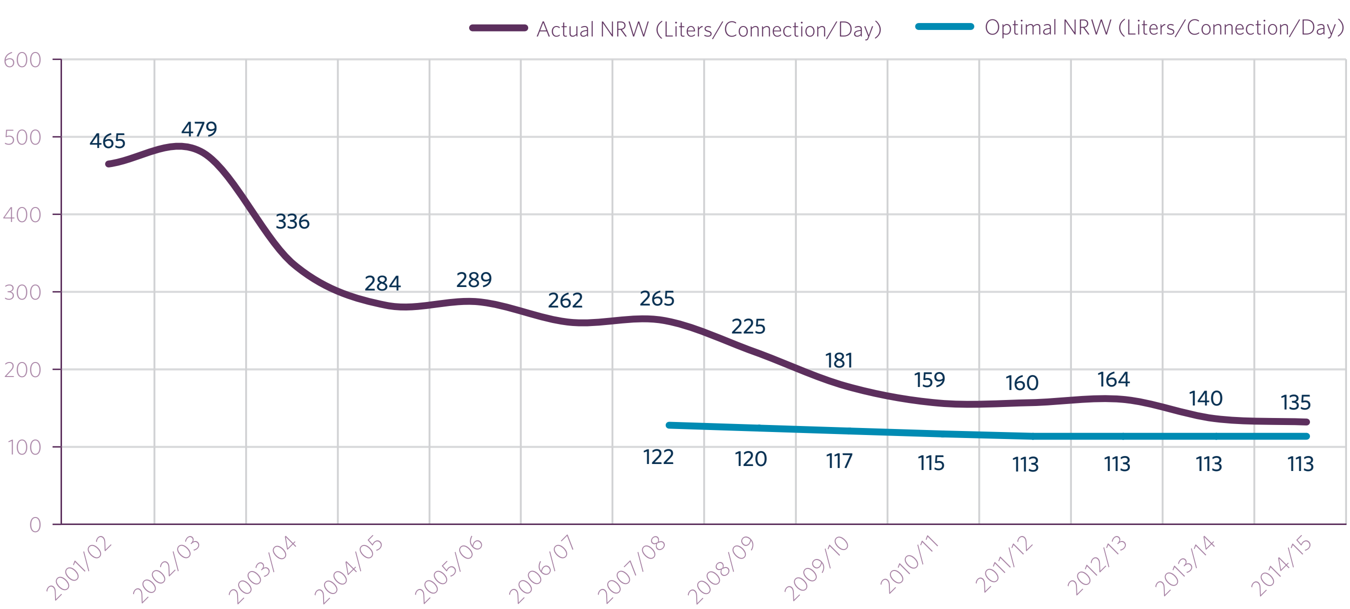
Defining the Scope of the NRW Management Program and the PBC

PBCs can vary widely in their scope, objectives and targets, depending on the local need, capacity of contractors and available funding.

Overall, a well-designed program will strike an appropriate balance among NRW reduction and maintenance expenses and revenues generated from the initiative, resulting in an improved financial condition for the utility. There is a financially optimal level of NRW, at which point spending more money on NRW reduction will not generate an equivalent financial return. In other words, further reduction efforts beyond this point will not pay for themselves. Optimization tools are available to determine this optimal level of NRW—which can serve as a long-run target—based on local technical and cost parameters. A utility with high water-production costs, high water prices and high consumption has more to gain from additional NRW reduction efforts than those with lower production costs, tariffs and consumption. Reaching it, however, could require at least 10 years of concerted effort, CAPEX and OPEX. Figure 6 shows how Belize, after some 15 years of work, is close to the optimal NRW level.

Part of this consideration is the scope of the contract—will the PBC cover all aspects of NRW or only some? Quantifying the volumes, the values of the various NRW components, and the cost of reducing each component

FIGURE 6: Actual and Optimal NRW in Belize



is a critical step in understanding the NRW situation and its financial implications, and planning an NRW reduction program. Commerical and physical losses have different cost curves, require different skills and techniques to address, and therefore, need to be considered separately even if they are combined into one contract.

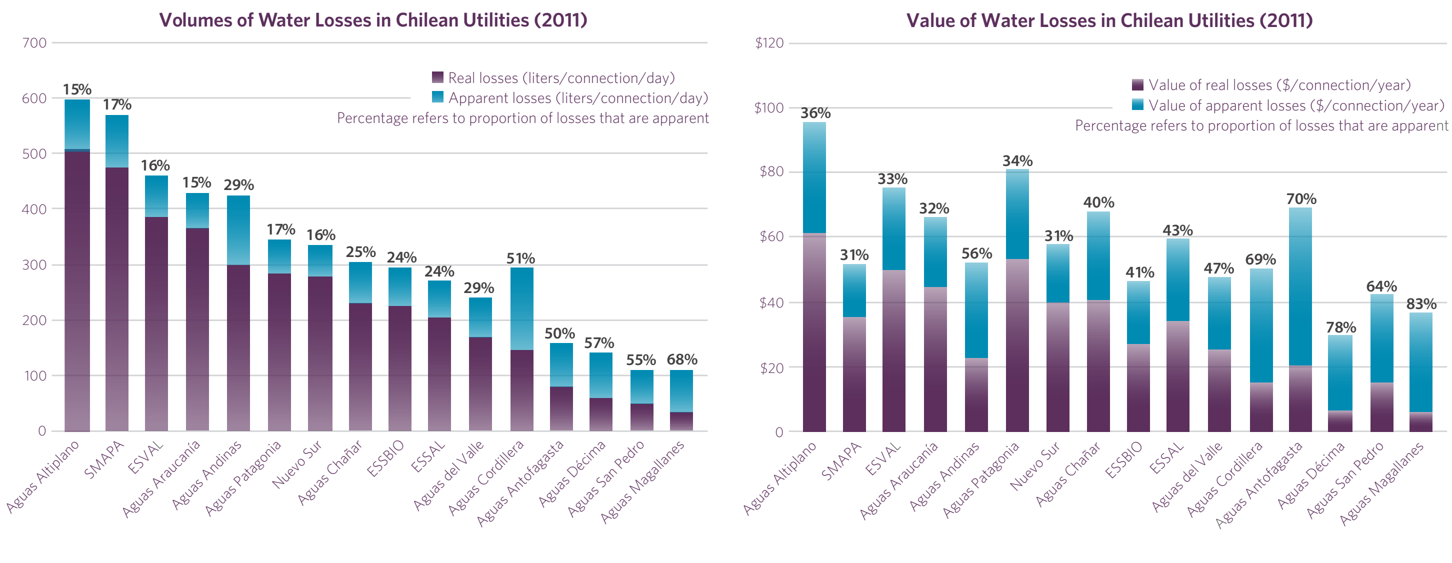
Usually the retail price of water is much higher than the variable cost of water production. This implies that the financial value of reducing a cubic meter of commercial losses is much higher than the financial value of reducing a cubic meter of physical losses. Figure 7 demonstrates this distinction for a variety of regulated large utilities in Chile. In terms of volume, commercial losses are relatively small, but in terms of value, they are relatively large. Thus reducing apparent losses is sometimes the first order of action in cases where financial resources are limited.

In some cases, the scope will cover all aspects of NRW, but only in a particular zone of the network or portion of the service territory of a national water utility. This is one way to get started with an NRW management program and to familiarize actors with the new PBC approach. This not only reduces NRW, but also more accurately ascertains the situation for future phases. PBCs in Jamaica's North Coast; Ho Chi Minh City, Vietnam; Tegucigalpa, Honduras; Colón, Panama; and New Providence, in the Bahamas are examples of this approach. Box 2 describes the strategy being employed by the South District of SABESP in São Paulo, Brazil, which has generated many small PBCs to deal with specific "problems spots" involving real losses.

Examples of limited-scope PBCs include PBCs being used for: pressure management (South Africa), water meter replacement (São Paulo, Brazil), and reducing apparent losses and improving billing and collections (three provinces in Jordan; ONEA in Burkina Faso; and EAAB in Bogotá, Colombia). PBCs that only focus on a specific NRW component can be quite simple to design and structure and can start quickly. PBCs for commercial losses can contain a fixed-fee component for preparatory work (planning, customer cadasters, billing system set up, etc.), and a performance fee based on a share of increased revenue, which is used as the bid parameter. The revenue shares of NRW PBCs focused only on commercial losses are typically in the range of eight to 14 percent.

However, the granting authority may not necessarily want the contractor to focus only on the "lowest hanging fruits" because bringing in a private contractor is premised on bringing in resources, initiative and skills that the public sector may be lacking. There are a number of interventions that a PBC contractor can pursue to reduce physical and commercial losses, some of them easier (and cheaper) to carry out than others. Specification of the contract objectives, the performance outcomes (and indicators), and even the outputs, must reflect a realistic possibility of making improvements in key indicators over the long run, within the contract's expected timeframe and cost constraints.

FIGURE 7: Volumes and Value of Real and Apparent Losses in Chile



BOX 2: Perspectives on PBCs from SABESP, in São Paulo, Brazil

SABESP, the concessionaire for the State of São Paulo, Brazil, runs one the world's largest water-supply systems, serving more than 25 million people. It has implemented more than a dozen NRW PBCs (from 2008 to 2010, SABESP South Unit conducted five PBCs, mostly for real losses, with a value of more than 27 million Brazilian Reals (R$)).

Why would a utility with world-class expertise use PBCs? South Business Unit Director Roberval de Souza explains how SABESP uses PBCs to ***supplement*** its in-house capacity and quickly solve particular problems that arise. The current model for NRW was developed in 2008, based on previous PBCs undertaken to meet energy-efficiency objectives. The benefits being realized by SABESP are:

A more efficient bidding process—Selections can be made on the basis of technical quality and price, or a combined score. In both cases, there is a reduction in the number of tenders and bids because engineering services and civil works are unified into one bidding process. The winning company or consortium is responsible for the outcome and will be remunerated according to the results. In a conventional process, there would be one contract for the design, one for civil works, and one for engineering services, which may not lead to the desired outcome within the projected timeframe.

Shorter time frames for project completion—Using the conventional contract model, the timeframe is about 48 months from design to final plans, execution of civil works, delivery of engineering services, and final results. In the PBC model, this timeframe is reduced to 18 months, because the same company or consortium is responsible for all stages of the project and is only paid after the outcome is achieved.

Financial benefits—Shorter timeframes for project completion, better results, and increased revenue, SABESP realizes financial gains sooner than with the traditional model. Reducing water losses leads to lower water-production costs (for electricity and chemicals) as well as revenue gains from the sale of water in places with latent demand. PBCs lead to high-quality projects, works and services because, in addition to the prescribed results-based remuneration, it is possible for the contractor to obtain a bonus (up to 20 percent of the projected pay). A contract clause stipulates that, if the water-loss reduction target is exceeded, the contractor and SABESP share the benefits.

The typical process and contract design considerations include the following elements:

- SABESP prepares a study of the project, which includes the objectives, minimum scope, cost estimate, potential water-loss reduction, and contractor payment per cubic meter of water loss reduction (contractor fee);
- After SABESP's financial and legal staff review the project concept, SABESP solicits expressions of interest and offers;
- Proposals are evaluated on the basis of a technical score (technical quality and proposed water-loss reduction) and financial score (overall reduction multiplied by price); and
- Contracts stipulate payment based on percentage of achievement of target (<70% — payment is 0; 70% to 99% — payment based on percentage and contractor fee with penalty applied; 100% to 120% — payment is full value + bonus).

Contract Provisions to Deal with Baseline Uncertainties

Given the usually considerable data challenges and imbalance in the know-how between the utility/granting authority and potential contractors, especially in developing country contexts, how have PBCs tried to optimize among the level of effort, the cost, and the resulting success?

PBCs need to establish a flexible scope for the contractor to achieve the targets. An overly restrictive scope is not desirable, not only because it may lock in the contractor (and the utility) to an inefficient plan, but also because PBCs are likely to deliver more value when competitive forces are exerted on the technical solutions proposed by contractors rather than just on the price for which contractors are willing to implement a pre-determined plan. Private contractors tendering for a contract will often apply value engineering (using the least cost option to meet the performance requirements) and have a comparative advantage in terms of determining the most efficient way to achieve a target.

A minimum level of information to conduct a water balance in order to define the target and the scope of potential activities and estimate the overall cost envelope may be all that is available. Thus, PBCs have dealt with scope uncertainty in the following ways:

- They include the baseline and diagnostic as an output of the contract and include a true-up period (for which the contractor collects information) in the beginning of the contract. This allows the parties to agree (or confirm) the NRW baseline and—especially in cases where the PBC has envisioned that CAPEX will be financed by the public sector (i.e., where the contractor is only providing professional services)—to define and agree on the CAPEX program that would meet the contract's performance specifications and still fall within the granting authority's budget. In the case of the PBC in Tegucigalpa, Honduras, the diagnostic and implementation phases were successfully combined into one two-stage contract.
- They include a provision that allows price rebasing or adjustment for material differences (described as plus or minus some specified percentage) for critical assumptions provided by the public party in the tender documents, that are not supported by subsequent verification.
- They give the contractor freedom to determine the CAPEX program within a budget envelope.

Contract Incentives for Cost-Effective Solutions

How can the public party control the cost of the CAPEX program while also affording the private contractor more flexibility in coming up with solutions?

Sharing the Upside: A starting point for how payment is apportioned between performance-based and fixed components is to consider that, fundamentally, PBCs engage private contractors for their know-how and effectiveness—for selecting the right sets of issues to focus on; for proposing efficacious and least-cost solutions; and for effective execution—which they can apply to reduce and, ideally, maintain NRW levels. The performance component of the payment can be set to cover the contractor's professional fees and margins, while the fixed component of the payment is set to reimburse other costs, such as for materials, labor and equipment, or even certain outputs, such as a diagnostic report or a control center. The fixed-payment component would be based on a bill of quantities (BOQ) specified by contractors in their bids as fixed-unit prices for a list of pre-specified inputs with pre-specified quantities.[3]

However, where the total professional fees and margins have all been recovered by the achievement of a given performance level, there no longer remains any incentive to do even better. This is a good reason to consider shifting further costs to the performance component of the payment. The higher the performance portion, the higher the incentive for the contractor, but also the higher the risk they assume, and thus the higher the price they may charge to mitigate the risk. Thus, devising payment structures that can "slide" upwards and split the reward for

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3 Despite the requirement to specify inputs against a minimum bill of quantities, bidders may be allowed to provide unit prices for additional items they deem necessary. This allows additional flexibility for the CAPEX program to be adjusted once a diagnostic or better data is available. In the case of Tegucigalpa, for example, once the diagnostic phase was completed, the successful bidder presented an implementation plan on the basis of those unit costs, giving them the flexibility to find the best engineering solution.

4 The Thailand PBC achieved a loss reduction of 165,000 m^3/day, for an average cost of $409 to $518 per m^3, which compares favorably to other contracts at that time.

cost-effectiveness between the two parties could provide additional incentives for the contractor to do better. For example, in the case of Thailand, the contract paid a fixed portion to cover materials and local labor, and set the performance fee at a 50-percent revenue share per cubic meter of water loss reduced per day. No targets were set, but because the performance-fee payment was based on revenue sharing and was limited only by the ability of the contractor to reduce losses as cost-effectively as possible, a high and efficient level of reduction was achieved.[4]

Based on a review of 15 PBCs, the balance of fixed versus performance payments has varied widely, but the current practice is about 60 to 70 percent for fixed payments and 30 to 40 for performance payments.

Prudent Investment Reviews: In cases where CAPEX is entirely funded using public money, the public party will want to ensure that the contractor is making prudent investments rather than gold-plating the project. This is accomplished by ensuring that minimum standards specifications are clarified in the contract and also by having a process for vetting prudent investments. This may require the granting authority to contract a third-party specialist to make sure that the proposed investments meet the specified standards, will be efficacious (based on technical expert opinion) and are cost effective (based on market knowledge and benchmarks).

Capital Gain Share: Contracts, such as those being introduced by the World Bank in Karnataka, India, have tried to deal with this by offering capital savings incentives through capital-gains shares, whereby contractors keep a portion of the savings from the CAPEX envelope. Because contractors are also rewarded on the basis of achieving the overall results on loss reduction, and minimum standards and specifications are set, the concern that contractors will choose low-cost, ineffectual investments is negated.

Target-Cost-Reimbursable Contract: To achieve optimal levels of NRW (i.e., where the benefit of saving more water would be outweighed by the cost), it is important to remember that the long-term cost of water loss (such as the cost of producing water that is physically lost, the foregone revenues from commercial losses, and the cost of supplying water from alternative sources) and the ongoing control of that loss is a heavier burden to the granting authority than the one-off costs of establishing a control system. Proposals have been put forward to use a target-cost-reimbursable contract approach, where an incentive to minimize the long-term cost of NRW maintenance is introduced by having contractors bid on a target cost based not just on their costs for the NRW reduction and maintenance phases, but also on the cost of water losses for the period of the contract, and on receiving a portion of the difference between the tendered target cost and the actual cost as a bonus (positive) or penalty (negative).[VIII]

When the trade-off between the marginal cost of NRW reduction and the value of water loss over the contract period is made explicit, bidders internalize the optimization process in their tenders and have an incentive to reduce the combination cost as much as possible.

Setting Targets and Measurement Indicators

The selection of outcome indicators and target values is more an art than a science. The process must account for the project's objectives and scope, the level and reliability of baseline information, engineering calculations regarding the amount of reduction that can be expected, and the feasibility of measurement. The most common indicator is the NRW volume, with a specific reduction target designated in terms of m^3/day, or m^3/connection/day. Section 4 of this paper provides some indicative numbers regarding the rate of reduction that has been achieved in more than 50 NRW projects in developing countries. However, if the utility is also trying to expand coverage at the same time as reducing NRW, the indicator has to be adjusted for network or customer growth, and perhaps also for pressure changes. This is a non-trivial exercise that will benefit from expert advice.

If physical losses are measured by the difference between system input and billed volumes based on customer meter readings, then key elements of commercial losses are internalized within the physical loss activities. The contractor will be incentivized to reduce customer metering inaccuracy; reach universal customer metering; and regularize illegal connections that otherwise would be part of the physical leakage calculation.

However, in some cases, adjusting NRW volumes to account for intermittent supply and changes in pressure can become too challenging. Thus, some contracts whose primary objective is to increase the hours of supply (continuity) have opted to measure and reward performance based on this indicator. The reduction of losses is indirectly captured by the increase in the hours of supply, where no new sources of water are introduced into the system.

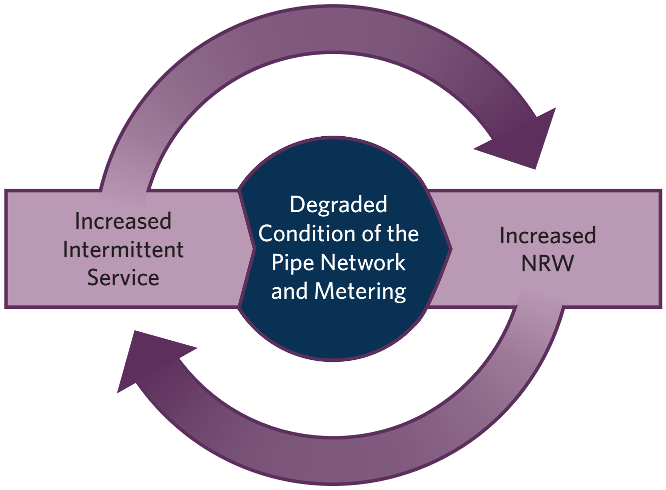
Working with Intermittent Supply

Many developing countries resort to the use of intermittent supply if leakage is high or water resources are limited.

However, this causes permanent damage to the pipe network and water meters,[IX] greatly increasing NRW and leading to even more intermittency. This negative feedback loop is shown in Figure 8. In terms of implementing an NRW PBC, measuring baseline leakage in the case of intermittent supply will be a challenge, but it can be estimated. The volume of NRW is the difference between the volumes of system input and billed consumption. Physical losses increase in proportion to the supply time, so the volume of NRW must be adjusted to reflect a 24/7 scenario (i.e., the volume of NRW should assume the present system provides continuous supply).

The average supply time can be estimated by taking measurements in different areas with different supply times and then calculating their weighted average, based on the number of connections in each area. This measurement technique can also be used to monitor PBC progress. Other PBCs have taken a more expedient path by replacing the direct measurement of NRW with the indirect measurement of service continuity, because increasing hours of service (assuming the system input is constant) requires managing NRW.

FIGURE 8: Negative Feedback Loop between NRW and Intermittent Supply



If there is a shortage of water, the granting authority might not be able to commit to delivering a given quantity of water to the area, which makes holding the contractor to account for the results more difficult. The emerging best practice is to address both NRW and intermittent supply in an integrated fashion. In some countries, service providers

BOX 3: Co-Management Approach in Jamaica

Since 2015, a co-management arrangement has been used for a PBC in Kingston, Jamaica. All activities are being coordinated by a project committee and delivered by a project team that includes employees of the contractor and of the utility (the National Water Commission (NWC)). The contractor is fully responsible for meeting the contract objectives. The committee has five members appointed by the NWC and three by the contractor. The project team leader is nominated by the contractor, and the deputy team leader by the NWC.

The committee’s functions include:

- Approving, on behalf of NWC, reports and work plans prepared by the project team;
- Reviewing contract and contractor performance, and directing the team leader to make improvements when necessary;
- Recommending to the NWC board the dispersal of funds from the project budget;
- Discussing and agreeing on key operational and business decisions related to the contract;
- Facilitating efficient coordination between the wider NWC organization and the contractor; and
- Acting as the first line of arbitration for contract disputes.

Project team members work within a matrix management system. For contract-related activities, members are responsible to the team leader. For employment-related matters, members are responsible to the NWC or to the contractor, as appropriate.

have addressed both using a zone-by-zone process, whereby one zone undergoes network rehabilitation and meter replacement and then is supplied with continuous water and ongoing maintenance. Financial returns from the first zone can help to fund the work in the next zone. However, in many places, intermittent supply is overwhelmingly linked to water shortages. In this case, project planners will need to consider NRW interventions in combination with water-source development.

Implementation Partnership

For maximum effectiveness and efficiency, there should be collaboration between the PBC's contracting parties. Choosing a PBC means choosing to outsource utility functions, at least for part of a territory, or for selected aspects of NRW management. The PBC contractor will probably have staff who are working on a different pay scale and have different training levels and incentives than service-provider staff, which could be problematic. If the working relationship between the PBC team and the rest of the utility is collegial and collaborative, the results will be better, and the knowledge transfer to the existing utility could be significant. In one water-sector PBC in the United States, the parties established a practice to "agree to agree"—this means each party will make every effort to find a way to reach a satisfactory compromise in the case of any disagreement. Box 3 shows an innovative partnering approach, now in use in Jamaica.

Sustainability of Results

Possibly the most challenging aspect of NRW PBCs is sustaining results. Many PBCs have made significant NRW reductions in a zone or city, but after the contract ends, the NRW begins to rise again. In a PBC, the contractor often operates distinctly from the main utility in terms of people, skills, practices, incentives, information, budget, etc. So when the PBC ends, those key inputs can disappear, unless:

- The utility itself has undergone a major transformation, creating more autonomy and internal accountability and incentives;
- Technical skills, information and practices are transferred to the remaining core of the utility; and, most importantly,
- Utility management allocates sufficient money in the budgets for those practices to be continued and refined over time.

There are two ways in which sustainability has been addressed:

Training and Adoption of Performance Incentives: A number of PBCs include a training and knowledge-transfer component as part of the scope of work. However, without broader reforms, training alone may not prevent backsliding. Reforms that encourage accountability and reward good behavior are important. Following the concession contract in Belize, the service provider was transformed from a government water office to a regulated private company and has continued to improve coverage, service quality, NRW and financial conditions. Some utilities (such as in Jordan) recreate the incentives in the PBC after the contract period ends, such as paying a bonus to utility staff to sustain or further improve levels of NRW. Utilities also seek ongoing technical support from consultants or through a twinning arrangement or operator partnership.

Continuous Outsourcing via PBC: Tendering a subsequent performance contract or extending the duration of the maintenance phase with incentives to fine tune the NRW management strategy and keep losses down (or to approach the optimal NRW level) are other strategies that are becoming common practice. The current PBC in New Providence, Bahamas will likely be followed by another PBC for ongoing NRW management. The city of Nashville in the United States has had a series of NRW PBCs that have been rebid every six years. In such cases, the service provider has the opportunity to fine-tune the scope of work and understand better the costs of water loss and reduction efforts based on previous engagements, and thus the ability to update the bid documents and apply more competitive forces on the subsequent phases of work.

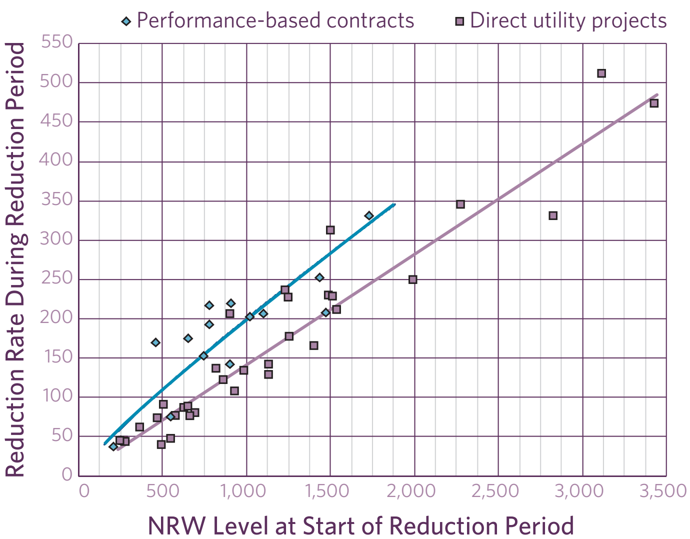
It is important that sector-level incentives also emphasize the need to sustain results from NRW PBCs. In this respect, the commitment of the public party is key. This can be reinforced by making financial resources available to support or reward the utility to pursue or persist with NRW management; by applying regulatory pressures and making adjustments to the policies on performance and tariff regulation of utilities; and by reinforcing the utility staff, board of directors and managers' own visions and abilities to act, by providing orientation and training or by comparing them to peers in a benchmarking exercise.

4. Comparison of PBCs and Conventional Approach and Assessing their Financial Cost-Benefit

How does a PBC compare to the conventional approach of in-house NRW management? Although this analysis could benefit from additional data, it suggests that NRW PBCs are financially advantageous in cases where initial water losses are high, large reductions are needed, and water is expensive; conversely, conventional approaches are advantageous when water losses are low, smaller reductions are needed, and water is less expensive.

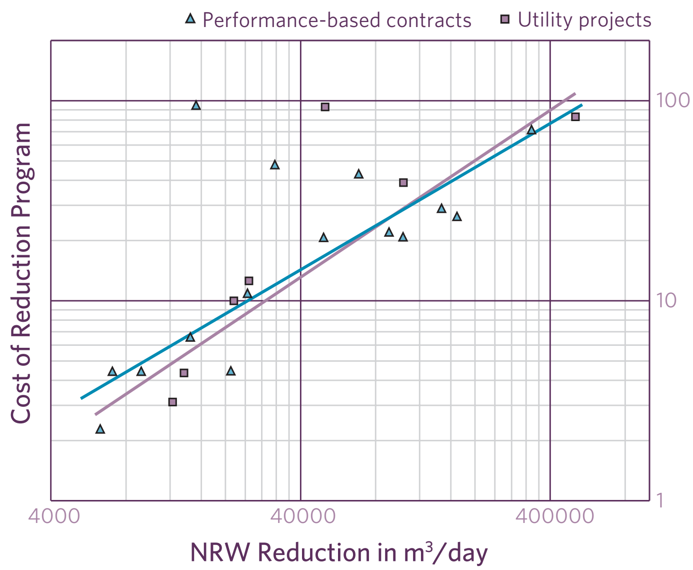
A comparison was made of the rate and unit cost of NRW declines during the reduction phase of various projects.[5] Figure 9 shows data on the average yearly reduction of NRW for two groups of projects—implemented through PBCs and implemented directly by utilities—relative to their initial NRW levels. These projects addressed both apparent and real losses in the reduction phase. For both groups, the average reduction is higher for projects that start at a higher level of water loss.

FIGURE 9: PBC vs. Utility (In-House) Average Annual NRW Reduction (Liters/Connection/Day)



Comparing the two groups, the PBC line to the left of the utility (in-house) line, shows that, in general, PBCs are able to make more rapid reductions at different starting levels compared to direct utility projects, although the difference in reduction rates is less pronounced at lower initial levels of loss. This seems logical, given that utilities reducing losses from a low level probably have some experience with NRW reduction and can be more effective. Utilities starting from a very high level would probably have less experience and not be able to match the effectiveness of experienced PBC contractors.

FIGURE 10: Cost of NRW Projects (in Million US$, 2010 prices)



While there is a substantial amount of data on NRW program effectiveness, there are fewer reliable data on the actual cost of NRW programs, whether or not implemented through PBCs. Figure 10 shows data on the total cost of reduction projects in relation to the reduction achieved. The results indicate that PBCs can achieve better economies of scale and are less expensive for large reductions but more expensive for small reductions. However the distinction is not statistically significant.

The financial performance of different NRW management programs can be compared. Figure 11 illustrates two different strategies: rapid reduction or slower reduction.

5 The data used in this analysis was derived from published reports and official documents for 49 NRW projects dating back to 1993. The countries included Albania, Abu Dhabi, Bahamas, Belize, Cambodia, Costa Rica, Ecuador, Jamaica, Honduras, India, Malaysia, Morocco, Paraguay, Thailand, Uruguay, Vietnam and Zambia. The data set includes 14 PBCs and 35 conventional projects. Where the data allowed it, NRW reduction programs lasting more than five years were segmented into phases of five years, so that the range-of-reduction period across different projects was comparable. The average reduction period was 4.5 years, with a range of 1.5 to 9 years; 33 of the 49 projects had a reduction period of four or five years.

A first-level analysis would be to compute the sum of the present value (PV) of the cost of the NRW reduction and maintenance activities and the PV of the value of the remaining NRW under each of these strategies. The option with the lower overall PV cost is the better option.

Then, the financial benefit-cost ratio (B/C) of any project—PBC or otherwise—can be compared to determine a preferred option. The financial benefit of any project is derived by calculating the difference between the total PV cost of that option and the PV of the value of the NRW in a "no-project" option. The financial cost, on the other hand, of any project is the PV cost of the NRW reduction and maintenance activities. From these parameters, a financial benefit/cost ratio can be computed to determine a preferred option.

For illustration purposes, Table 2 shows the results of a comparative financial analysis of PBCs and utility-implemented NRW projects. The following assumptions were used: a time frame of 10 years; a program structured to reach the optimal NRW level and hold it over a maintenance period; a water price equal to twice the variable water production unit cost; a real discount rate of 10 percent; 100,000 connections; and a growth rate of water connections of two percent per year. The B/C values are based on a matrix of inputs reflecting a range of initial NRW levels and water-production unit costs.

Many observations can be made from the results. First, at low initial NRW levels, the B/C values for conventional projects are superior to those of PBCs, especially if water is inexpensive. The difference is smaller as water costs

FIGURE 11: Framework for Financial Analysis of NRW Management Programs

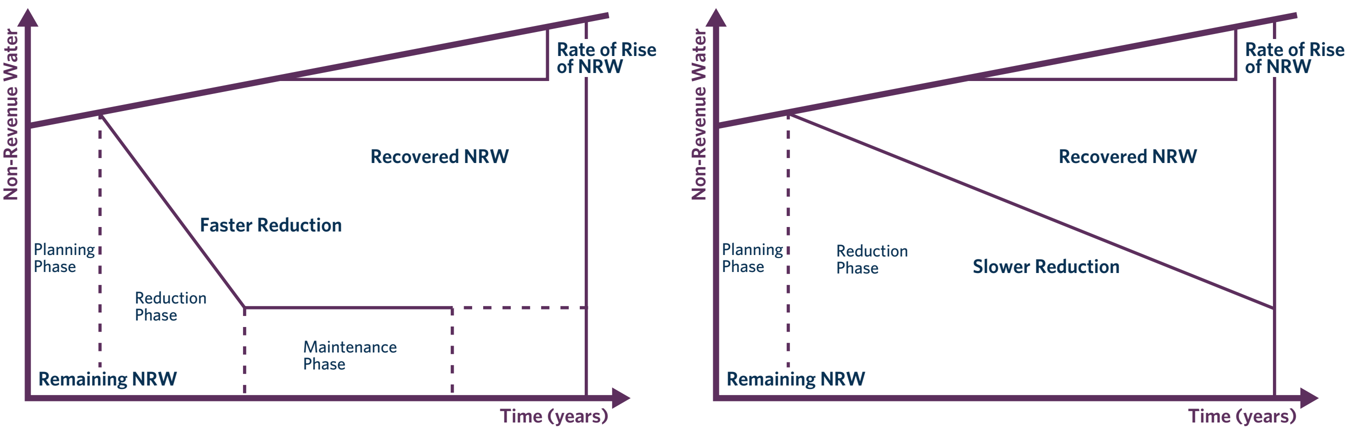


TABLE 2: Benefit/Cost Ratio of PBCs and Utility-Implemented NRW Projects

Variable Cost of Water Produced ($/m ³)	Initial Level of NRW (liters/connection/day)							
	Low = 300		Medium = 600		High = 1000		Very high = 2000	
	Utility	PBC	Utility	PBC	Utility	PBC	Utility	PBC
$0.20	4.3	3.0	2.2	2.0	2.1	2.2	2.2	2.5
$0.40	8.0	6.0	5.3	4.9	5.1	5.3	5.4	6.1
$0.60	11	8.5	8.1	7.7	8.1	8.3	8.5	9.5
$0.80	13	11	11	10	11	11	12	13
$1.20	18	15	16	16	17	17	18	20
$1.50	20	18	20	20	21	22	22	25
$2.00	24	23	26	26	27	29	30	33

increase. At high initial NRW levels, the PBC approach has a superior B/C ratio. Although the difference between B/C values may seem small, it reflects millions of dollars' worth of investments and future costs. For example, for an initial NRW of 1,000 liters/connection/day, the utility project has a B/C ratio of 8.1, and the PBC project has a B/C ratio of 8.3. The calculation details indicate a PV cost of $164 million over 10 years for a conventional project and $148 million over the same 10 years for a PBC contract, compared to a PV cost of $331 million for the "no-project" scenario. It should also be stressed that the B/C ratios can get very high—on the order of 20, which is exceptionally high for any infrastructure-related project—especially at high water costs.

Given the modest amount of input data, these results must be viewed as a qualitative indication of the financial attractiveness of PBC and utility-implemented projects, and not the basis for specific project planning. However, the results do show that careful monitoring of the effectiveness and cost efficiency of all types of NRW projects is very important.

5. Conclusion

Non-revenue water management can deliver significant financial and economic benefits, and to a large extent, NRW programs can be self-financing—rapid revenue gains from commercial loss reduction, for example, can supply the OPEX and CAPEX funds needed to reduce the NRW. But these benefits often remain unrealized, because water service providers face many political, financial and technical hurdles. NRW PBCs provide an opportunity to invite a third party to overcome some of these hurdles, with the incentive to do so as rapidly and cost-effectively as possible. The principal advantages of PBCs over conventional projects that are directly implemented by a utility is that the utility can benefit more rapidly from NRW reduction and faces a lower risk of the project not achieving its targets, because performance risk is assumed by the private contractor. However, there are a number of issues discussed in this paper that need to be taken into consideration in designing the NRW program and PBC contract so that it delivers the best value for the service provider. Utilities and their staff have the opportunity to learn new best practices and gain practical NRW management experience, which they can employ after the contract ends, or plan a successive PBC tender.

Where to Obtain Guidance in Investigating and Planning NRW PBCs

The World Bank Group, the Inter-American Development Bank and the International Water Association, with support from the Public Private Infrastructure Advisory Facility (PPIAF), launched a global Program for Developing Good Performance-Based Contract Practices in the Marketplace to Manage Non-Revenue Water. It seeks to catalyze better practices in NRW PBCs. In the short term, these result in a shorter and more cost-effective preparation of PBC transactions and more market participants; in the medium-to-long term, they improve the value-for-money of PBC activities in NRW management. The program will have the following four components: guidance, standardization and systematic learning aimed at development financing institutions and other practitioners; support to client countries for NRW PBC investigation, planning and preparation; capacity building and engagement of private-service companies; and support to client countries to develop national scale-up programs. For more information about the program, please contact worldbankwater@worldbank.org.

Annex 1

Project	Objective and Targets	Activities Undertaken	Targets Set
Selangor, Malaysia	Increase water availability through leakage reduction and metering accuracy	• Established DMAs • Pressure management • Replaced/installed meters • Installed data loggers	• 198,900 m^3/day
Bangkok, Thailand	Reduce physical losses in distribution networks	• Reduce physical losses in distribution networks	• No targets were set
São Paolo, Brazil	Replace meters	• Replace meters	• Replace 27,000 meters
Ho Chi Minh, Vietnam	Leakage reduction and management in Zone 1	• Leakage reduction and management in Zone 1	• 37,000 m^3/day • Establish 119 DMAs
Tegucigalpa, Honduras	Demonstrate quick, visible improvements in service continuity	• Update of cadaster, water balance and audit • Established DMAs, rehabilitates reservoirs and pumps • Leak detection and reduction • Meter reading and normalization of illegal connections	• Increased continuity from average of 4.5 hours/day to 14 hours/day • Increased metered consumption by 30%
Jamaica	Augment revenues of utility	• Water audit • DMA set up • Pressure management • Commercial surveys and geo-referencing customers • Meter installation	• NRW reduced from 71% to 53% • Billable consumption increased from 41,000 m^3/day to 55,000 m^3/day

Resulting Water Savings at End of Contract	Fees and Rewards	Penalties
198,900 m^3/day	• Fixed fee	Portion of unachieved target x 5% of contract value
165,207 m^3/day	• Performance fee of 50% of tariff of NRW improvement levels for international staff, operation & profit • Fixed fee for local staff • Materials reimbursement	
41,208 m^3/day	• Per meter installed (incremental revenues from water saved)	Built in based on per-meter installation fee
92,000 m^3/day	• Leakage reduction: 30% fixed, 70% performance-based • DMA set up: fee per DMA	VND 800,000 per m^3 for unachieved amount against annually minimum targeted DMA: 10% liquidated damages/ monthly delay
Data not yet available; although meters have been replaced, reports indicate that very little of the leakage detection and control has been done	• Lump sum payments for 85% of contract costs • 15% performance fee based on target continuity of service and increase in metered consumption	Built into the performance payment
27,000 m^3/day	• Contractor equity paid pro-rata, based on the achievement of results during the implementation and sustainability phases	

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