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LESSONS LEARNED IN NRW-REDUCTION

FROM 8 SUSTAINABLE WATER FUND CO-FUNDED INTERVENTIONS WITH 19 WATER OPERATORS

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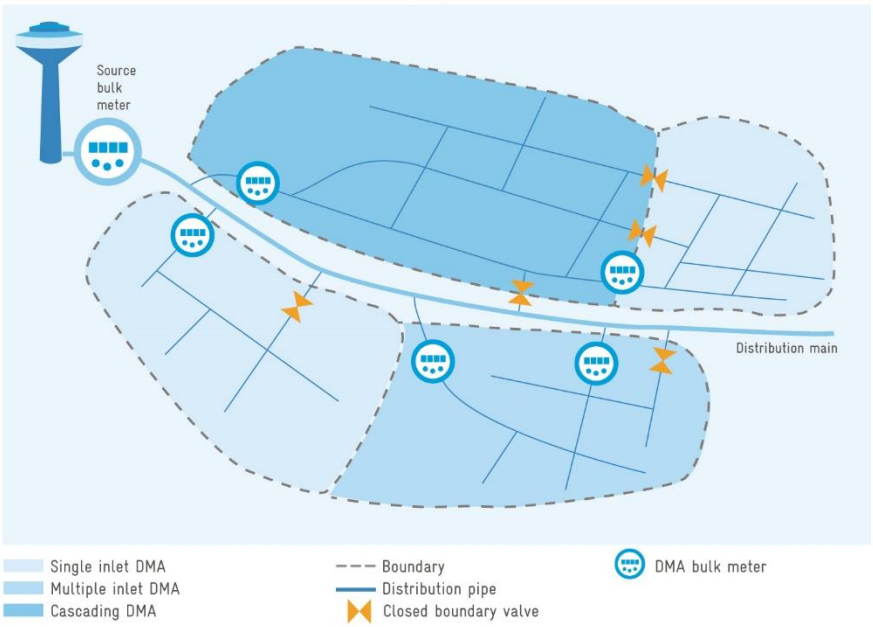
Table of Contents

Abbreviations

DMA District Metered Area - is a sub distribution network, which is isolated from the main network. Typically, a DMA contains 500 to 1,000 connections. Water flows to the DMA via 1 or 2 feeder mains, which are metered. On a monthly basis a water balance is compiled of the total inflowing water and the total water billed of the connections in the DMA. The difference between the total inflow and water billed is NRW.

Figure 6.2 Typical layout of DMAs, based on [22]



LIA Low Income Area

MD Managing Director

OCC Operating Costs Coverage

OPEX Operational Expenditure

O&M Operation and Maintenance

NRW Non-Revenue-Water

PPP Public Private Partnership

RoI Return on Investment

RVO Netherlands Enterprise Agency

SMART Specific, Measurable, Achievable, Relevant and Time-bound

FDW Fonds Duurzaam Water; Sustainable Water Fund

TA Technical Assistance

VEI Vitens-Evides International

WfL Water for Life Foundation (Vitens and Evides consumer fund for pro-poor investment in water and sanitation infrastructure)

WASPA Water Service Provider Association (Kenya)

1. Introduction and background

1.1. Objective of this Practice Note

This Practice Note presents the results of a joint *review* commissioned by RVO and executed by by VEI and Ad Doppenberg of achieved results and underlying approaches of 8 Non-Revenue Water (NRW) reduction interventions by 19 water operators between 2012 and 2019. The review was triggered by a mutual desire to document and disseminate lessons learned with other practitioners: *'we learn from our mistakes but develop from our successes'*[1].

The difference between the total inflow (light blue on the left) and water billed ('billed authorized') in a distribution network is NRW - consisting of physical losses, commercial losses and unbilled authorized consumption (each with their own sub-components).

These interventions were co-funded by the Ministry of Foreign Affairs through the Sustainable Water Fund (SWF), a programme of the Netherlands Enterprise Agency (RVO). The review focused on:

- NRW reduction strategies applied
- Evaluation of the *business cases* i.e. Return on Investment (RoI).
- How NRW-reduction can enhance the *financial performance and credit-worthiness* of the recipient utility in attracting debt financing - for *scaling-up* of demonstrated approaches by the recipient utility following the completion of the project.
- *Contributing factors to success* in the 'enabling environment'.
- The extent in which NRW-reduction (can) effectively contributes to *improving service delivery to the urban poor*.

Presented conclusions and recommendations in this Practice Note can assist water operators, VEI, RVO and external (third) parties in designing and implementing future NRW interventions.

The *review*[2] was based on desk research[3] and carried out by Ad Doppenberg in close collaboration with RVO staff, VEI's NRW expert in Utrecht (Reint-Jan de Blois) and the respective -VEI- project managers.

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1 Quote of one of our leadership coaches - Herman Wittocks.

2 It is NOT an *evaluation* - which would require field visits and interviews with utility managers and operational staff on the ground.

3 An elaborate assessment framework (template) filled in by the respective project managers.

It is important to note that NRW management was one various other (i.e. pro-poor investment, water quality and safety, investment planning, leadership development) components of the project.

1.2. Scope of the 8 Sustainable Water Fund (FDW) co-financed interventions

It is important to note that the NRW-component was one of several interventions (e.g. pro-poor delivery, water treatment or energy efficiency improvement). The (varying) scale of the NRW-component of the evaluated interventions is reflected in Table 1:

- Within 12 water operators (Addis Ababa and Harar - Ethiopia, PEWAK - 10 water operators in Kenya), NRW-reduction strategies are piloted in DMAs.
- At the water operator in Kigali - Rwanda (WASAC), NRW-reduction strategies are implemented in 2 large zones.
- At the 6 other water operators (Beira - Mozambique, Mzuzu - Malawi, Cagayan de Oro - Philippines, and 3 utilities in the Mekong Delta - Vietnam) NRW-reduction strategies on are implemented on a company-wide scale.

Table 1: Scope of NRW component in SWF co-financed interventions

Water Operator	Intervention period	NRW-reduction targets in			Connections in NRW component
		Pilot DMA(s)	Pilot zone(s)	Company Wide	
Addis Ababa (Ethiopia)	2013 - date	50% of baseline (36%, 50%, 52%, 51%) in 4 DMAs			1,600
Harar (Ethiopia)	2013 - date	50% of baseline (45% at company-level) in pilot DMAs			2,000
Kenya (10 operators)[4]	2015 - 2019	<25%			59,741
Kigali (Rwanda) ▪ Remera zone ▪ Kanombe zone	 2013 -2017 2013 - 2017		 42% - 20% 42% - 20%		 15,546 17,193
Beira (Mozambique)	2015 - 2019			47% - 37%	62,729
Mzuzu (Malawi)	2013 - 2019			42% - 21%	26,743
Cagayan de Oro (Philippines)	2018 - 2022			54% - 30%	100,908
Mekong Delta[5] (Vietnam) ▪ Tra Vinh ▪ Soc Trang ▪ Gia Dinh	 2013 - 2017 2013 - 2017 2013 - 2017			 16% - 15% 16% - 15% 53% - 45%	 42,270 74,854 132,713
19 water operators					435,848

[4] 10 water operators scattered across cities and small towns in Kenya: Kikuyu, Nakuru (urban), Nakuru rural, Kakamega, Kericho, Kisumu, Bomet, Murang'a, Mathira, and Malindi

[5] Although NRW-reduction in Soc Trang and Tra Vinh was not a project activity, the FDW-project supported these utilities in some areas of NRW-reduction.

2. Approaches, achievements and lessons learned in NRW reduction

2.1. Summary of achievements

2.1.1. Achieved NRW reduction and evaluated business case

Substantial to moderate reductions in NRW (in *1,000 m3/year or L/connection/day) were achieved at most operators:

1. **Substantial NRW reduction** (6-20% of System Input Volume) was achieved by 13 water operators: 10 utilities in Kenya - 27 DMAs, Kigali - 2 branches, Mzuzu (company-wide focus) and Gia Dinh[6] (District of Ho Chi Minh City - Vietnam), see Table 2 overleaf.
2. **Moderate NRW reduction** (<6% of System Input Volume) was achieved by 3 water operators:
   - Soc Trang and Tra Vinh (the 2 other beneficiary partners - Vietnam) though minimal TA input was directed towards NRW reduction activities.
   - Beira (company-wide focus).
3. The Ethiopian operators in Addis Ababa and Harar did not achieve a sustained reduction in NRW. DMA formation in Harar was hampered by various technical set-backs and institutional (motivational) constraints. In Addis Ababa, priority was given to other activities, like water resources management/quality monitoring.
4. The intervention in Cagayan de Oro had just gotten underway; too early to expect and review substantial progress.

The calculated Return on Investment (RoI)[7], typically between 2 and 4 years, confirms the cost-effectiveness of the capital investment(s) in NRW-reduction.

Table 2: Reduced NRW (volume, %) and Return on (capital) Investment

Utility	Population	No. of connections NRW component	Project duration		Business case (ROI) evaluation						
			Start	Finish	Investment amount hardware	NRW reduction (%)	Investment period (years)	NRW reduction **average** per year (1,000 m3)	Monetary value per year (1,000 €)	ROI in years	Operating Cost Coverage (%)
Addis Ababa	no data	1.600	2013	2019	136.211	no data	5	no data	no data	N/A (no data)	no data
Harar	no data	2.000	2013	2019	183.452	45% - 45%	5	no data	no data	N/A (no data)	no data
PEWAK	varies per utility	59.741	2015	2019	1.049.545	50% - 43%	3	676	379	2,8	improved for all but 4 utilities
SUSWAS											
• Remera	51.611	15.546	2013	2017	575.441	42% - 21%	3	320	134	2,6	121-136%
• Kanombe	54.064	17.193	2013	2017		45% - 31%		208	88		
Beira	385.000	62.729	2015	2019	1.179.365	44% - 38%	3	197	96	12,3	80% - 105% (2015-2017)
Mzuzu (2015 - 2018)	187.000	26.743	2013	2018	557.206	43% - 31%	3	272	178	3,1	175% - 300% (2013-2017)
Cagayan de Oro	566.373	101.138	2018	2022	410.000	54% - 54%	3	tbd	tbd	tbd	121%
Mekong Delta											
• Tra Vinh	274.755	42.270	2013	2017		16% - 10%	3	78	no data		>100%
• Soc Trang	486.551	74.854	2013	2017		16% - 12%		77	no data		>100%
• Trung An	1.220.000					no data		no data	no data		>100%
• Gia Dinh	663.565	132.713	2013	2017	822.234	53% - 29%		9.821	no data		>100%

6 NRW-reduction at Gia Dinh is not representative for the other SWF-projects, as the project: i) merely financed 10 km of distribution network replacement, but ii) relied heavily on investment and TA under a parallel ADB project executed by VEI.

7 By using the *marginal cost of water production* (treatment and electricity) cost/m3 and *average water tariff* to calculate the monetary value physical/real and commercial/apparent losses respectively.

Overall, the RoI's confirm that *low-cost* strategies do have *high impact* on the reduction of NRW, as pay-back periods of less than 10 years in the public water sector are considered favorable. Improved financial returns enable these water utilities to improve their service delivery standards for existing and new consumers, including the urban poor.

The longer RoI for Beira is plausible since: i) a large portion of the hardware budget (50%) was used to replace pipelines in the network[8], ii) new (additional) production capacity increased the supply pressure and time in the distribution network, inducing new NRW.

VEI's approach focused on implementing low-cost-high-impact intervention, the so-called "quick wins" - typically the commercial/apparent loss reduction measures[9] outlined in Table 3 below. Highlights of (the more capital intensive) physical/real loss reduction measures are enclosed in Appendix 1.

Table 3: Prioritized commercial/apparent loss reduction measures

Strategy	Update & validation customer database			Improvement customer billing		
Activity	Update customer database	Address illegal practices	Door-to door survey	Improved meter management	Meter replacement	Improved meter reading & billing process
Addis Ababa	yes	yes	no	no	yes	No
Harar	yes	yes	no	yes	yes	yes
Kenya (10 operators)	yes	yes	yes	yes	yes	yes
Kigali	yes	yes	yes	no	no	yes
Beira	yes	yes	yes	yes	yes	yes
Mzuzu	yes	yes	yes	yes	yes	yes
Cagayan de Oro	yes	yes	no	yes	yes	no
Mekong Delta	No	yes	no	yes	yes	yes

2.1.2. Implications for financial performance (O&M cost coverage) and credit-worthiness

Operating Cost Coverage (OCC) levels, the ratio between the collected revenue and operational expenditure (OPEX), increased for most of the beneficiary utilities (see last column in Table 2) - in part due to cost savings (reduced physical losses), improved sales (in part due to reduced commercial losses) and revenue collection. As such NRW-reduction *contributes to* improved financial performance and credit-worthiness.

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8 These physical loss reduction measures are capital-intensive; relatively expenses (per connection) in comparison with commercial loss reduction measures outlined in Table 3.

9 *Update of customer database* involves the identification of ghost (on the ground non-existent) consumers, double entries (disconnected consumers who have registered under the same name or name of their spouse), *addressing illegal practices* involves the identification of reversed meters, tampered meters, meter by-passes, illegal connections from the mains (including issuance and collection of fines), *Door-to-Door surveys* can serve to identify illegal practices, evaluate meter installation and (correct) reading, identify leaks on the service connections/at the meter, etc., *improved meter management* focusses on reviewing the meter design (sizing), (proper) installation, (accurate) reading, servicing and replacement (above a certain age or m3 through-put).

It is important to note, however, that this is not only the result of reduced NRW losses. After all, project-independent tariff adjustments, other cost savings (e.g. staff, energy), revenue collection efforts and numerous other internal and external factors also contributed to these OCC increments. Revenue increments, too, are often used to settle bills of creditors or re-invested in postponed[10] Capital (CAPEX) and Operating (OPEX) Expenditure.

2.1.3. Contributing factors to success

Paragraphs 2.2.1 and 2.2.2 highlight some of the proposed adjustments to the VEI promoted (IWA-compliant) approach to NRW-reduction (by our local water operator partners) based on this *Review*.

The effectiveness of these strategies, however, depends on (problem) ownership and willingness of the recipient utility to effect changes/improvements within a relatively short time period (i.e. the learning capacity of an organization); a typical project with a 5 year duration is insufficient to achieve systemic change i.e. 'utility turnaround'.

Key success factors and constraints are presented in Table 4 below. Noticeable *success factors* include the promotion of NRW problem ownership by introducing steering committees (management ownership), operational NRW Units to boost the day-to-day implementation capacity, a proper baseline (during start-up phase at latest), and the use of DMAs for demonstration and trial purposes (NOT as ending point). Governance, managerial and motivational issues are frequently mentioned *constraints*.

Table 4: Success factors and constraints from internal evaluations

	Success factors			Constraints	
	Ownership	Preparation	Implementation	Ownership	Implementation
Addis Ababa			▪ Multi Stakeholder Platform	▪ Absence of top-down assessment to promote political willingness ▪ Pilot level, hardware/TA budget too small ▪ Excessively low tariffs (insufficient financial incentive)	
Harar	no data	no data	no data	no data	no data
Kenya (10 water operators)	▪ NRW units ▪ DMA responsibility introduced ▪ Utility co-financing (55% of total budget)	▪ Integration with peer-to-peer benchmarking programme of WASPA	▪ Champions of change: strong Managing Directors MDs, better results (Kikuyu, Kakamega) ▪ Full time local NRW expert in the field	▪ Governance issues County/ management level ▪ Delayed investments (pre-financing by utilities) and uptake advice (limited on-site presence 10 utilities)	
Kigali	▪ Weekly (NRW progress) meetings in both branches (decentralized ownership)	▪ Early creation of 5 DMAs (demonstrating quick wins)	▪ Isolation of zones ▪ Intensive training and coaching ▪ NRW unit expanded from 3 to 16 persons	▪ Unstable governance (split-up of EWSA into WASAC and energy company)	▪ Result chain logic in proposal not based on proper baseline Interdisciplinary ownership of NRW fair at best

[10] Due to cash flow constraints with most utilities cash-strapped (especially when NRW levels were -even- higher prior to intervention).

	Success factors			Constraints	
	Ownership	Preparation	Implementation	Ownership	Implementation
Beira	▪ Steering committee	▪ Well-developed baseline survey ▪ SMART sub-targets for NRW activities	▪ Door-to-Door survey ▪ Hiring of local work force (to speed up implementation) ▪ Change management training	▪ Changing management/staff	▪ Procurement is time consuming ▪ Organization local workforce is time consuming
Mzuzu	▪ NRW Steering Committee, NRW Manager, 2 NRW Officers, 6 Caretakers and a NRW Task Force		▪ Dedicated management ▪ Door-to-Door survey ▪ DMA approach	▪ Caretaker (zonal/DMA-level ownership + organization is too weak, not incentivized/ enforced	▪ Budget too small ▪ Knowledge & mindset caretakers insufficient
Cagayan de Oro	▪ Established NRW Task Force, pledge for reducing NRW co-signed by management and TF, resources allocated to TF and 'Project NRW Team'	▪ Top-down assessment/ NRW Strategy/ Plan prepared ▪ Up-scaling (12 additional DMAs) initiated	▪ Quick wins in DMA ▪ Monitoring with KPIs, and DMA-specific targets for 6 out of 8 DMAs)	Failing staff not held accountable for poor performance Staff prefer to avoid conflict: process for punishing illegal customers inadequate/ not enforced	▪ The (small-scale) rehabilitation efforts achieved no significant improvement due to the dilapidated state of the network ▪ Implementation of quick wins (e.g. PSRV) very slow due to COWD operation and bureaucracy
Mekong Delta	▪ Pressure from local government of HCMC		▪ Leverage with WB and ADB programmes (to finance DMA establishment and TA for NRW reduction)		▪ Roll-out DMA in existing network of Soc Trang complicated

2.1.4. Implications for service delivery to the urban poor

FDW focuses on inclusive service delivery which considers the impact of the interventions on the urban poor. Through grant (co-) financing under the 8 interventions, an estimated **340,000 un(der)served Low Income Area (LIA) residents acquired access** to safe drinking water services. With an average investment of € 20 per capita towards 'last mile connectivity' (network extensions and service connections to shared water kiosks/standpipes or private connections on premises), the impact is evident.

In some cases (e.g. Beira), NRW reduction interventions specifically targeted LIAs with high suspected NRW levels as well (among other company-wide priorities). This directly contributed to **improved water availability (through reduced physical losses), and/or financial performance/debt financing capacity** (through reduced commercial losses) of the beneficiary utility. In most cases, however, NRW reduction measures focused on low-cost-high-impact interventions within specific DMAs or company-wide and thus did not explicitly target LIAs.. Reduced NRW levels within these utilities contributed to favorable financial conditions for utilities to sustainably finance O&M expenses of the newly developed infrastructure.

The 'cross-subsidization' of the urban poor by large consumers[11] that is in-built in the tariff structure of most utilities in developing economies has the same effect; regardless of the project scope and direct/indirect/missing link between NRW-reduction and pro-poor (service delivery improvement) activities in a specific project, **NRW-reduction results in cost savings, increased sales and revenue collection** on the basis of which service delivery to existing and un(der)served consumers, both rich and the poor, is improved in the medium and long term.

The **influence of the regulatory framework on inclusiveness** (e.g. 'human right to water incorporated in sector policies/strategies/guidelines[12], benchmarking of pro-poor service delivery indicators) and the availability of grant (co-)financing as an incentive are both far greater than an inclusive intervention logic of a 'one-off project'.

2.2. Lessons learned

2.2.1. Intervention design: company-wide focus (beyond 'pilot' DMAs)

Traditionally VEI *solely* focused on DMAs as a building block for scaling-up; based on achieved results in one or two 'pilot' DMAs, the 'demonstrated' approach is replicated DMA by DMA was the line of thought. While this remains one of the key objectives of DMAs, the Review underlines the need[13] to:

- Use the DMAs as: i) a diagnostic tool in quantifying physical losses (through a so-called 'bottom-up assessment'), and ii) validate the results of the company-wide NRW assessment (i.e. top-down assessment, quantifying commercial losses based on historic billing and meter age/performance/reading data) - in iii) establishing an evidence-based NRW Reduction Strategy/Plan (see Appendix 2).
- Complement the above captioned *quantitative* top-down assessment (IWA water balance) with a *qualitative* NRW organizational assessment (see § 2.2.4).
- Identify low hanging fruit at company-level (e.g. meter replacement, improved meter reading starting with large consumers in ALL DMAs); which if prioritized by senior management will pave the way for a DMA-by-DMA up-scaling process; starting in zones/DMAs with >> water pressure and supply hours (i.e. those with the largest NRW *volume*) and supported by telemetry (online flow and pressure monitoring).

Key conclusions and recommendations

- A company-wide focus has greater potential impact on the performance of the utility (and thus, also, in raising awareness and motivating senior management to own and implement a comprehensive NRW reduction Strategy/Plan) during and after the implementation period of the project;
- Small scale piloting of NRW-reduction activities with the intention to scale-up after project completion should be discouraged. With limitations in TA and financing scale-up is unlikely. Secondly, there is a risk that the recipient utility loses interest if piloting is done for a prolonged period at a micro level (<5% of the total no. of service connections).

[11] Who pay more per m3 consumed – typically on the basis of a rising block tariff.

[12] See e.g. the Pro-Poor Water and Sanitation Services Guidelines of the Water Services Regulatory Board (WASREB) in Kenya.

[13] This has been mainstream in our way for working through a 'NRW master class' for project managers/short-term experts and utility staff that we developed 2 years ago (and continue to update based on emerging insights).

2.2.2. Intervention approach: differentiation between commercial and technical losses as a key to success

The general practice in the international drinking water industry is that NRW-reduction approaches and methodologies are tailor made, based on various important internal and external *situational factors*[14] of the utility.

The 8 implemented interventions were conceptualized and developed in response to three open Calls (for Proposals) by RVO. VEI therefore designed and customized the interventions in close consultation with existing and/or new utility partners and (non-)state actors on the ground; including NRW-reduction -among other - components/result areas.

Prepared under time pressure, NRW-reduction approaches and methodologies were based on available (at times scanty) information during the proposal phase; refined with supplementary data and qualitative information from interviews during the inception phase. A comprehensive baseline, as outlined in the text box below, would benefit the prioritization of interventions and benefit service delivery.

In most interventions, NRW-targets were set up without differentiating between commercial and technical losses. This presents a risk of agreeing on overly ambitious and unachievable NRW targets during the proposal phase.

Key conclusions and recommendations

- During the inception phase, conduct a comprehensive baseline: i) a *qualitative (NRW organization) and quantitative top-down assessment* of commercial NRW losses[15] (can be done by 1 or 2 short-term experts with NRW Team Leader/Billing Officer/Data Analyst in a 3 week mission), ii) a *bottom-up assessment of physical losses* (can be done by a short-term expert + NRW Team within 4 months) to validate/firm up the results of the bottom-up assessment (see § 2.2.1),
- Prepare a NRW Reduction Strategy/Plan using the above captioned ingredients - refining/firming up the required budget (which differs significantly for commercial and physical losses) and NRW reduction targets in the process.

2.2.3. Post-intervention up-scaling: nurturing ambition and generating resources to do so

The lower the NRW levels, the more difficult and costly further NRW-reduction becomes. While the RoI i.e. business case speaks for itself (Table 2), capital intensive network extensions are politically more attractive - as they are visible to constituents/consumers. Up-scaling of demonstrated achievement company-wide (at DMA or higher level) is challenging as it requires perseverance of a motivated Management Team and Board.

Beyond the signing of *Sustainability Compacts (commitment on paper)*, 'projects' should lobby for- and focus on:

- *demonstrating the business case* (§ 2.1.1) in a *top-down/bottom-up approach* (§ 2.2.1)
- monitoring progress in *improving/sustaining financial resourcing of commercial and technical operations*: i) financing of material (spares), equipment, transport (OPEX) and

[14] Driving forces behind prevailing high NRW levels.

[15] And in doing so (using EasyCalc) a first estimate of the commercial/physical losses ratio – starting point in prioritizing appropriate commercial and/or physical loss reduction interventions.

'small but smart' investments (CAPEX), ii) staff capacity i.e. hiring of qualified managers/staff, intensive training and coaching.

- *ring-fencing revenue increments* (from NRW-reduction activities) to: i) evaluate the business case, ii) re-invest in (continuously) re-prioritized interventions.
- *sharpening CAPEX priorities and leveraging resources* with investment programmes of International Financing Institutions i.e. as demonstrated in Gia Dinh (ADB), Mzuzu (EIB).

2.2.4. Good utility governance essential in 'making the difference'

High NRW-levels are an indicator of poor utility management. Board guidance in leadership transformation (avoiding micro-management, managing political interference), NRW Strategy/Action Plan implementation (i.e. resource allocation), sustainable tariff setting (covering justifiable O&M costs) etc. is key.

High NRW-levels are typically the result of underperforming Commercial and Technical Operations and inadequate facilitation by- or immaturity of the underlying management processes themselves (see Figure 1 below).

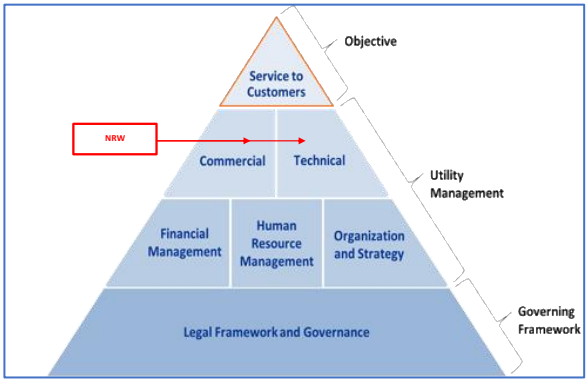

Figure 1: NRW-management inter-related with management processes

Key conclusions and recommendations

- Conduct a comprehensive Organisational Assessment during the inception phase to establish utility *readiness*: evaluate current working processes, resourcing (financial position), human capital (leadership, change management[16] competences besides technical skills), level of applied technology, and investment in utility ownership of the NRW-reduction process.
- Institutionalizing tasks for NRW-reduction in the organization; building on successes (in an appreciate inquiry style), address emerging bottlenecks pertaining to the 5 utility management elements in "The pyramid of Success" (Figure 1).

2.2.5. Resourcing to 'make (and sustain) the difference'

The allocated hardware budget for NRW reduction per service connection varies per intervention, ranging from €4 to €92. While the allocated budget of the Asian projects (Cagayan de Oro and Mekong Delta, €4 and €6 per connection) is small, these projects provide TA parallel to investment in infrastructure - financed ADB and USAID respectively. The 2 FDW-projects in Addis and Harar have the highest allocated budget per connection (€85 and €92 respectively), despite the small scale of the intervention (DMAs covering less than 2.000 connections - a small percentage of the total no. of service connections.

[16] Assuming that the governing framework is functional, which enables and supports changes/improvements.

Key conclusions and recommendations

- Allocate sufficient (at least € 40) budget per -DMA- connection and/or leverage resources with third parties (as was done in Mekong and Cagayan de Oro). With modest hardware budgets tangible reduction in NRW can be achieved by applying low-cost-high-impact interventions (focusing on commercial losses).
- Spreading out a relatively small hardware budget per connection (< € 20 per) on a company-wide scale may limit the potential impact of the intervention in reducing NRW.
- The level of OPEX allocated by the recipient utility dictates which strategy can be sustained by the utility; commitment up-front, during and after (e.g. Sustainability Compact, Board approval of budget increment/tariff adjustment) the project is crucial.

Appendix 1: Prioritized physical/real loss reduction measures

Strategy	Pressure management	Active leak control		Repair	Replacement
Activity	Installation of PRVs	Leak detection in DMAs	Improved leak repair and workmanship	Distribution network/ connections	Distribution network/ connections
Addis Ababa	no	no	yes	No	yes
Harar	no	no	yes	No	no
Kenya (10 water operators)	yes	yes	yes	Yes	yes
Kigali	yes	yes	yes	Yes	yes
Beira	no	no	yes	Yes	yes
Mzuzu	no	yes	yes	yes	no
Cagayan de Oro	no	yes	yes	No	no
Mekong Delta	yes	yes	yes	Yes	yes[17]

[17] Since 2007 with co-financing from WB and ADB in Gia Dinh. SWF project financed 10 km of pipe-replacement in Gia Dihn.

Appendix 2: Top-down and bottom-up approach to NRW-reduction