AFRICA NON-REVENUE WATER PROGRAM SYNTHESIS REPORT

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AFRICAN WATER ASSOCIATION (AfWA) AND

USAID FURTHER ADVANCING THE BLUE REVOLUTION INITIATIVE (FABRI)

DISCLAIMER

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ACRONYMS AND ABBREVIATIONS

ABRI	Advancing the Blue Revolution Initiative
AfWA	African Water Association
FABRI	Further Advancing the Blue Revolution Initiative
PIP	Performance Improvement Plan
GWCL	Ghana Water Company Limited
KPI	Key Performance Indicator
MD	Managing Director
M&E	Monitoring and Evaluation
NCWSC	Nairobi City Water and Sewerage Company
NRW	Non-Revenue Water
NWSC	National Water and Sewerage Company, Uganda
ONEA	L'Office National de l'eau et de l'assainissement / National Office for Water and Sanitation (Burkina Faso)
SDE	Sénégalaise des Eaux
SEG	Société des Eaux de Guinée / Water Company of Guinea
SEEG	Societe d'energie et d'eau du Gabon / Energy and Water Company of Gabon
SONEB	Société de Distribution d'Eau de la Cote d'Ivoire
STC	Scientific and Technical Council (of AfWA)
SUWASA	Sustainable Water and Sanitation in Africa
SWSC	Swaziland Water Services Corporation
SWOT	Strengths, weaknesses, opportunities and threats
TDE	Togolaise des Eaux
TF	Task Force
TOR	Terms of Reference
USAID	United States Agency for International Development

EXECUTIVE SUMMARY

Non-revenue water (NRW) is a major problem for water utilities worldwide and especially in low and middle income countries (LAMIC). According to a World Bank study, nearly 45 million m^3 of water is lost daily as leakage (enough to serve nearly 200 million people) in the developing countries and close to 30 million m^3 of water is delivered everyday to customers but not paid for due to metering inaccuracies, theft and corrupt utility employees, costing water utilities about USD 6 billion every year (World Bank, 2006).

Acknowledging that reducing NRW is a major problem for Africa, AfWA and USAID's FABRI launched a new four-year program to reduce NRW in 20 African water utilities (NWSC audited two different locations Entebbe and Jinja) in 16 countries in east, central, southern, and West Africa. The NRW program had three phases: diagnostic (audits), implementation and monitoring and evaluation. One unique aspect of the NRW program is the involvement of AfWA senior management and members of the AfWA NRW Task Force in the day-to-day management and guidance of the program. Task Force members completed audits of the 20 water utilities and supported the development of the performance improvement plans (PIP) drafted based on the results of the audit.

This Synthesis Report has been prepared to disseminate the results of the audit process – the challenges facing the utilities on NRW management and the lessons learned. These lessons have been invaluable to the utilities for translating the challenges and gaps in their institutional and operational policies into issues for improvement – the PIPs - individual to each utility.

Section 1 describes the scope of the FABRI programme, how the utilities were selected, and lists the participating utilities.

Section 2 describes the methodology for conducting the audit at each utility and for eventually developing the utility's PIP. The main objective of the program is to develop capacity among water utility staff, from senior level down, and to help the utility reduce NRW via three steps:

- Conduct a water audit to quantify and understand how much water is lost, where and why it is lost, and to recommend realistic actions to reduce NRW in then audit report
- Support the utility in developing a PIP, if necessary
- Monitor and evaluate progress on the implementation of the PIP

Section 3 examines the audit findings - the relative significance of NRW across the audited utilities and the impact it has on the utility and its customers. It is clear that not all countries or regions of Africa have the infrastructure and established operational procedures to begin tackling NRW. Many are struggling to ensure that customers receive a reasonable supply of water to sustain health and life. Water utility managers in most African countries invariably face challenges such as:

- Rapid urbanization
- Diminishing water supply
- Environmental pollution
- Outdated infrastructure

- A high level of poor operations and maintenance policies including ineffective record-keeping systems
- Inadequate technical skills and technology
- Greater financial constraints, including an unsuitable tariff structure and/or revenue collection policy
- Political, cultural, and social influences
- A higher incidence of commercial losses, particularly illegal connections

These factors all influence the scope for managing losses and demand, and affect the pace of change. At the same time, continuous NRW limits the financial resources available to tackle the challenges facing water utilities in Africa.

The average volume of NRW (expressed as a percentage of system input volume) in the 19 utilities audited was 39% of system input volume. The figure varies greatly between utilities - ranging from 17% in Entebbe in Uganda to 83% in Benue in Nigeria. One of the factors causing such variations is that in some countries the data that was collected represented small towns (Uganda), in other countries the main city networks (Kenya), or for the whole country (Swaziland).

Section 3 also describes the 'preventers and promoters' of good NRW practice, and highlights examples of the lessons learned - and changes implemented by utilities. The audit process identified some key challenges - institutional, technical and commercial – but also identified some good solutions for addressing the challenges. Utilities are at various levels of awareness, understanding and commitment to improvement, but there have been positive responses and enthusiasm from the utilities' management teams, a sign of a strong will and commitment to the program.

Section 4 reviews the actions made by the utilities – contained in short, medium and long term action plans - to develop a NRW reduction strategy. Some actions - the 'quick wins' – were identified during the audit process and the later development of individual PIPS by the water utilities. Quick wins are actions and tasks that the water utility can put in place in the very short term, or immediately, at low cost or at no cost to the company. Examples of these are company policy changes – or the correct implementation of a policy, or adjusting the staffing structure to implement a new NRW department, or strengthen an existing department structure with extra staff. Some tasks can be put in place using in-house staff, with minimal re-training and capacity building.

Section 5 (and Annex E) illustrates the funding support mechanisms available to each utility for supporting NRW programmes in the categories of asset management, technical and commercial operations and institutional strengthening. The categories of funding are:

- Utility internally generated funding
- Government funding
- Private Sector Participation
- Development Partners

1. INTRODUCTION

Non-revenue water (NRW) is a major problem for water utilities worldwide and especially in low and middle income countries (LAMIC). According to a World Bank study, nearly 45 million m^3 of water is lost daily as leakage (enough to serve nearly 200 million people) in the developing countries and close to 30 million m^3 of water is delivered everyday to customers but not paid for due to metering inaccuracies, theft and corrupt utility employees, costing water utilities about USD 6 billion every year (World Bank, 2006).
In Africa, NRW figures ranging from 5% (Saldanha Bay, South Africa) to 70% (LWSC, Liberia) have been reported (WSP 2009). The NRW problem is likely to be compounded by the diminishing water resources, increasing costs of producing water, high rate of infrastructure deterioration, inadequate investment budgets, and increasing global change pressures (urbanization, climate change, population growth). Water utilities are under increasing scrutiny to use water resources more efficiently by reducing water losses in their distribution systems and ensure sustainable service delivery.

1.1 Background

Globally, two major problems facing countries are how to close the gap between available water resources and demand for water and how to fund system maintenance and service expansion. USAID'S FABRI and AfWA'S joint program to reduce NRW, directly tackles these two key challenges.

Too frequently, countries try to close their water resources gap by promoting new water production. In countries with access to large financial resources, seeking new water resources might be one reasonable alternative, but most countries do not have the necessary funds. Instead, they are far better positioned to improve the management of their existing resources. Their highest priority should be to ensure that they are making effective and productive use of as much water entering the system as possible by reducing water losses. Low cost interventions can yield disproportionate gains.

One of the major challenges facing water utilities in the developing world is the high level of water losses, frequently from leakage, theft, and problems with billing. The difference in volume between the water entering the distribution system and the water billed to consumers is currently called NRW. High rates of non-revenue water significantly reduced water for allocation and impact the financial viability of water utilities through lost revenue and increased operational costs. NRW reduces a utility's capacity to fund service expansion, especially to the poor.

Reducing water losses not only conserves a scarce natural resource but also improves utility financial viability (increased revenue and reduced repair and energy costs), deferment of capital expenditure for new sources and system expansion to keep pace with increasing demand, saves energy, reduces carbon emissions, thus mitigating climate change impacts and fostering sustainability.

1.2 Joint AfWA – USAID/FABRI NRW Program

AfWA and USAID's FABRI launched a new four-year program to reduce NRW in 20 water utilities (NWSC audited two different locations Entebbe and Jinja) in 16 countries in east, central, southern, and West Africa. The NRW program has three phases – diagnostic (audits) implementation and monitoring and

evaluation. One unique aspect of the NRW program is the involvement of AfWA senior management and members of the AfWA NRW Task Force in the day-to-day management and guidance of the program. Task Force members completed audits of the 20 water utilities and supported the development of the performance improvement plans (PIP) drafted based on the results of the audit.

The NRW program was initiated with two launch workshops in 2012, one in East Africa in June, hosted by Nairobi City Water and Sewerage Company (NCWSC) and the other in West Africa in October, hosted by the National Office for Water and Sanitation (ONEA) in Ouagadougou, Burkina Faso. Forty-three utility managers and senior technical staff from 15 water utilities in 13 east, central, and southern African countries participated in the Nairobi launch. Fourteen of the 43 participants were also NRW task force members and met for two days prior to the workshop to develop terms of reference for their work over the next three years. In the October launch, 54 managers and senior technical staff (including 12 NRW Task Force members) participated. Participants represented 18 water utilities in 14 African countries. Representatives from USAID, Sustainable Water and Sanitation in Africa (SUWASA), Japan International Cooperation Agency (JICA), Global Water Operators' Partnerships Alliance (GWOPA), African Minister's Council on Water (AMCOW), The National Offices for Water and Electricity, AfWA and FABRI also participated in the Ouagadougou launch workshop, for a total of 65 participants.

NRW Task Force members met for two days prior to the Ouagadougou Launch Workshop to agree on their roles and responsibilities as audit team members and participated in an after action review on the day after the workshop ended.

The aims of the AfWA-USAID/FABRI NRW program are to:

- Implement the program in close partnership with the AfWA NRW Task Force
- Design and carry out the NRW program based on utility priorities
- Scale up efforts to include as many utilities as possible
- Reflect both physical and commercial losses
- Attract donor funds to expand the program and address physical losses directly

This Synthesis Report has been prepared in line with the framework of the African Water Association (AfWA) and United States Agency for International Development (USAID)'s Further Advancing the Blue Revolution Initiative (FABRI) partnership.

1.3 Objectives and Scope of the NRW Program

The objective of the AfWA – USAID/FABRI NRW program is to improve the capacity of utilities by introducing management and technical tools and systems to enable them to reduce NRW losses. The main objective of the NRW program is to develop capacity and help a water utility reduce NRW losses through the following steps.

- Conduct a water audit in the utility in order to quantify and understand how much water is lost, where and why and recommend realistic actions to reduce NRW losses as part of the audit report
- Support the utility in developing a PIP, if necessary
- Monitor and evaluate progress on implementation of the PIP

1.4 Partner Utilities

The process for selecting utilities to participate in the program was demand driven - utilities had to demonstrate their willingness and commitment to the program. The participating utilities were selected in two stages:

- Self-Assessment Survey and Analysis
- Identification of the water utilities for the first phase

1.4.1 Self Assessment Survey and Analysis

AfWA undertook a survey of member utilities on the status of their NRW activities, using the self-assessment matrix from the USAID/FABRI publication 'The Manager's NRW Handbook for Africa – A Guide to Understanding Water Losses' as the basis, and asking for letters of intent to indicate their interest in taking part in the project (see Annex A for an example matrix). Some 44 utilities were contacted, out of which 34 responded. The regional breakdown of the received responses is shown in Table 1.1:

Table 1.1 Received responses from water utilities

REGION	NO OF RESPONSES	COUNTRIES
Central Africa	3	Cameroon, Congo, Chad
Eastern Africa	17	Kenya, Zambia, Tanzania, Malawi, Uganda
Western Africa	11	BF, Mali, Togo, Cote d'Ivoire, Benin, Guinea, Ghana, Nigeria
Southern Africa	3	South Africa, Namibia, Swaziland

1.4.2 Categorization of the water utilities

The Self –Assessment Matrix had 16 questions in all, and the responses to each question were graded on a scale of 1-5 (poor to excellent). The overall score for a given utility was obtained by averaging the individual scores. With the overall scores obtained, three categories of the utilities were identified as follows:

- NRW awareness is very low, utilities have little or no idea of how to estimate losses (no measurement system in place)
- Aware of NRW but have no clear strategy for how to deal with loss
- Aware of NRW issues, measuring is in place (on paper) – however, NRW is not a priority and there is a lack of resources to move to the next step of working on losses
- Opportunity/likelihood for significant impact
- Proven record in reducing NRW
- Ability to replicate within and outside their country
- Able to contribute staff, budget, and in-kind support
- Encouragement of participation in AfWA activities

Figure 1.1 Selection of Participating Utilities

1.4.3 Identification of the First 22 Water Utilities

A meeting to undertake the selection of utilities to participate in the program was held from 26-28 March 2012. Participants included officials of AfWA, USAID, and the FABRI Secretariat (Figure 1.1).

In order to select which utilities should be included in the first phase, the following criteria were developed and used:

Criteria

- Visionary/committed leadership to change
- Explicit commitment and interest in the program
- Record of successful operations

The score for a given criterion was a simple YES or NO. Utilities which were included in the first phase had to satisfy at least 4 out of the above 8 criteria. In addition, the following considerations were also borne in mind:

- Regional balance (4 regions: West, East, Central, Southern Africa); 3-6 utilities per region
- Geographic spread : 1 city or 2 utilities/country
- NRW Reduction Awareness: Utilities with different levels of experience (see the 3 levels in 1.4.1)
- Entity balance: national, regional, city
- Language balance – French, English, Portuguese
- Ability of utilities to scale up/replicate in secondary towns.

The collaborating utilities and responses are listed in Table 1.2, and the final list participating utilities is shown in Table 1.3. The map in Figure 1.2 illustrates the regional distribution of participating water utilities.

Table 1.2 Collaborating water utilities

		Name	Country	Visionary Leadership Committed to Change	Explicit Commitment and Interest in the Program	Record of Successful Operations	Opportunity /Likelihood for Significant NRW Impact	Proven Record in Reducing NRW	Ability to Replicate within and/or outside Country	Able to Contribute Staff, Budget, In-Kind	Selection Encourages Utility to Participate in AfWA Activities
COLLABORATING PARTNERS											
1	WA	Water Company of Guinea (SEG)	Guinea	X	X		X			X	
2	WA	Benue State Water Board	Nigeria								
3	WA	Ogun State Water Corporation	Nigeria								
4	WA	Ghana Urban Water Company LTD	Ghana	X	X	X	X		X	X	
5	WA	Societe Nationale des Eaux du Benin (SONEB)	Benin	X	X		X		X	X	
6	WA	Societe Togolaise des Eaux (TdE)	Togo		X		X		X	X	
7	EA	Dar es Salaam Water and Sewerage Company (DAWASCO)	Tanzania	X	X	X	X			X	
8	EA	Nairobi City Water and Sewerage Company LTD	Kenya (Nairobi)		X		X		X	X	
9	EA	Kisumu Water and Sewerage Company (Kiwasco)	Kenya (Kisumu)	X	X	X		X	X	X	
10	CA	Camerounaise Des Eaux (CDE)	Cameroon	X	X		X		X	X	
11	CA	REGIDESO	Congo DRC		X		X		X	X	
12	CA	Societe Tchadienne des Eaux (STE)	Chad		X		X		X	X	X
13	SA	Kafubu Water and Sewerage Company	Zambia (Kafubu)	X	X	X		X	X	X	X
14	SA	Lukanga Water and Sewerage Company LTD	Zambia (Lukanga)		X		X		X	X	X

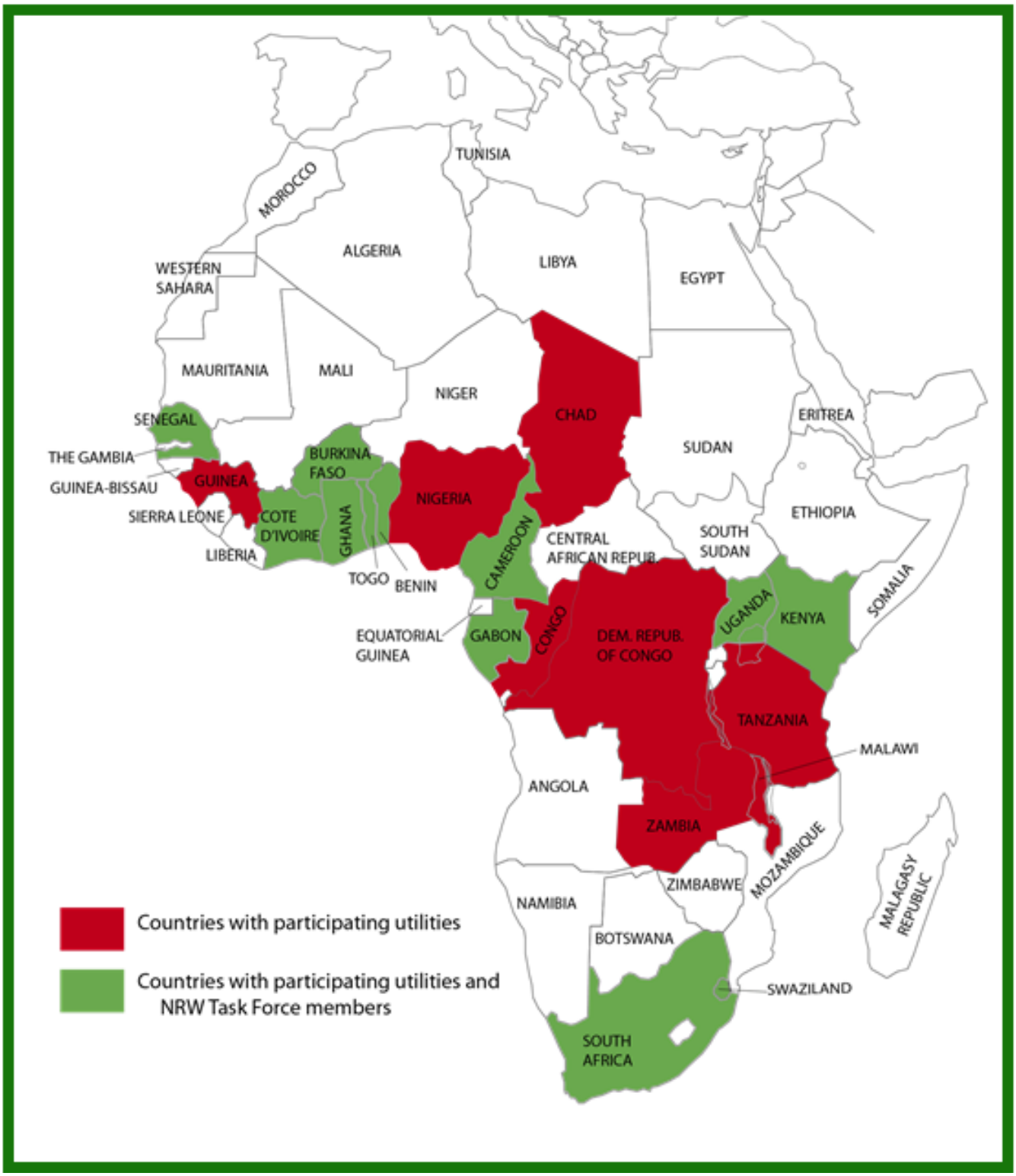
		Name	Country	Visionary Leadership Committed to Change	Explicit Commitment and Interest in the Program	Record of Successful Operations	Opportunity /Likelihood for Significant NRW Impact	Proven Record in Reducing NRW	Ability to Replicate within and/or outside Country	Able to Contribute Staff, Budget, In-Kind	Selection Encourages Utility to Participate in AfWA Activities
15	SA	Namwater	Namibia		X		X		X	X	X
16	SA	Northern Region Water Board	Malawi		X		X		X	X	X
REGIONAL LEADERS											
1	WA	Cote d'Ivoire Water Distribution Company (Sodeci)	Cote d'Ivoire	X	X	X		X	X	X	
2	WA	Office national de l'eau et de l'assainissement (ONEA)	Burkina Faso	X	X	X		X	X	X	
3	WA	Senegal Des Eaux (SDE)	Senegal								
4	EA	National Water & Sewerage Corporation (NWSC)	Uganda (Jinga)	X	X	X		X	X	X	
5	SA	Swaziwater	Swaziland	X	X	X			X	X	
6	SA	Johannesburg Water	South Africa								

Table 1.3 List of participating utilities

COLLABORATING PARTNERS			
1	WA	Water Company of Guinea (SEG)	Guinea
2	WA	Benue State Water Board	Nigeria
3	WA	Ogun State Water Corporation	Nigeria
4	WA	Ghana Urban Water Company LTD	Ghana
5	WA	Societe Nationale des Eaux du Benin (SONEB)	Benin
6	WA	Societe Togolaise des Eaux (TdE)	Togo
7	EA	Dar es Salaam Water and Sewerage Company (DAWASCO)	Tanzania
8	EA	Nairobi City Water and Sewerage Company LTD	Kenya (Nairobi)
9	EA	Kisumu Water and Sewerage Company (Kiwasco)	Kenya (Kisumu)
10	CA	Camerounaise Des Eaux (CDE)	Cameroon
11	CA	REGIDESO	Congo DRC
12	CA	Societe Tchadienne des Eaux (STE)	Chad
13	SA	Kafubu Water and Sewerage Company	Zambia (Kafubu)
14	SA	Lukanga Water and Sewerage Company LTD	Zambia (Lukanga)
15	SA	Namwater	Namibia
16	SA	Northern Region Water Board	Malawi
REGIONAL LEADERS			
1	WA	Cote d'Ivoire Water Distribution Company (Sodeci)	Cote d'Ivoire
2	WA	Office national de l'eau et de l'assainissement (ONEA)	Burkina Faso
3	WA	Senegal Des Eaux (SDE)	Senegal
4	EA	National Water & Sewerage Corporation (NWSC)	Uganda (Jinga)
5	SA	Swaziwater	Swaziland
6	SA	Johannesburg Water	South Africa

Annex B contains the full list of participating utilities and the AfWA NRW Task Force members who were responsible for the utility audits.

Figure 1.2 Regional distribution of participating countries



2. INTERVENTION METHODOLOGIES

2.1 Water Audit Objectives

The diagnostic phase is the first step of the water audit process that assesses the existing situation and whether there is a problem with a utility's water supply system. This phase poses some basic questions on NRW:

- How much water is being lost?
- Where is the water being lost from?
- Why is water being lost?

Answers to the questions are provided by conducting a "top-down" water audit approach, which is largely a desk top exercise of gathering and analyzing data and information from the utility records on water use and loss (water balance), water supply system and utility management (policies, procedures, information systems, etc.). The example Utility Fact Sheet (SWSC) in Annex C provided supporting information for this stage.

From this platform of knowledge, intervention measures (action plans) are developed and implemented for reducing water losses:

- Proposing key action recommendations for NRW reduction
- Supporting the utility indeveloping a NRW reduction plan, and by monitoring and evaluating its progress with implementation of action plans

The program scope was limited to supporting the above key specific objectives and other activities related to achieving the objectives:

- Developing databases and collecting data for water balance
- Providing technical NRW and management training
- Providing NRW technical expertise and institutional support
- Developing investment plans and business plans
- Providing linkages, and convening meetings with, donors
- Providing limited funding for travel costs of audit teams and cost of travel to international conferences
- Developing communications tools and training workshops, operator partnerships and a small number of pilot projects for establishing DMAs

The program was unable to support infrastructure replacements, large scale metering, and acquisition of leak detection equipment.

2.2 Audit Approach

The audit process comprised meetings, focus group discussions and workshops. It was important that the utility being audited understood the need for the audit, and utility staff had been sensitized to this earlier by the utility counterpart member of staff taking part in the audit. The utility provided all the

necessary logistical support. There was active involvement and consultation of management and staff involved in the day-to-day operations through focus group discussions. The focus group discussions centred on 3 issues that impact on NRW and how a water utility deals with it:

- Institutional Assessment
- Technical Operations
- Commercial Operations

In addition, a water balance calculation was an essential component of the audit. The methodology defines NRW as the difference between system input volume and revenue water. It is comprised of water losses and unbilled authorised consumption. WB EasyCalc, accepted internationally as a water balance spreadsheet tool, was the methodology used for each audit.

Other tasks carried out during the audit process included:

- Inspection of records of water use and water loss
- Verifying meter testing and calibration records (system input meters and customer meters)
- Verifying billing and accounting information
- Workshops and interviews with utility employees
- Field visits for inspecting water supply system installations

Annex C gives an example of an audit report (NWSC – Jinja)

2.3 Performance Improvement Plan (PIP) Preparation Methodology

The PIP is part of the second phase of the AfWA-FABRI NRW program and was prepared by each participating utility following the audit. The findings and key recommendations of the water audit formed the basis for the PIP.

The AfWA NRW Task Force members jointly developed the framework for the PIP, which guided the PIP development for each utility. Utilities themselves formed their own task forces that championed the formulation of PIP – this was done through a consultative process involving all relevant stakeholders including the utility management, implying that the buy in process was comprehensively addressed.

The PIP preparation process identified solutions to the numerous performance and NRW challenges faced by utilities. In preparing the PIP, the utility management reflected on the current status of the utility; the challenges and opportunities and the socio-economic environment; and related these to the internal institutional capabilities.

Appendix D gives an example of a PIP (ONEA)

3. CURRENT STATUS OF NRW IN UTILITIES

3.1 Audit Findings

3.1.1 The Significance and Impact of NRW

Non Revenue Water (NRW) is a major problem for water utilities worldwide, especially in developing countries. NRW is defined as the difference in volume between the water entering the distribution system and the water billed to consumers. The main reasons for NRW are leakage from the pipe network, theft of water by customers and errors in billing records. According to a 2006 World Bank study, nearly 45 million m^3 of water is lost daily from leakage in developing countries, enough to serve nearly 200 million people. Close to 30 million m^3 of water is delivered every day to customers but not paid for, due to metering inaccuracies, theft, and corrupt practices by utility employees. These losses cost water utilities approximately USD 6 billion every year (World Bank, 2006). In Africa, NRW figures ranging from 5% (Saldanha Bay, South Africa) to 70% (LWSC, Liberia) have been reported (WSP 2009). According to the MDG Joint Monitoring Program by WHO/UNICEF (2010), as many as 343 million people in Africa, 477 million people in Asia, and 38 million people in Latin America and the Caribbean live without adequate water supplies. Table 3.1 shows NRW volumes across African water utilities for the year 2009

Table 3.1 NRW in African countries, 2009

	Total volume of water into supply(Mm3/year)		% growth in prod.	Total volume of water sold (Mm3/year)		% growth in sales	Non-revenue water (%)		Non-revenue water('000 m3/day)		Non-revenue water(lcpd)	
Countries	2006	2009		2006	2009		2006	2009	2006	2009	2006	2009
Central Africa	106	132	25%	77	92	19%	28%	31%	81	111	20	25
Eastern Africa	496	537	8%	278	318	14%	44%	41%	595	599	56	46
Southern Africa	988	1576	60%	633	967	53%	36%	39%	973	1,670	94	115
Western Africa	1,224	1539	26%	939	1,160	24%	23%	25%	780	1,039	17	20
Grand Total	**2,814**	**3,785**	**35%**	**1,927**	**2,537**	**32%**	**32%**	**33%**	**2,430**	**3,419**	**35%**	**41%**

The benefits from reducing NRW are substantial:

- Water utilities would gain access to a further USD 3 billion in self-generated cash flow
- Reducing illegal connections would result in greater fairness between users
- Utilities would become more efficient and sustainable, improving service to their customers service
- New business opportunities would create more jobs

It is widely acknowledged that NRW is a key indicator of a utility‘s operational and financial performance. A high level of NRW normally indicates a water utility that lacks good governance, lacks autonomy and has no established method of estimation or measurement.

During the audit process, it was necessary to ensure that the utilities' estimates of NRW were reasonable and based on some form of baseline information. Care was taken to ensure that the NRW figures reported were based on the same standard method – calculating an annual volume - to enable comparisons to be made. The WB Easy Calc Water Balance spreadsheet tool was used to calculate the various components of water balance and performance indicators.

From the audits carried out it is clear that not all countries or regions of Africa have the infrastructure and established operational procedures to begin tackling NRW. Many are struggling to ensure that customers receive a reasonable supply of water to sustain health and life. Water utility managers in most African countries invariably face challenges such as:

- Rapid urbanization
- Diminishing water supply
- Environmental pollution
- Outdated infrastructure
- A high level of poor O&M policies including ineffective record-keeping systems
- Inadequate technical skills and technology
- Greater financial constraints, including an unsuitable tariff structure and/or revenue collection policy
- Political, cultural, and social influences
- A higher incidence of commercial losses, particularly illegal connections

These factors all influence the scope for managing losses and demand, and affect the pace of change. At the same time, continuous NRW limits the financial resources available to tackle these challenges facing water utilities in Africa. In the 19 utilities audited the average volume of NRW was 39% of system input volume.

NRW significantly reduces the amount of water available for allocation. It also impacts on the financial viability of water utilities through lost revenue and increased operational costs. NRW also reduces a utility's capacity to fund service expansion, especially to the poor, which is clerarly unacceptable. The NRW problem is likely to be compounded in the future by diminishing water resources, increasing costs of producing water, high rates of infrastructure deterioration, inadequate investment budgets, and increasing pressures from urbanization, climate change, and population growth. Water utilities are under increasing scrutiny from citizens, government, and donors to use water resources more efficiently by reducing water losses in their distribution systems and ensuring sustainable service delivery.
Reducing water losses not only conserves a scarce natural resource but also improves the utility's financial viability (through increased revenue and reduced repair and energy costs), defers capital expenditure for new water sources and system expansion to keep pace with increasing demand, saves energy, and reduces carbon emissions, thus mitigating climate change impacts and fostering sustainability.

The audit reports indicate that many African water utilities face an uphill task, given the ageing infrastructure (especially WTP, transmission and distribution). In addition, not all customers are universally metered. In some instances there is lethargy - and lack of management commitment to NRW reduction efforts. There is clear evidence of a culture of poor maintenance, low skilled manpower, and a weak financial position as revenue collected does not meet full cost recovery. Plans of the transmission and distribution network are not updated, meaning that time and resources are wasted trying to find the exact location of pipelines and appurtenances. Asset management policy, maintenance

plans and planned preventive maintenance (PPM) schedules and an Asset Register are in many instances not updated. Because this requires significant resources, PPM is often ad hoc, reactive and un-programmed.

Although significant capital investment may be required for rehabilitation of the old pipeline network infrastructure, performance weaknesses will not be resolved through flagship capital projects alone. Greater attention should also to be given to maintenance and revenue management systems, and to improving internal institutional and operational aspects - accountability, and the technical and managerial skills necessary to provide a reliable service.

In this regard, short, medium and long-term strategies are needed and have been proposed by the audits.

3.1.2 The Audit Programme and NRW Results

19 water utilities (out of the original 22) remained in the programme. NRW audits were conducted at each utility by AfWA NRW Task Force members on various dates between September 2012 and May 2014. Standard NRW audit methods were applied to ensure that data obtained and used in the water balance would result to credible results for benchmarking. Field assessment of the level and accuracy of production and customer metering, asset management practices, operations and maintenance methods such as pressure management, was essential in linking the results of the water balance with the utility's practice in NRW reduction. Whether the flows were estimated or actually measured, standard methods were used, and, where appropriate, an allowance for meter error was made depending on the age and type of flow meter. Table 3.2 shows the results of the water balance calculation from each utility audit.

Table 3.2 NRW levels for the audited utilities

Item no	Utility	Level of metering		losses from water balance					
		Production metering	Customer metering ratio	Production (m3/yr	authorised unbilled	Commercial losses	Physical loss	nrw(m3/yr)	nrw% (Water balance analysis)
1	Bauchi, Nigeria	No	0	12,923,329	1,517,322	444,570	5,716,239	7,678,131	59%
2	Benue, Nigeria	No	0	1,627,800	160	29,953	1,244,052	1,274,166	78%
3	CDE, Cameroon	No	0	34,949,379	28,030	2,763,929	8,680,995	11,472,954	33%
4	Ghana Water co.	yes	100%	145,755,546	0	18,612,041	57,378,674	75,990,715	52%
5	Karonga, Malawi	yes	100%	1,392,524	185	100,159	316,486	416,830	30%
6	KIWASCO, Kenya	YES	100%	7,648,575	3,285	315,360	3,717,160	4,035,805	53%
7	Lukanga, Zambia	YES	70%	23,764,405	419,629	1,006,197	14,710,289	16,134,115	68%
8	NCWSC - Nairobi, Kenya	yes	100%	184,230,824	7,235,344	21,487,366	40,102,690	68,805,420	37%
9	NWSC -Entebbe, Uganda	yes	100%	3,858,583	360	267,861	396,095	664,316	17%
10	NWSC - Jinja & Iganga, Uganda	yes	100%	4,474,714	7,800	371,944	492,254	871,998	19%
11	NWWSC, Zambia	yes	100%	4,277,397	3,010	236,730	993,007	1,232,747	29%
12	ONEA, Burkina Faso	yes	100%	13,190,037	668	763,234	1,799,526	2,563,428	19%
13	SODECI, Côte D'Ivoire	yes	100%	34,953,308	373,928	4 ,496,428	5,219,523	10,089,879	29%
14	SDE, Senegal	No	0	54,887,035	79,194	2,611,204	12,127,491	14,817,889	27%
15	SEG, Guinea	No	0	53,673,464	16,943	11,195,436	4,622, 683	15,835,062	30%
16	SONEB ,Benin	yes	85%	28,358,111	283,581	2,340,632	4,988,232	7,612,455	27%
17	STE , Chad	No	0	15,529,413	205,629	845,311	5,837,349	6,890,470	44%
18	SWSC, Swaziland	yes	100	19,186,817	654,000	2,626,492	3,333,839	6,614,331	34%
19	TDE, Togo	yes	100	13,866,640	9,600	1,444,149	3,600,405	5,054,154	36%
	Total			658,547,901	10,838,668	67,462,568	170,654,306	258,054,865	39%

Figures 3.1 to 3.3 illustrate the main components of water balance for each utility

Figure 3.1 Total Annual NRW (m3/year)

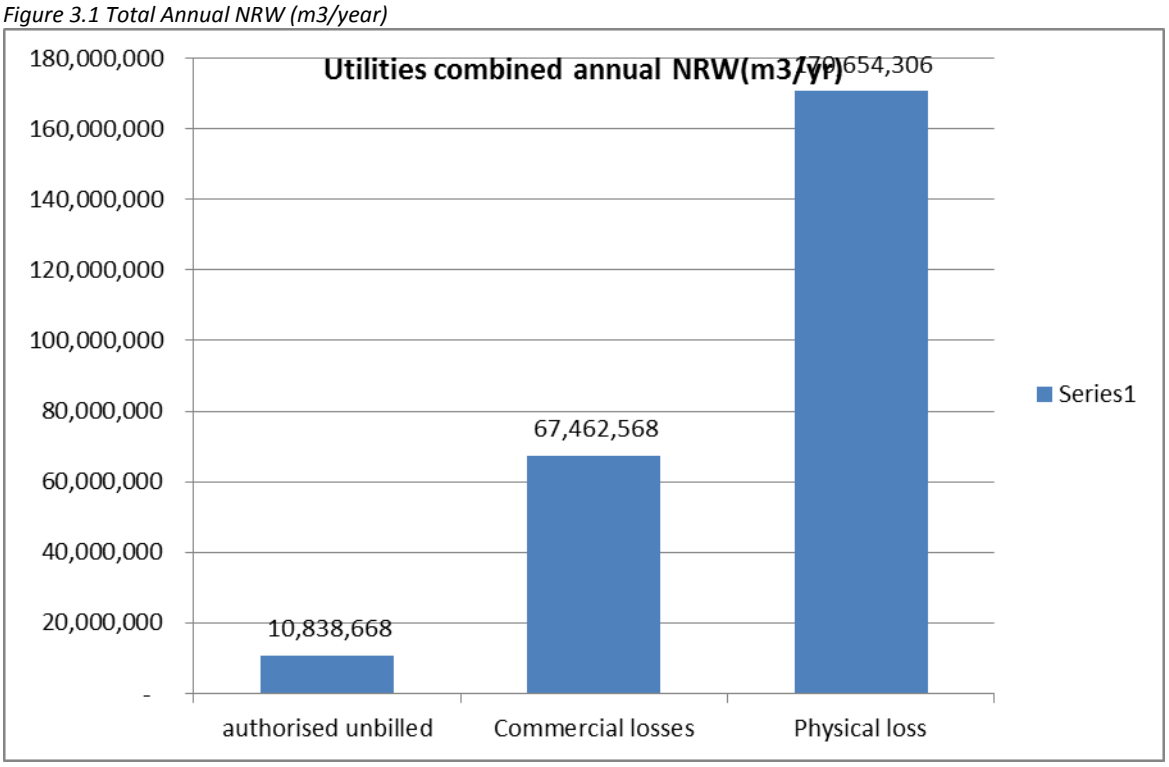


Figure 3.2 Production against different categories of losses

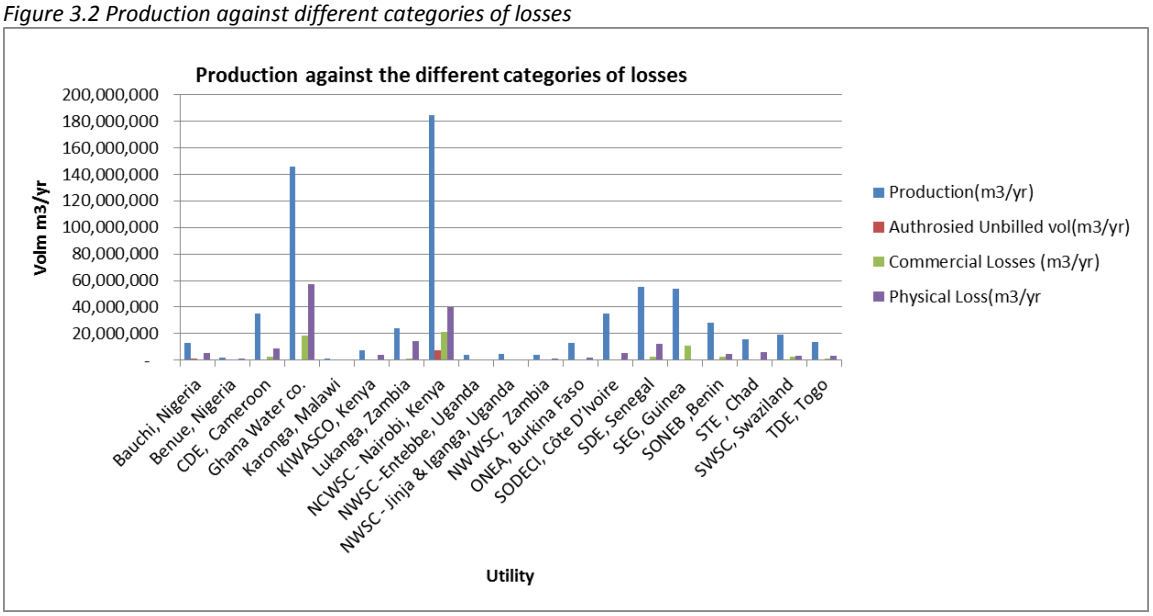
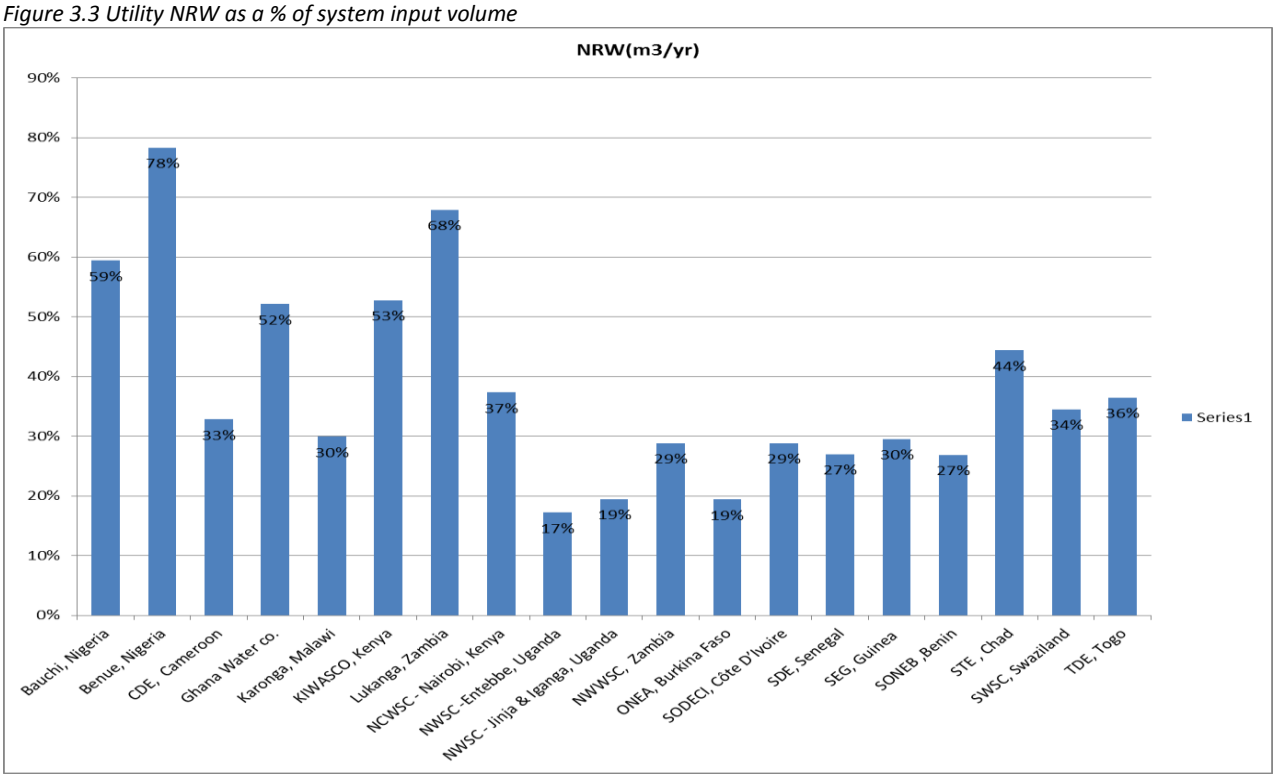


Figure 3.3 Utility NRW as a % of system input volume



3.1.3 NRW Trends (Key Performance Indicators)

In 2013 President Jacob Zuma of South Africa said that South Africa is not a water rich country and therefore they 'must reduce water losses by 50%'. However, because NRW has only relatively recently become a topic of concern for most African countries, there is little data available to accurately analyse NRW trends across the African continent. This programme - 'Reducing Non Revenue Water in Africa', sponsored by USAID through FABRI - has provided a useful insight into the real NRW issues affecting the African continent.

This section presents NRW trends in terms of country and or regional comparisons rather than in terms of data collected over a wide range of time. The data is compared in terms, for example, of how NRW affects supply time, and the relationship between Infrastructure Leakage Index (ILI) and NRW for African countries.

In the utilities that were audited NRW (expressed as a percentage of system input volume) varies greatly - ranging from 17% in Entebbe in Uganda to 83% in Benue in Nigeria. One of the factors causing such variations is that in some countries the data that was collected reprsented small towns (Uganda), in other countries from the main city networks (Kenya), or for the whole country (Swaziland).
For the purposes of this report all the information given is assumed to represent the true NRW value. The average NRW figure in terms of percentage was 40% across the whole Africa. This compares well with the rest of the world as per the KPMG report which states that in developed countries 25% to 40% of water is lost through leakage.

Figure 3.4 shows the NRW trends across the regions of Africa. Out of the countries audited Nigeria (West Africa) had the highest level of NRW with 83% in Benue and 59% in Bauchi. There is a commonality between these two utilities - they are both government managed and do not have customer meters. This indicates the importance of ensuring that water utilities are governed as profitable businesses – and the importance to the revenue stream of the business of metering all customers.

Figure 3.4 NRW trends across regions of Africa (as a % of system input volume)

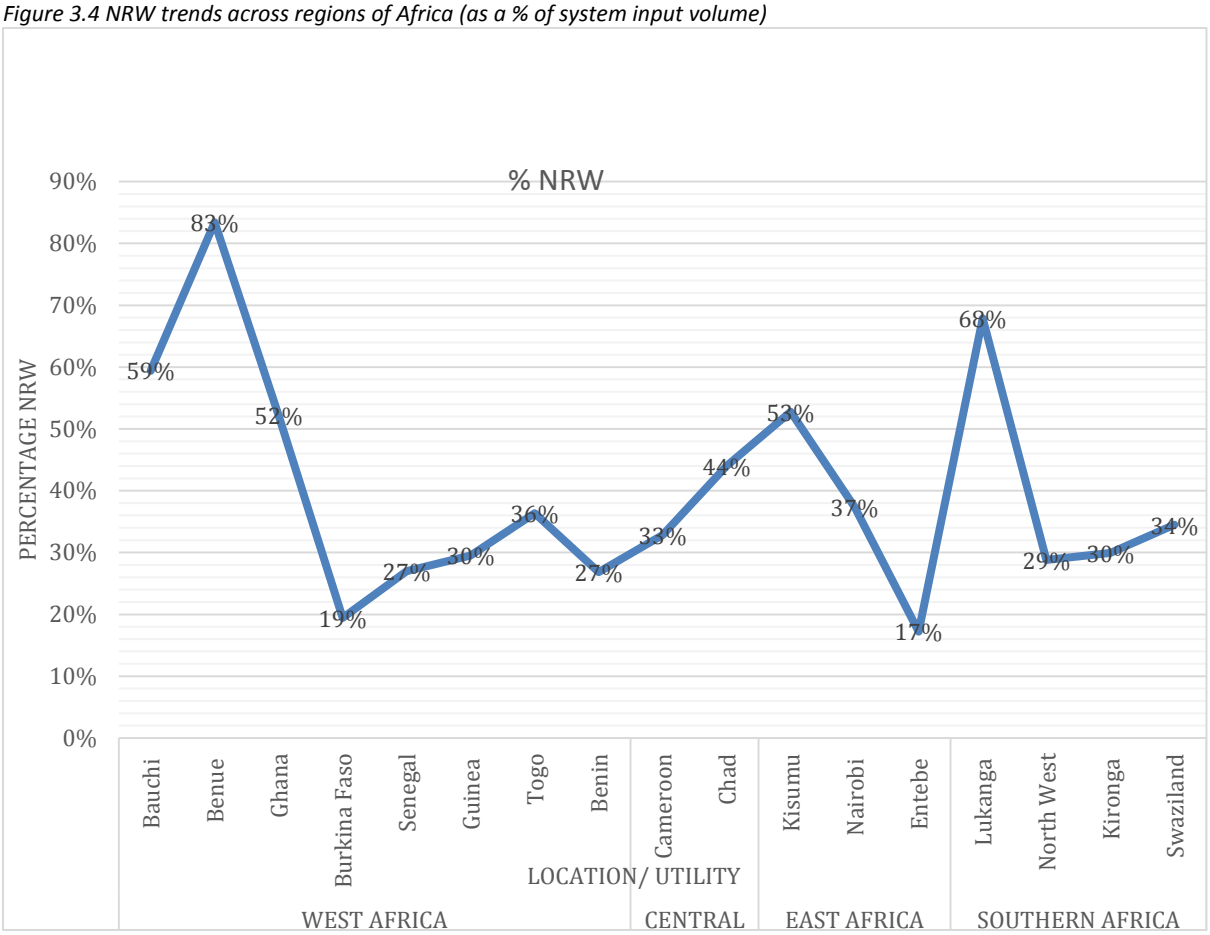


Table 3.4 illustrates the average NRW (as a % of system input volume) in each of the four regions - West Africa, Central Africa, East Africa and Southern Africa.

Table 3.4 Average NRW in the regions of Africa

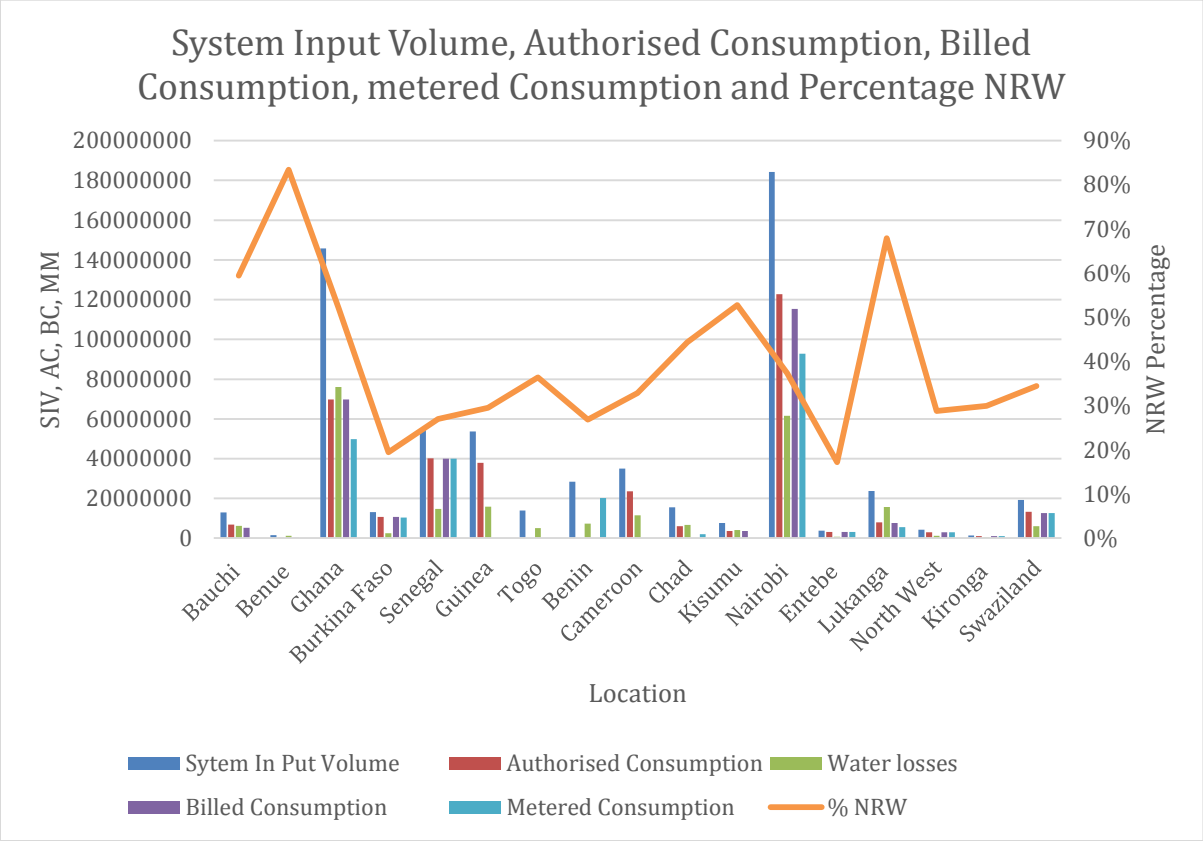
African Region	Average NRW %	Overall African NRW %
West Africa	40	40
Central Africa	38	40
Southern Africa	50	40
East Africa	36	40

Figure 3.5 shows the relationship between system input volume, billed authorised consumption and percentage NRW.

Utilities with less than 100% metering ratio had NRW figures above 35%. Although this does not necessarily suggest a correlation between metering ratio and NRW, it is a result worthy of further investigation

System input volume has no clear influence on the NRW value, the general assumption is that the greater the system input volume the higher the NRW figures, but evidence from the field investigations shows this is not the case. Utilities with high system input volumes such as NWSC (Nairobi Water) have an acceptable NRW figure . Benue, however, which has the smallest system input volume of the audited utilities, has the highest level of NRW. This confirms that NRW is a complex issue that is affected by a variety of factors.

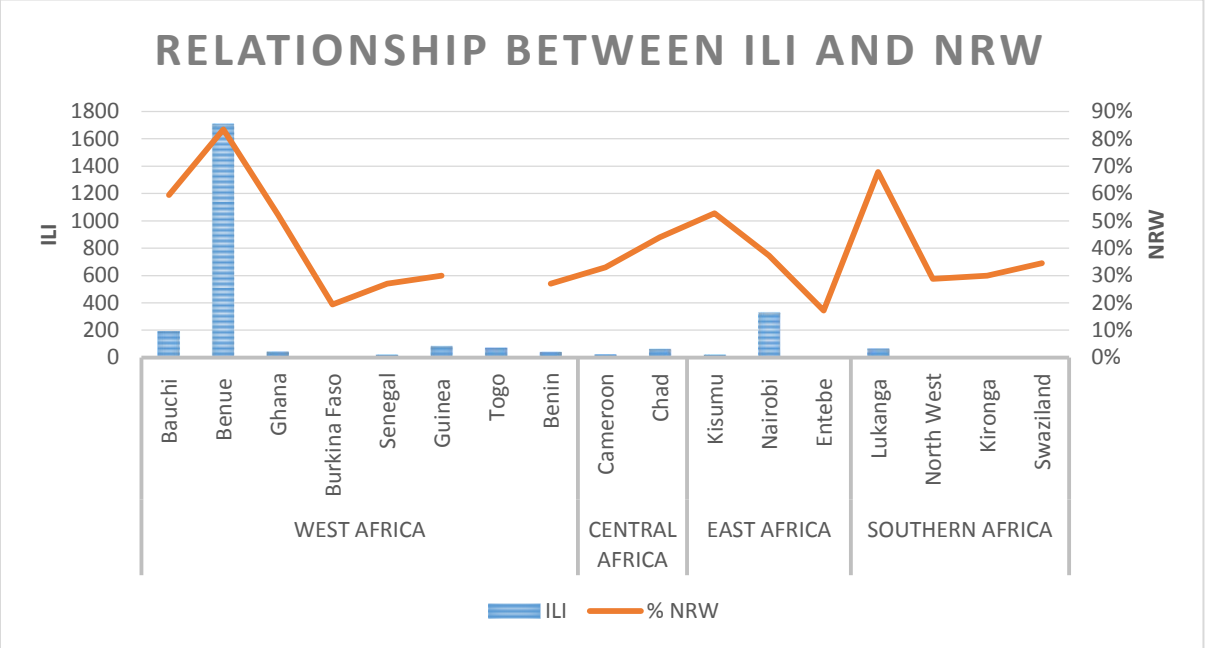
Figure 3.5 Relationship between System Input Volume, Billed Consumption and % NRW



The infrastructure leakage index (ILI) is a ratio used to measure how well a water utility's infrastructure is managed, particularly the pipe network. The ILI is a ratio – the lower the ILI the better the water network is managed, and a high ILI shows that the water network is being poorly managed. A high ILI also relates to a high value of NRW. The ILI ranges from as much as over 1500 in one state in Nigeria to as low as 1.0 in the Ugandan town of Entebbe. The shows the wide range of water network management competence (and incompetence) that exists across the African continent.

As Figure 3.6 illustrates, water utilities with NRW between 25% and 35% had average ILI of 20, while water utilities with NRW figures above 35% had an average ILI of 80. Utilities with NRW figures of less than 25% had average ILI less than 5. This shows not only how well a water network is managed but also has a direct impact on the NRW figures for that network.

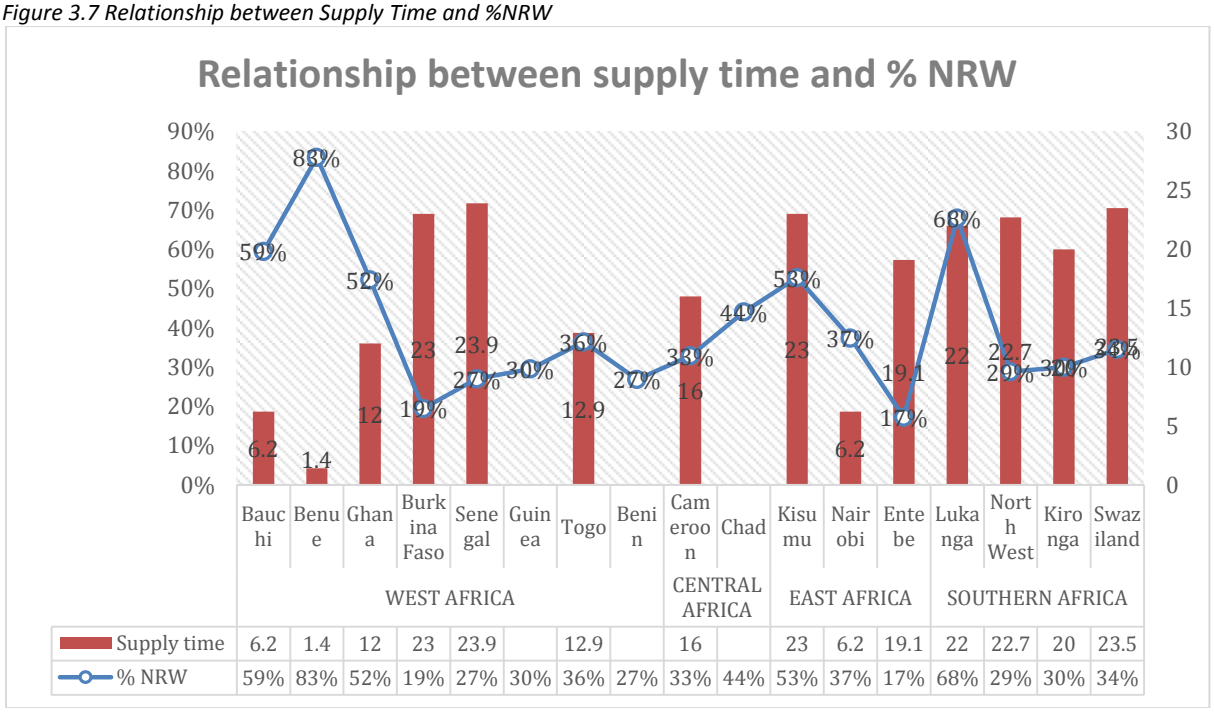
Figure 3.6 Relationship between ILI and % NRW



One of the main challenges affecting African water utilities is scarcity of water. According to WHO, more than 1.0 billion people do not have access to clean water. As can seen from the audit results, NRW is a major contributor to this lack of access to clean water.

Figure 3.7 shows that the highier the NRW level the less the supply time in hours per day. This is true for all audited African water utilities except Kisumu and Lukanga - but these utilities have highier than expected system input volumes considering their customer base.

Figure 3.7 Relationship between Supply Time and %NRW



Although Guinea had commercial losses of over 70%, it is the only utility with commercial losses greater than physical losses - the majority of African utilities have most challenges with physical losses. Figure 3.8 shows the relationship between physical and commercial losses - more than 70% of the audited water utilities reported that physical losses accounted for over 70% of their losses. This is mostly due to old water network infrastructure which requires replacement, and/or lack of pressure management initiatives.

Figure 3.8 Relationship between Physical and Commerial Losses

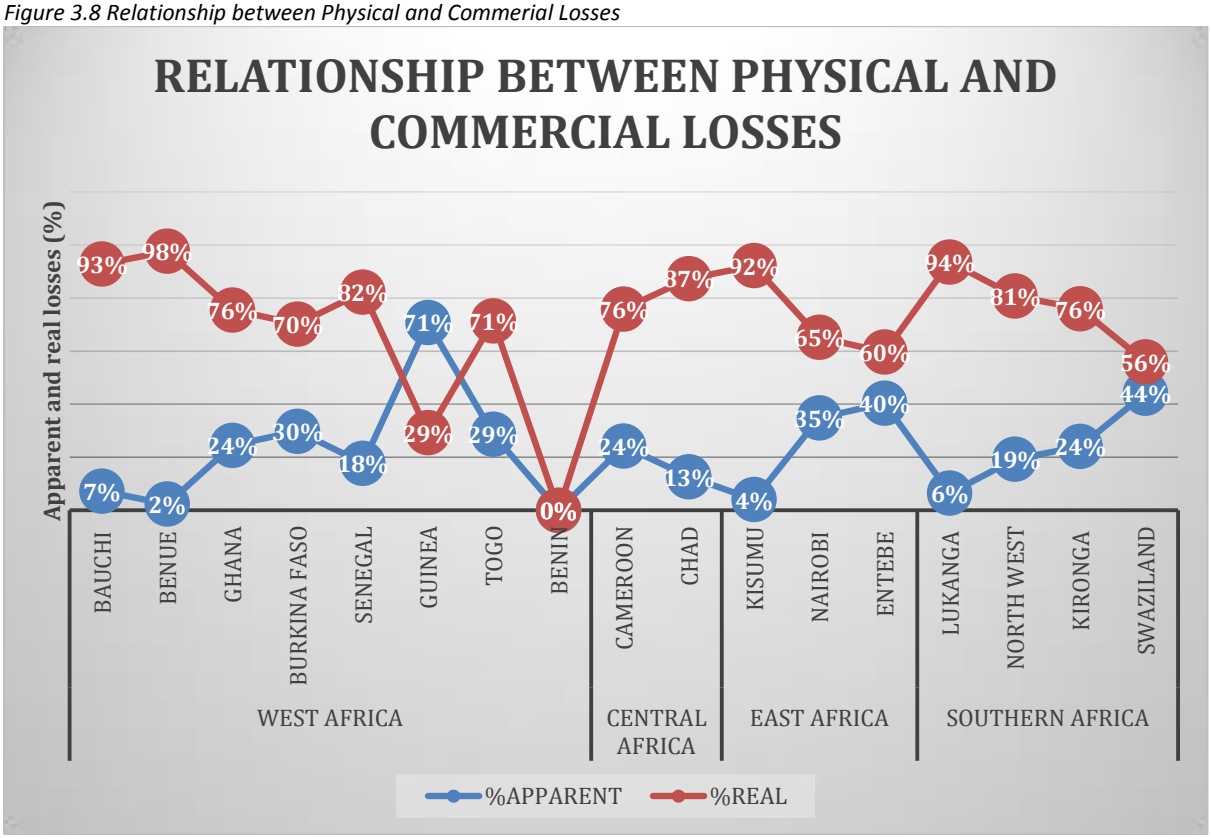


Figure 3.9 illustrates the effect of pressure on real losses in terms of litres per connection per day, and in litres per connection per day per metre of pressure.

Figure 3.10 illustrates the relationship between physical and commercial losses across the regions. Southern and Central Africa are the regions most affected by physical losses with averages of 83% and 80% respectively.

Figure 3.9 Effect of pressure on real losses in litres/connection/day

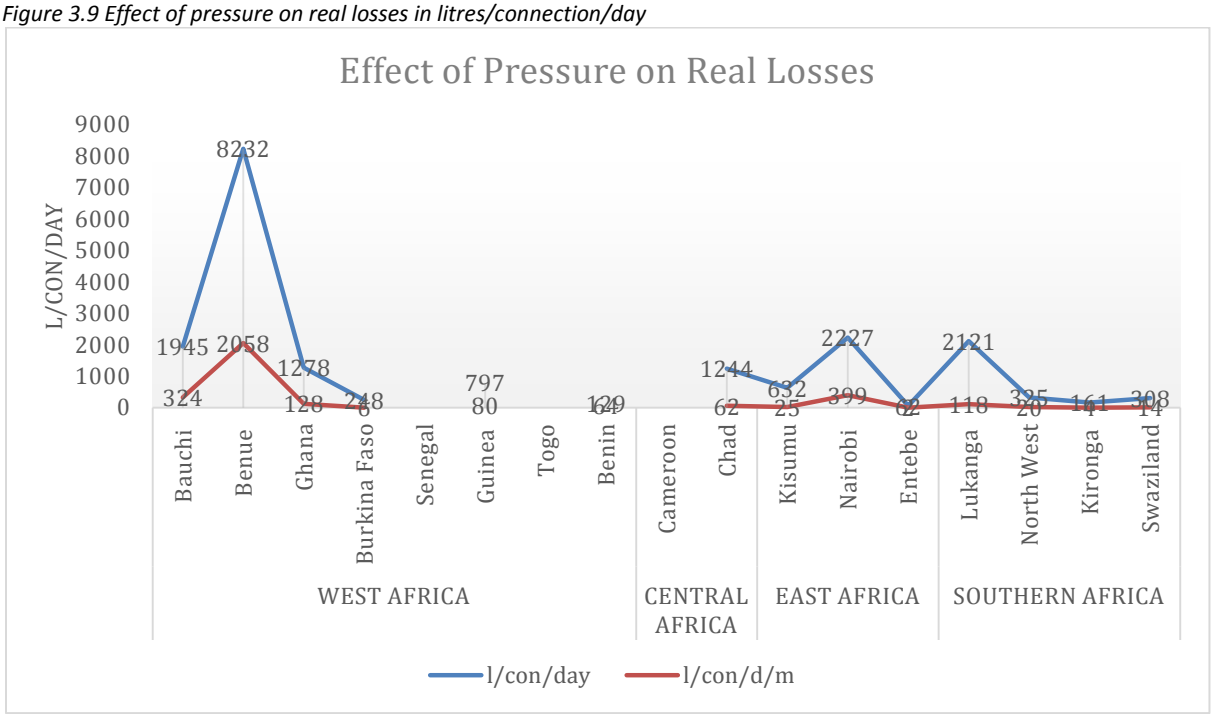
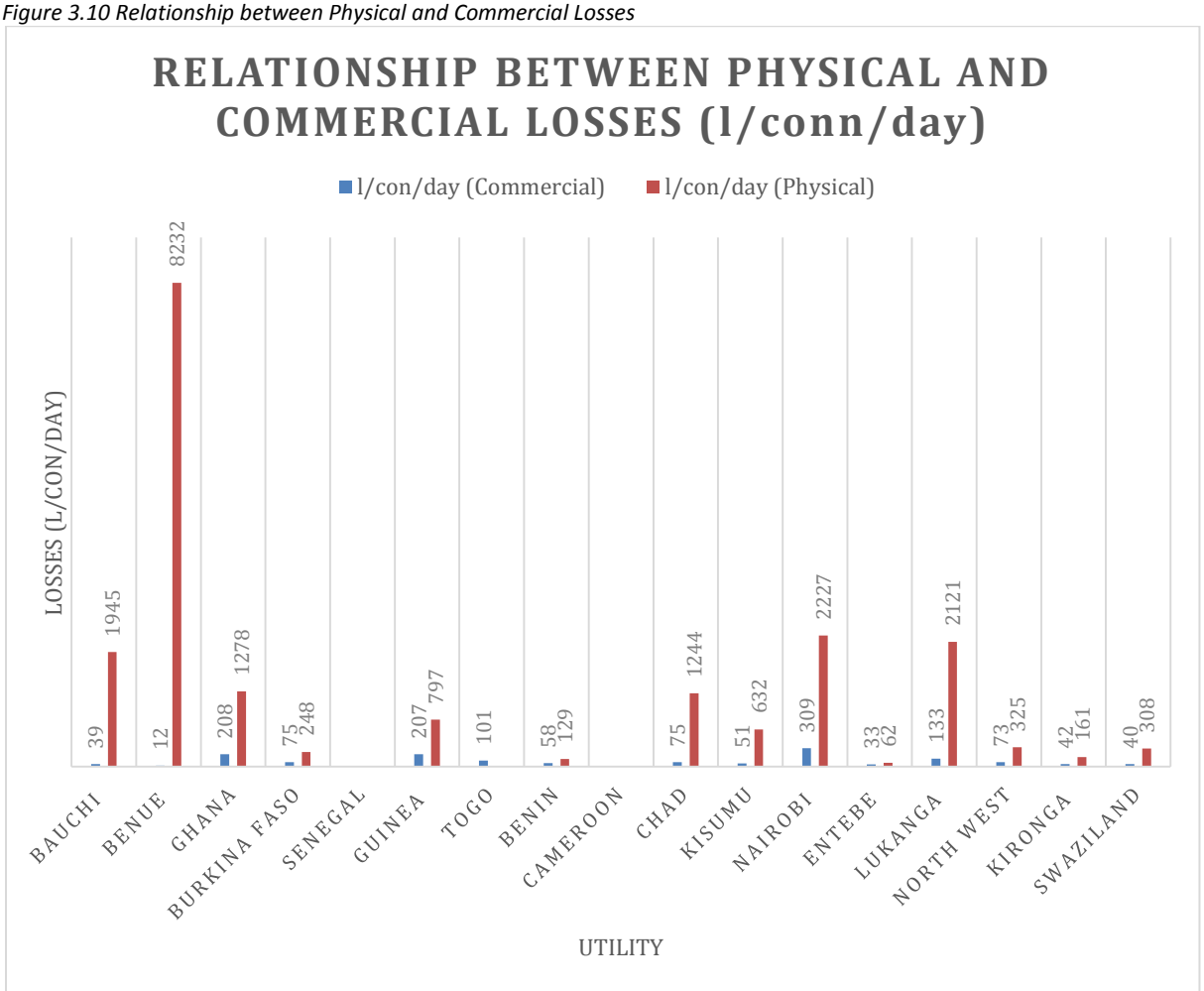


Figure 3.10 Relationship between Physical and Commercial Losses



3.2 The Cost of NRW to Utilities

The total volume of water lost in the audited utilities accounts for approximately 37% of the total system input volume. The cost of this loss is estimated at USD 75.5 million.

The volume of unavoidable losses represents less than 5% of the total.

The average tariff of the utities is USD 0.6 per m^3 with an average marginal cost of production of USD 0.2 per m^3

3.2.1 Promoters of Good NRW Practice

The NRW audits conducted at the various water utilities have, as would be expected, revealed disparate performance between utilities. The situation varies, depending on several factors related to lack of senior management awareness and perception of NRW:

- Water utility policies and strategies
- Political, social and cultural influences
- Availability of the water resource
- Lack of knowledge of the costs to the utility arising from NRW
- Lack of a dedicated, fully funded NRW reduction staffing structure and management strategy

The audit process identified the influencing factors on how NRW is viewed by a utility - and therefore how these are promoters of good utility performance. These are summarised in the three main categories as follows:

Institutional and Organisational

- Recognition and management of NRW
- Policies and strategies relating to NRW reduction
- A staffing structure and budget dedicated to NRW
- Control of the network management and customer billing
- Legal policies to prevent and punish theft and fraud

Technical Operations

- Network zoning (DMAs) and pressure management
- Checking and validation system input meters
- A fast leak repair policy
- An operation and maintenance policy to follow up repairs

Commercial Operations

- Measurement and control of water consumption by customers
- Measurement and control of volumes of water taken for authorised use (eg flushing and fire hydrants)

- Policy to identify and a plan to reduce the carious forms of theft and frauds
- Relliable technology for checking customer meter accuracy

3.2.2 Preventers of Good NRW Practice

The reasons for weak performance differ from utility to utility. Examples are:

- Dependency on the state or its utility agencies (asset renewal, tariff, budgets etc)
- Needing to be aware of visible leakage - and reducing it
- Absence of a policy for active leakage control for finding invisible leaks (lack of montoring equipment and leak detection equipment)
- A culture that allows absence of customer metering
- Lack of communication between the utility and the community

3.3 Lessons Learned

Utilities are at various levels of awareness, understanding and commitment to improvement. There have been positive responses and enthusiasm from the utilities' management teams, a sign of a strong will and commitment to the program.

The audit process has identified some key challenges - institutional, technical and commercial – but it has also identified some key responses and some good solutions for addressing the challenges. This has often due due to an AfWA NRW Task Force facilitator being engaged on the audit programme, and having a mentoring role as well as an auditing one.

Examples of the lessons learned - and changes implemented - are highlighted in the following sections, and are again set out in the three main categories: Institutional Assessment, Technical Operations and Commercial Operations, and with examples of some utilities that have implemented changes.

3.3.1 Institutional Assessment

Recognition:

- Recognition by senior management of the importance of the financial loss implication of NRW (**NWSC, ONEA, SDE, SONEB**)

NRW Department:

11 of the 19 audited utilities (58%) have departments or units dedicated to NRW. All the other utilities recognise the need to implement an NRW department:

- Departments need to be brought up to date by integrating other policies, strategies and methodologies that have an impact on a NRW reduction strategy
- There are frequently insufficient staff dedicated to NRW reduction to ensure it is carried out efficiently

Finance:

- There is frequently an insufficient budget – or no budget - allocated to NRW
- Lack of investment – or delays in investment – that impact on NRW, such as infrastructure maintenance and renewal of pipes, fittings and meters (**CDE, TdE**)

3.3.2 Technical Operations

Network Plans:

- The importance of updating and maintaining network plans, including service connections and additional pipes, and using available technologies such as network modeling and GIS, and, in the long term, to integrate GIS to make it a decision support tool (**SODECI, ONEA, SDE, SWSC**)

Water Balance:

- Regular water balance calculations are important for prioritizing NRW activities
- Understanding the significance of good data - limited data, of poor quality and with too many estimated values leads to too many water balance errors (margin of error of NRW in the audited utilities is 9% - 75%)

Active Leakage Mananagement:

- Network zoning (DMAs) is essential for improved management of the network, for active leakage management, and for monitoring and managing pressure (**SWSC)**
- Regular checking and validation of system input (production) meters **(ONEA)**
- Follow up by the utility to research and identify reasons for leakage and bursts is good practice for planning infrastructure reinfiorcement or renovation

3.3.3 Commercial Operations

Customer meters:

- 13 of the 19 audited companies (68%) have 100% of their customers with meters installed, but of the meters installed some are not operational
- Checking customer meters to ensure reliability and accuracy of measurement, and taking account of the type and age of the meters
- Having all the necessary information on customer connections (connection points, service length, address, etc)
- Understanding the impact on meter accuracy of poor meter installation (eg vertical installation)
- Understanding the importance of data evaluation - measurement method and data transfer has a bearing on the accuracy and reliability of the figures for NRW
- Upgrading and improving Management Information Systems (MIS)

Theft and fraud:

- Accepting the importance and significance of internal and external customer theft, fraud and vandalism **(NWSC, SODECI)**
- Paying special attentionto inactive connections and active connections not invoiced, which could be a source of fraud

Authorised use:

- Understanding and controlling the volume of water taken as authorised consumption (fire posts, hydrants etc)

4. UTILITY STRATEGIES FOR NRW REDUCTION

This section reviews actions made by the utilities to develop a NRW reduction strategy.
Some actions - the 'quick wins' – were identified during the audit process. These are reviewed in 4.1.
Other actions and strategies were identified in the PIPs.

4.1 'Quick Wins'

The audit process, and the later development of individual PIPS by the water utilities, identified short, medium and long term action plans for implementing a NRW reduction strategy. But, in addition to these, in any NRW reduction programme there are invariably some 'quick wins'. These are actions and tasks that the water utility can put in place in the very short term, or immediately, at low cost or at no cost to the company. Examples of these are company policy changes – or the correct implementation of a policy, or adjusting the staffing structure to implement a new NRW department, or strengthen an existing department structure with extra staff. Some tasks can be put in place using in-house staff, with minimal re-training and capacity building:

Tasks that can be carried out done within the existing workload include:

- Surveys by meter readers and NRW department staff to look for illegal connections
- Using mobile phones to record meter readings and record tampered and bypassed meters
- Persuading customers to report neighbours with illegal conections or taking water fraudulently
- Making surveys of customer meters and unregistered connections
- Conducting tests of meter accuracy on a sample of customers
- Checking and verifying network data as a starting point for water balance

Examples of quick wins from the audit reports, identified by most of the utilities, are:

Institutional:

- Establish NRW Reduction Department - or strengthen an existing one - with adequate budget provision for staff and logistical support **(GWCL, NRWB, NWSC, Jinja, SODECI)**
- Couple the NRW Department set up with an appropriate performance measurement system for NRW reduction - target-setting, KPIs, incentives, monitoring, and feedback **(GWCL, NRWB)**
- Institute monthly reporting of NRW to senior management team **(SEG)**
- Conduct staff rationalization - and building of capacity - for key staff members to improve on staff productivity **(LGWSCL, SEEG, STE, SWSC)**
- Initiate internal restructuring, especially redeployment of water loss technicians for cost-effective leak detection and maximum utilization of leak detection equipment **(SWSC)**
- Strengthen customer complaint feedback procedure/mechanism (**GWCL)**
- Carry out stakeholder education on water demand management (**NCWSC)**
- Conduct annual water audits and continuously refine water balance input data **(NRWB)**
- Reorganize the supply chain – equipment stocks and spares **(SEG, TdE)**

Physical Losses and Leak Detection:

- Acquire (low cost) leak detection equipment **(KIWASCO)**
- Strengthen active leak detection by the creation of new teams, given the length and the age of the network **(CDE)**
- Identify all known and/or visible leaks immediately and improve response time to reported leaks and bursts **(LGWSCL, Bauchi, NRWB, ONEA, SDE)**
- Analyze the primary causes of leaks on service connections and initiate an appropriate corrective action – pipe material, quality of installation, soil movement, storage conditions, etc. **(ONEA)**
- Develop customer leak repair code of practice **(LGWSCL)**
- Expose and repair buried valves and hydrants to maximise leak detection sounding points **(Bauchi, KIWASCO, LGWSCL, SDE)**
- Implement a call centre and install toll free customer service lines for leak reporting **(Bauchi, NRWB, SEEG, SONEB)**

Commercial Losses :

- Immediately conduct field customer surveys and update the customer database **(LGWSCL, Jinja, SEG, TdE)**
- Make more use of mobile phone technology for meter readers **(NWWSSCL)**
- Set up network surveys to dentify and record all illegal connections and immediately resolve and legitimize their status **(Bauchi, LGWSCL, NWWSSCL, ONEA, SEG)**
- Pay special attention to inactive connections, which can be a source of fraud **(CDE, SEEG)**
- Institute alternative paying option in additional to office pay points **(GWCL, NWWSSCL)**
- Introduce improvements for customer meter testing and meter replacement **(NWWSSCL, SWSC)**
- Introduce improvements for measuring water taken from hydrants **(SDE, SODECI)**

Of all the quick-wins, the two that are common to almost all utilities are:

- Ensuring the provision of a recognized and 'powerful' NRW department, equipped with sufficient staff and logistical resources (vehicles and equipment) to sustain an active NRW reduction and leak detection policy

- Ensuring that all customers are registered, dealing with illegal connections, and investigating inactive connections

4.2 PIPs - Cross-Cutting Common Solutions and Priorities

The first step is to review the issues that are perceived by utilities as being preventers of successful NRW reduction, then to identify the priority areas and common approaches that utilities can apply to introduce solutions.

The analysis has been applied to the four main PIP categories, expanded in the respective sections:

- Institutional Strengthening
- Asset Management and O&M
- Commercial Operations
- Management Information Systems
- Financial Management

The tables blow each category review the goals and strategic actions - and the supporting tasks required to achieve them.

4.2.1 Institutional Strengthening

The setting up of a dedicated NRW department, empowered and fully equipped, is seen as an essential first step in implementing a NRW reduction strategy.

Some utilities see change management as being a precursor to this step – increasing awareness and perception of NRW at the highest level in the utility, to ensure that the need for an NRW department is fully recognised, so that it becomes authorised and empowered.

Training and capacity building is clearly a cross-cutting priority - recognised as a major institutional requirement for enhancing most utility functions involving NRW (asset management, leak detection and addressing commercial losses)

Goal	Strategic Action	Supporting tasks
NRW Department Elevate the profile of NRW management with a dedicated NRW Department	Introduce an NRW Department or elevate its position. Identify staff training needs	Staff training, motivated workforce
Change Management Improve staff performance and accountability	Develop framework for change and staff training programme	Train champions, staff awareness campaigns
HR Policies and Capacity Building	Capacitate staff via staff training, workshops, guideline manuals Exchange experiences with other utilities	Improve staffing structure and staff performance, produce business plans

4.2.2 Asset Management and O&M

Goal	Strategic Action	Supporting tasks
Reduce Physical Losses	Annual NRW audits Active leakage control, pressure management Replace old pipes	Procure equipment Improve asset maintenance and train staff in maintenance
Reduce pipe bursts	Introduce pressure management	Procure PRVs

Improved O&M methods	Improve skills for repair and maintenance of assets	Skills training for artisans and plumbers
Improved Zoning and DMAs	Improve GIS, zoning, DMAs and PMAs	Verify zone boundaries
Comprehensive Asset Management System to improve reliability	Advanced GIS, updated and verified drawings and records Age profiles of pipes	Asset renewal programmes
Introduce Pilot Zones	Demonstrate benefits	Roll out
Quality Assurance	Production meter data verification	

4.2.3 Commercial Operations

Goal	Strategic Action	Supporting tasks
Improve Billing Efficiency and Revenue Growth	Meter all customers (universal metering programme) Improve new connections procedure Improve customer database and verify accounts	Ensure meter readers are trained
Reduce Theft	Address illegal connections – implement law enforcement and legal policies against theft (NWSC)	Include in NRW Department's actions
Reduce Commercial Losses	Introduce AMR Test meters and analyse meter age profile Prevention of tampering (reposition meters)	Include in NRW Department's actions
Improve Customer Awareness	Awareness/feedback campaigns, stakeholder education and collaboration Use public for alerting to leaks and theft	

4.2.4 Management Information Systems (MIS)

Goal	Strategic Action	Supporting tasks
MIS Strengthening	Set up MIS Staff training – IT, GIS	
Enhance NRW Data Reliability and Accuracy	Improve data capture (AMR/DMAs) Establish decision support	Clean up and upgrade customer data management and billing system

	systems	AMR pilots
Enhance IT solutions and system applications	Telemetry systems, continuous monitoring and data capture	
Integrate MIS system	Include billing systems	

4.2.5 Financial Management

Goal	Strategic Action	Supporting tasks
Increase Revenue	Increase coverage – simplify connection procedures Customer outreach programmes Introduce payment options and pre-paid metering Simplified tariff model	Increase billing and collection efficiency
Financial Planning and Control	Expenditure controls Streamline financial management systems Procurement planning	Introduce revenue function

5. FUNDING SUPPORT MECHANISMS AND PARTNERS

The spreadsheet in Annex F illustrates the funding support mechanisms available to each utility for supporting NRW programmes. The categories of funding are:

- Utility internally generated funding
- Government funding
- Private Sector Participation
- Development Partners

Funding is targeted to funding improvements in one or more of the 5 PIP categories:

- Institutional Strengthening
- Asset Management and O&M
- Commercial Operations
- Management Information Systems
- Financial Management

6. CONCLUSIONS

It is widely acknowledged that NRW is a key indicator of a utility's operational and financial performance. A high level of NRW normally indicates a water utility that lacks good governance, lacks autonomy and has no established method of estimation or measurement. The total annual volume of water lost in the audited utilities accounts for approximately 37% of the total system input volume, costing USD 75.5 million, while globally these losses cost water utilities approximately USD 6 billion every year (World Bank, 2006).

It is not difficult to define the business case for introducing a NRW reduction strategy to an individual water utility. Water lost from the pipe network is potable water, with a cost attached for chemicals used during the treatment and disinfection process. In many cases, potable water is pumped to reach customers in elevated regions, requiring electrical energy to run high lift and booster pumps. Losses from the pipe network become even more significant in regions where production cost is high, as in water scarece regions where expensive processes like desalination and reverse osmosis are used. So the production cost (marginal cost of water) can be clearly clearly identified and accounted. The other cost is the loss of income to the utility from theft of water and fraudulent use, such as illegal and unregistered connections, meter bypassing and tampering, and theft from hydrants.

The effect of NRW on an individual utility becomes clearer during the water balance calculation – one of the key financial performance indicators in the water balance is the cost of NRW expressed as a % of the utility's annual operating cost. This provides a useful financial comparison when introducing a NRW reduction strategy, for the utility too measure the financial savings year on year.

The audit process provided an opportunity for participating water utilities to review the factors that affect NRW, based on an external and independent review – but with the ful participation of the urility at a senior level. The audit was an essential precursor of defining a NRW reduction strategy, allowing the utility to:

- Quantify the volume of water lost in each component of water balance
- Highlight gaps in the data, and the tasks needed to quantify estimated data more accurately
- Identify the challenges of NRW – and the preventers of good NRW practice
- Identify and build on the promoters of good NRW practice

From the audits carried out, NRW (expressed as a percentage of system input volume) varies greatly between utilities - ranging from 17% in Entebbe in Uganda to 83% in Benue in Nigeria. Another factor causing such variations is that in some countries the data that was collected represented small towns (Uganda), in other countries from the main city networks (Kenya), or for the whole country (Swaziland).

It it is clear that not all countries or regions of Africa have the infrastructure and established operational procedures to begin tackling NRW, and this will be reflected in the focus for the action plans taken forward to each utility's PIP. Many utilities are struggling to ensure that customers receive a reasonable supply of water to sustain health and life. Water utility managers in most African countries invariably face challenges such as:

- Rapid urbanization
- Diminishing water supply
- Environmental pollution

- Outdated infrastructure
- Poor operations and maintenance policies including ineffective record-keeping systems
- Inadequate technical skills and technology
- Greater financial constraints, including an unsuitable tariff structure and/or revenue collection policy
- Political, cultural, and social influences
- A higher incidence of commercial losses, particularly illegal connections

The PIP process that followed the audit provided an opportunity to build on the audit recommendations for short, medium and long term action plans – providing a pathway for the utility to address some of the challenges listed above, and to put in place actions for meeting the challenges - filling gaps and improving its management of NRW - over several stages of implementation.

During the preparation of the PIP each utility was able to identify solutions to the numerous performance and NRW challenges it faced, reflect on the utility's current status and operational practices, the challenges and opportunities, and to review thecultural, socio-economic, political and environmental issues that affected its internal institutional capabilities.

Some utilities are at a different starting point, notably Benue and Bauchi, in Nigeria, which are characterized by having the highest NRW levels of the audited utilities, with 83% and 59% respectively. There is a commonality between these two utilities - they are both government managed and do not have customer meters. This indicates the importance of ensuring that water utilities are governed as profitable businesses – and will no doubt will be reflected in the focus of these utilities' PIPs – to reflect the importance to the revenue stream of the business of metering all customers.

Utilities are also at various levels of awareness, understanding and commitment to improvement. There have been positive responses and enthusiasm from the utilities' management teams, a sign of a strong will and commitment to the program.

The audit process has identified some key challenges - institutional, technical and commercial – but it has also identified some key responses and some good solutions for addressing the challenges. This has in part been due to an AfWA NRW Task Force facilitator being engaged on the audit programme, and having a mentoring role as well as an auditing one, assisting the utility to make decisions on the priorities for action, and the tasks to be carried forward to the PIP.

ANNEXES

A: Example Utility Self-Assessment Matrix

B: List of all Participating Utilities

C: Example Utility Fact Sheet

D: Example Utility Performance Improvement Plan

E: Example Utility Audit Report

F: Funding Support Mechanisms and Partners

Annex A: UTILITY SELF-ASSESSMENT MATRIX

	Level / Issues questions	1 Basic	2	3	4	5 High
1 Water Balance, Flow and Pressure Monitoring, Mapping						
1.1	**Water Balance**	We do not establish a water balance	We have tried to establish a water balance but gave up since we don't know the split in physical and commercial losses	We establish a water balance following our own format	We establish an annual water balance in accordance with the international form	We establish an annual water balance in accordance with the international form and also use 95% confidence limits to indicate accuracy bands.
1.2	**System Input Metering**	Most of our system input is not metered	Not all, but > 50% of our system input is metered	Our system input is metered but we are not sure about the accuracy of these (partly old) meters	Our system input is metered with mechanical and/or magnetic flow meters that are rarely calibrated	Our system input is metered with magnetic flow meters that are regularly calibrated
1.3	**Pressure Monitoring**	We do not have any pressure recorders installed	We have a few pressure recorders at pumping stations and treatment plants installed	We have a few pressure recorders at pumping stations and treatment plants installed and sporadically measure pressure in the distribution network with pressure gauges	We have a few pressure recorders at pumping station and treatment plants and sporadically measure pressure in the distribution network with pressure loggers	We have permanently installed pressure loggers and continuously monitor pressure in the distribution network

	level / Issues questions	1 Basic	2	3	4	5 High
1.4	**Maps/GIS**	We do not have maps at all	The maps we have are not updated	We have started to update our maps	Our maps are updated but do not include GIS	We use GIS based on updated maps
2 Leak Repair Records						
2.1	**Leak Repair Records**	We have no records of leak repairs	The only way to know the number of leaks repaired is to look into the customer complaints book	We keep basic leak repair records that only tell us whether the leak was on a main pipe or a service connection	We keep detailed records that indicate location, pipe diameter, material and type of leak as well date of detection and date and duration of repair	We keep detailed records that indicate location, pipe diameter, material and type of leak as well date of detection and date and duration of repair and have linked this to our GIS
3 Performance Indicators						
3.1	**Performance Indicators**	The only PI used is % NRW	We have tried to calculate water loss performance indicators	We regularly calculate physical loss performance indicators	We regularly calculate physical and commercial loss performance indicators	We regularly calculate physical and commercial loss performance indicators and publish them in our annual report
4 Active leakage control						
4.1	**Active leakage control**	We only repair visible leaks.	We have leak detection equipment but we do not use it.	We do leak detection occasionally if there is a specific problem in an area.	We have started to do regular leak surveys.	We cover the network by leakage survey at least once a year.

	Level / questions Issues	1 Basic	2	3	4	5 High
4.2	**District Meter Areas (DMAs)**	We have no DMAs and have no plans to establish DMAs	We have started to establish the first DMAs	The first DMAs are established and we have already the first results	We have several DMAs and check and analyse inflow data sporadically	We have several DMAs and monitor flow and pressure on a regular basis
4.3	**Leak Repair - Distribution Pipes(Repair Time)**	We have no records and therefore don't know how fast our leaks repaired	Our average repair time is more than 7 days	Our average repair time is between 7 and 3 days	Our average repair time is between 3 and 1.5 days	Our average repair time is less than 1.5 days
4.4	**Leak Repair - House Connections**	We have no records and therefore don't know how fast our leaks repaired	Our average repair time is more than 14 days	Our average repair time is between 14 and 7 days	Our average repair time is between 7 and 2 days	Our average repair time is less than 2 days
5 Customer Metering						
5.1	**Customer Metering**	We have no customer metering	Only large customers are metered	We have started with universal customer meters but at present not all customers have meters installed	Nearly all of our customers are metered, except public fountains, stand pies and similar.	100% of our customers are metered
5.2	**Customer Meter Replacement and Age**	We have no reliable information on the age of our customer meters	Many of our customer meters are older than 10 years, we have not yet introduced a regular replacement policy	We only change meters if they are obviously not functioning anymore	We have a meter replacement policy but have not been able to change all meters so some of our customer meters are still older than 10 years	We strictly follow our customer meter replacement policy and replace ALL meters every 5 - 7 years

	Level / Issues questions	1 Basic	2	3	4	5 High
5.3	**Customer Meter Class**	All customer meters are class B	All customer meters are Class B and C	All customer meters are class C	All customer meters are Class C and D	All customer meters are class D
5.4	**Customer Database**	Our customer database has not been updated for a long time	We sporadically update our customer database	We are in the process of updating our customer database	We regularly update our customer database by house to house surveys and checks	We have an updated customer data base that is linked to the GIS.
5.5	**Customer Meter Reading**	We have no special system of controlling meter readers	We only rotate meter readers if we are suspicious of inaccuracies	We regularly rotate meter readers	We regularly rotate meter readers and make often spot checks	Our meter readers use handheld meter reading devices
5.6	**Illegal Connections, meter tampering, bypasses**	We have not made any assessment and have no program to deal with water theft	We occasionally detect illegal connections	We occasionally detect illegal connections and other forms of fraud	We have a thorough illegal connection detection program	We have a thorough illegal connection detection program and also try to identify bypasses

ANNEX B: PARTICIPATING COUNTRIES AND UTILITIES

Table 1. AfWA-USAID FABRI NRW Program: Countries, Utilities, and Task Force Members

Country	Utility	TF Member
Benin	Societe Nationale des Eaux du Benin – SONEB	Jean Michel Klican
Burkina Faso	Office National de l'Eau et de l'Assainissement – ONEA	Moumouni Sawadogo
Cameroon	Camerounaise Des Eaux – CDE	Lahcen Iderdar
Chad	Société Tchadienne des Eaux- STE	
Cote d'Ivoire	Cote d'Ivoire Water Distribution Company – SODECI	Vincent Gnalla Olivier Gosso
Gabon	Société d'Eau et Electricité du Gabon – SEEG	Alain Bilong Atsame
Ghana	Ghana Urban Water Company LTD – GUWCL	Cephas Oguah (Chair)
Guinea	Water Company of Guinea – SEG	
Kenya	Kisumu Water and Sewerage Company LTD – KIWASCO	David Onyango
Kenya	Nairobi City Water and Sewerage Company LTD – NCWSC	John Ruhiu
Malawi	Northern Region Water Board – NRWB	
Nigeria	Bauchi State Water Board – Bauchi	
Nigeria	Benue State Water Board – Benue	
Uganda	National Water & Sewerage Corporation – NWSC	Kiwanuka Sonko Mahmood Lutaaya
Senegal	Senegal Des Eaux – SDE	Dierry Ba
Swaziland	Swaziland Water Services Corporation (SWSC)	Peter Bhembe Malusi Dlamini
Togo	Societe Togolaise des Eaux – TDE	
Zambia	North Western Water & Sewerage Company – Zambia	
Zambia	Lukanga Water and Sewerage Company Ltd – LWSC	

Annex C. SWSC Fact Sheet

1.	**General Information**						
	Utility Full Name: *Swaziland Water Services Corporation*			Country: *Swaziland*			
	Ownership: *Government*			Coverage: *National*			
	Number of towns served (for National/regional) Four regions **(4)**, twenty one **(21)** towns			Name of project area: *Mbabane-Manzini Corridor*			
	Type of service provided: *Water and sewerage services*			[redacted]			
	Is there a separate oversight regulatory agency?			YES	NO		
2.	**Technical information**						
	Population in the service area: 234 000 (number of connections multiplied by 6, average population per connection)			Water service coverage: 95 *(%)*			
	Annual Volume of water produced (m^3): 19 186 817 m^3			Number of water connections:	Total: 40 136 Active: 36 792 Inactive: 3 344		
	Total Water Network Length (km): 734 km			Number of employees: 538			
	Average hours of supply per day: 24 hours			Water treatment plant capacity utilization: 94%			
3.	**Financial information**						
	[redacted]						
4.	**NRW Management**						
	Non-revenue water	6 614 691 m^3 34%	m^3 %	Is the network zoned into DMAs?	YES	NO	
	Is water produced metered?	YES	NO	Customer metering coverage ratio:	100%		
	Are production meters regularly calibrated	YES	NO	Is there a customer meter testing and replacement program?	YES	NO	
	Is there a functional NRW Department/Unit	YES	NO	Is there a pro-active illegal use investigation program?	YES	NO	
	Is the network pressure measured on regular basis?	YES	NO	Are there pressure reducing valves (PRVs) in the network?	YES	NO	
	Are there leak detection equipment?	YES	NO	Is Active Leakage Control practiced (searching for invisible leaks)?	YES	NO	
	Is there an asset management plan?	YES	NO	Is there an information management system for capturing and managing data on leaks, response time and customer complaints?	YES	NO	
	Are annual water audits conducted:	YES	NO	Is there an established water balance	YES	NO	

ANNEX D

AFRICA NON-REVENUE WATER PROGRAM PERFORMANCE IMPROVEMENT PLAN

KISUMU WATER AND SEWERAGE COMPANY LTD. (KIWASCO)

AUGUST 2014

AFRICAN WATER ASSOCIATION (AfWA) AND

USAID FURTHER ADVANCING THE BLUE REVOLUTION INITIATIVE (FABRI)

DISCLAIMER

The authors' views expressed in this publication do not necessarily reflect the views of the United States Agency for International Development or the United States Government.

CONTENTS

TABLES

ACRONYMS AND ABBREVIATIONS

AfWA	African Water Association
DMA	District Metered Area
DMM	Delegated Management Model
FABRI	Further Advancing the Blue Revolution Initative
FY	Financial Year
GIS	Geographic Information System
IT	Information Technology
KIWASCO	Kisumu Water and Sewerage Company
KPI	Key Performance Indicator
KShs	Kenya Shillings
LVSWSB	Lake Victoria South Water Services Board
MD	Managing Director
MIS	Management Information System
MMS	Meter Management System
NRW	Non-Revenue Water
O&M	Operations and Maintenance
PIP	Performance Improvement Plan
PRV	Pressure Reducing Valves
SIV	System Input Volume
SWOT	Strengths, Weaknesses, Opportunities, and Threats
UARL	Unavoidable Annual Real Losses
USAID	United States Agency for International Development
WSRB	Water Services Regulatory Board
WTP	Water Treatment Plant

EXECUTIVE SUMMARY

Background: This Non Revenue Water (NRW) Performance Improvement Plan (PIP) for Kisumu Water and Sewerage Company (KIWASCO) has been prepared in line with the recommendations of the system audits carried out by the AfWA/FABRI team. The program is to run for 3-5 years.

The PIP will require support under FABRI program to implement the key plans under it.

This PIP aims to provide an operations platform for improving the achievement of the corporate strategic themes and objectives that target NRW management. The implementation of the PIP will mainly contribute to the achievement of the Corporate Strategic Objectives number 1 and number 7, which are:

a) Objective 1: To ensure operational efficiency and institutional strengthening. This includes reducing NRW through technical means.

b) Objective 7: To achieve operational financial sustainability by revamping activities to reduce NRW amongst other strategies.

Objectives: This PIP's main Objective with reference to the 2012 AfWA/FABRI audit report is to develop a strategy for reducing Non-Revenue Water to below 35% by 2016 in line with the company's strategic plan. This is to be achieved through improvement of the technical operations, commercial operations and institutional management.

This report is intended to help KIWASCO approach partners/funding agencies to fund these key aspects that would assist KIWASCO transform its operations by launching on the path of continuous NRW reduction. The report has been prepared based on assessment of external experts audit of NRW in KIWASCO.

Description: NRW is a problem of utilities world wide, but is more pronounced in the utilities in developing countries. The high NRW is attributed to leakages, water theft and billing problems. High rates of NRW significantly reduce the amount of water available for use and hence the financial viability of the utility due to lost revenue and increased operational costs. NRW also reduces the utility's capacity to fund service expansion. Managing NRW is therefore a priority for many utilities. The resources for the required intervention however remain a challenge.

The methodology and approach adopted in dealing with the problem was to conduct a thorough study of the problem and prescribe the appropriate intervention depending on the outcomes.

Using a condensed fact sheet that gives key technical, financial and NRW management information, the auditors were able to plan the audit in a systematic way

The water loss assessment was carried out using Easy Calc Water Balance Tool. Easy Calc is a conventional spreadsheet that is used to derive water losses. Using a top-down approach based on data gathered from the utility's records.

The methodology provides a list of indicators that have been accepted immediately as the best practice and hence applied widely.

1 INTRODUCTION

1.1 Non-Revenue Water Program

This Performance Improvement and Non-Revenue Water (NRW) Reduction Action Plan (PINRAP) for the Kisumu Water and Sewerage Company (KIWASCO) has been prepared in line with the framework of the African Water Association (AfWA) and United States Agency for International Development (USAID)'s Further Advancing the Blue Revolution Initiative (FABRI) partnership. The PINRAP is one of the means of improving KIWASCO's performance with particular focus on NRW reduction. The PINRAP is to run for a four-year period (Jul 2014 – June 2018).

NRW is a major problem for water utilities worldwide and especially in the developing countries. According to the World Bank study, nearly 45 million m^3 of water is lost daily as leakage (enough to serve nearly 200 million people) in the developing countries and close to 30 million m^3 of water is delivered everyday to customers but not paid for due to metering inaccuracies, theft and corrupt utility employees, costing water utilities about US $6 billion every year (World Bank, 2006).

In Africa, NRW figures ranging from 5% (Saldanha Bay, South Africa) to 70% (LWSC, Liberia) have been reported.

The NRW problem is likely to be compounded by the diminishing water resources, increasing costs of producing water, high rate of infrastructure deterioration, inadequate investment budgets, and increasing global change pressures (urbanization, climate change, population growth). Water utilities are under increasing scrutiny to use water resources more efficiently by reducing water losses in their distribution systems and ensure sustainable service delivery.

To support African water utilities tackle these increasing challenges, AfWA in partnership with the USAID - FABRI embarked on a four-year joint program (2012-2015) to reduce NRW. The program covers 19 utilities in 16 countries in east, central, southern, and West Africa. The NRW program aimed at introducing management and technical tools and systems that will enable water utilities – both national water boards and state and city entities – to reduce water losses. The program has three phases: 1) audit, 2) PIP development and implementation, and 3) monitoring and evaluation. One unique aspect of the NRW program is the involvement of AfWA and the utilities in the day-to-day management and guidance of the program and well as development and implementation of the tools and systems.

KIWASCO is one of the beneficiary utilities under the AfWA-FABRI NRW program and the PINRAP is part of the second phase of the program and one of the means of improving KIWASCO's performance with particular focus on reducing NRW.

1.2 Kisumu Water and Sewerage Company

KIWASCO is a limited liability company. It was formed in July 2003 after transformation of the Water and Sewerage Department of the Kisumu Municipal Council. KIWASCO serves slightly more than 297 Km^2. 238 $Km^2$of its service area is peri-urban and 59 Km^2 is urban. Kisumu's population was estimated at 460,000 (as of 2010) with a projected annual population growth rate of 4%. The service coverage of KIWASCO in Kisumu is estimated at about 60%. Kisumu being at the confluence of various trading routes, its population is estimated to be 1 million.

KIWASCO's performance parameters are set out in the National Water Service Strategy, Millennium Development Goals and Targets, License issued by the Water Services Regulatory Board (WSRB) as well as the performance contracts signed between Lake Victoria South Water Services Board (LVSWSB) and KIWASCO. The performance parameters include the following:

- Strengthening the institution and building the capacity of KIWASCO
- Providing water and sewerage services in an efficient, effective, affordable and sustainable manner
- Increasing access and availability of water and sewerage services within KIWASCO's area of jurisdiction
- Enhancing the financial sustainability of KIWASCO
- Strengthening KIWASCO's communication with stakeholders
- Mainstreaming good corporate governance, gender, and HIV/AIDS awareness campaign in all KIWASCO's core activities.

From the broad performance parameters, KIWASCO developed seven strategic objectives for 2012-2016. Two of these strategic objectives, number two and number seven, address the management of NRW.

This PIP is focused on improved operation with the focus of managing NRW through the technical and commercial approaches and institutional strengthening.

1.3 Description of the Area

The utility capacity and profile for NRW management was summarized and presented in a utility fact sheet, Table 1 below. The fact sheet presents in a condensed form the key technical, financial and NRW management information. The information was used to assess the water use and loss in the utility, commercial and operational practices and institutional structures.

Table 1. KIWASCO Fact Sheet

General Information			
Utility name:	**Kisumu Water and Sewerage Company Limited**	Country:	**Kenya**
Ownership (private/government/municipality/jointly owned govt/private):	**Government/city council**	Coverage (national/regional/municipal/city wide/other):	**City of Kisumu and environs**
Number of towns served (if national/regional):	**One**	Project area:	**Kisumu City**
Type of service provided:	**Water and sewerage services**	Is there a separate oversight regulatory agency?	**Yes**
Year utility established:	**2003**	If yes, agency name:	**WASREB**
Technical Information			
Service area population:	**500,000**	Water service coverage:	**50%**
Annual volume of water produced (m^3):	**10,950,000**	Number of water connections:	Total: **19,459**
Total water network length (km):	**365**		Active: **14,490**
Average hours of supply per day:	**23**		Inactive: **4,969**
Water treatment plant capacity utilization:	**70%**	Number of employees:	Permanent:**122**
			Temporary: **172**
Financial Information			
Total annual revenue:	Local currency:**397,346, 548**	Unit revenue (average tariff):	Local currency: **Kshs.83/m^3**
	USD: **4,535,920**		USD/m^3: **0.95**
Unit cost of production:	Local currency: **Kshs.86.02/m^3**	Collection ratio:	**93%**
	USD/m^3: **0.98**	Operating cost recovery ratio:	**100%**
NRW Management			
NRW	**5,669,910 m^3**	Is the network zoned into DMAs?	**Yes, one pilot DMA**
	51.78%	Customer metering coverage ratio:	**100%**
Is water produced metered?	**Yes**	Is there a customer meter testing and replacement program?	**Yes**
Are production meters regularly calibrated?	**Yes, but not regularly**	Is there a pro-active illegal use investigation program?	**Yes**
Is there a functional NRW department/unit?	**Yes, unit**	Are there pressure reducing valves (PRVs) in the network?	**No**
Is the network pressure measured on a regular basis?	**Yes, but not regularly**	Is active leakage control practiced (searching for invisible leaks)?	**Yes, but not regularly**
Is there leak detection equipment?	**Yes**	Is there an information management system for capturing and managing data on leaks, response time and customer	**No**

		complaints?	
Is there an asset management plan?	**No**	Is there an established water balance?	**Yes**
Are annual water audits conducted?	**No**		

1.4 Scope and Purpose of the Performance Improvement Plan (PIP)

This PIP aims to provide an operations platform for improving the achievement of the corporate strategic themes and objectives that target NRW management. The implementation of the PIP will mainly contribute to the achievement of the corporate strategic objectives number one and seven, which are:

Objective 1: To ensure operational efficiency and institutional strengthening. This includes reducing NRW through technical means.

Objective 7: To achieve operational financial sustainability by revamping activities to reduce NRW amongst other strategies.

This PIP's main objective with reference to the 2012 AfWA/FABRI audit report is to develop a strategy for reducing NRW to below 35% by 2016, in line with the company's strategic plan. This is to be achieved through improvement of the technical operations, commercial operations and institutional management. This report is intended to help KIWASCO approach partners/funding agencies to fund these key aspects that would assist KIWASCO transform its operations by launching on the path of continuous NRW reduction. The report has been prepared based on assessment of external experts audit of NRW in KIWASCO.

1.5 Methodology for PIP Preparations

NRW is a problem of utilities worldwide, but is more pronounced in the utilities in developing countries. The high NRW is attributed to leakages, water theft and billing problems. High rates of NRW significantly reduce the amount of water available for use and hence the financial viability of the utility due to lost revenue and increased operational costs. NRW also reduces the utility's capacity to fund service expansion. Managing NRW is therefore a priority for many utilities. The resources for the required intervention, however, remain a challenge.

The methodology and approach adopted in dealing with the problem was to conduct a thorough study of the problem and prescribe the appropriate intervention depending on the outcomes.

Using a condensed fact sheet that gives key technical, financial and NRW management information, the auditors were able to plan the audit in a systematic way.

The water loss assessment was carried out using the Easy Calc Water Balance Tool. Easy Calc is a conventional spreadsheet that is used to derive water losses. Using a top-down approach based on data gathered from the utility's records.

The methodology provides a list of indicators that have been accepted immediately as the best practice and hence applied widely.

2 SITUATIONAL ANALYSIS

This chapter presents key audit findings focusing on institutional, technical and commercial operations, measurement and management information systems related to NRW.

2.1 Diagnostic Audit Findings

The AfWA/FABRI team's key performance findings focused on institutional performance, commercial prcesses and technical processes that influence NRW.

Institutional Performance

The institutional performance in terms of administrative organization is as follows:

- The company has documented systems and procedures
- The company's board and management are committed to reducing NRW to below 35%
- The new NRW unit needs capacity building in terms of skill development and necessary equipment
- The company lacks digital management information system (MIS)
- The middle management has a weak skill base

Technical Operations

The findings on the technical operations included:

- Poor workmanship and aged infrastructure were the main causes of physical losses
- Invisible leaks were not detected due to lack of equipment
- Water reservoirs need monitoring with appropriate water level indicators
- DMA piloting is ongoing in the supply system
- No proper pressure management system in place
- Insufficient mains replacement annually (less than 1%)
- Asset registration and documentation (especially using software like GIS) is not done
- No hydraulic models of the network
- No asset management strategy

Commercial Operations

Commercial operations impacting NRW include, but are not limited to:

- Lack of a robust billing software to relate all customers data
- Illegal consumptions are found in the long-term disconnected accounts
- There is not adequate data for on-site customer location, i.e. meter location and the plot numbers
- Customer-care and complaint handling are not adequate (especially need for establishment of toll free line and customer relations management software)

- Meter management practices are not adequate as there is lack of a test bench and equipment for on-site testing.

2.2 Audit Recommendations

Water audit is an effective tool of evaluating water losses in systems with a view to establishing the level of loss and identifying the areas where losses occur. The baseline water balance indicated high levels of NRW at 53% of system input volume (SIV). This strongly indicates poor conditions of the network and inadequate asset management practices. Following from the above observation, it would be prudent to do the following:

- Fully operationalize meter management policy including acquisition of meter management software and test bench
- Calibrate master meters regularly to accurately ascertain system volume
- Formulate and operationalize a pressure management strategy including installation of pressure loggers, flow data loggers, install PRVs
- Hydraulically zone the network and develop a hydraulic model and load on Geographic Information Systems (GIS) and install DMA
- Acquire modern meter reading gadgets, including a modern billing software
- Control valves identification and protection
- Install a Delegated Management Model (MMS) for proper record keeping that would help in building a credible water balance.
- Acquire leak detection equipment
- Builid capacity of technical and commercial staff, especially foremen, supervisors and zonal managers on the best practices of water loss reduction techniques
- Control valve identification servicing and protection
- Replace the dilapidated water lines

2.3 Strengths, Weaknesses, Opportunities, and Threats Analysis

The strengths, weaknesses, opportunities, and threats (SWOT) analysis table below providesan overview of the internal and external environment in which KIWASCO operates.

Table 2. SWOT Analysis

Strengths	• Readily available materials • Good knowledge of pipe diameter, age lengths • 100% customer metering • Innovative pro-poor approach • All customer connected • Receive 24 hours supply • Well trained senior staff • Information on illegal activities are available • Repair scouts exist • Proper operational structures	**Weaknesses**	• Errors in data acquisition • Pipeline data not up to date • Network not digitized in GIS • System meters have errors • Large customer meters have errors • System pressures not measured • Repairs are only on visible leaks • Old pipeline that give in to high pressures
Opportunities	• Expansion of the treatment plant • Construction of trunk mains and reservoirs • Trying DMA pilot • Increasing demand • Expansion of service to entire county • Capacity building of staff and institutional strengthening	**Threats**	• Power outages are frequent • Inadequate network control • Sub-surface leaks • Encroachment on pipeline way-leaves by private developers • Overflows at reservoirs due to lack of controls • Vandalism, meter theft and destruction of pipeline by road contractors

3 PERFORMANCE IMPROVEMENT PLAN OBJECTIVES AND TARGETS

3.1 Performance Objectives

The overall objective of the PINRAP is to reduce NRW and hence contribute to the improvement in the operational and financial performance of KIWASCO. The specific objectives include; (a) institutional strengthening, (b) asset management and operations and maintenance (O&M) improvement, (c) commercial operations improvement, (d) measurement and MIS strengthening, and (e) financial management improvement. The objectives and the attendant goals are detailed as follows:

Table 3. Performance Objectives

Objective 1: Institutional Strengthening
Establish and maintain a rationalized, well-trained, productive and motivated workforce
Elevate the profile of NRW management and establish dedicated NRW unit
Enhance institutional coordination and stakeholder involvement in NRW reduction
Ensure that law enforcement is more effective
Enhance NRW performance accountability
Objective 2: Asset Management and O&M Improvement
Improve service reliability and coverage
Establish a comprehensive asset managment system
Develop and implement asset renew programs
Establish hydraulic zones and District Meter Areas
Reduce physical losses
Objective 3: Commercial Operations Improvement
Streamline commercial systems and procedure
Reduce commercial losses
Validate and clean customer data
Enhance public awareness and collaboration with stakeholders
Objective 4: Measurement and MIS Strengthening
Enhance NRW data reliability and accuracy
Enhance IT Solutions and Systems Applications
Establish decision support systems
Integrate information management systems
Objective 5: Financial Management Improvement
Increase revenue
Optimiaze costs
Streamline financial management systems
Mobilize investment financing

3.2 Performance Targets and Key Assumptions

Over the period of the PIP implementation, the main tool for monitoring and evaluating the overall performance of the action items is through the key performance indicators *(KPI).* These indicators, with their ultimate targets are shown in the table below. Note that these are moving performance targets.

Table 4. Key Performance Targets

Goal Description – Indicator	Base Performance (April 2014)	PIP Targets (June 2016)
Non-Revenue Water (NRW) (%)	45	35
General NRW KPI's		
Water produced (m^3/Month)	19,756,038	29,634,057
Water sold (m^3/Month)	10,521,234	19,262,137
NRW (%)	45	35
Billed revenue – sales (*1000 KES)	33,963,563	79,945,772
Revenue collection efficiency (%)	93	96
Data Handling Customer Accountability		
Number of meters read	17,633	31,338
Percentage of meters read (%)	100	100
Number of meters gate-locked (unread)	131	100
Percentage of connections gate-locked (%)	1	<1
Billing Process Data Errors		
Number of metered connections	17,633	31,338
Number of sampled readings	750	1000
Number of sampled readings incorrect	75	100
Incorrect meter readings (%)	10	1
Unauthorized Consumption I		
Number of meters reversed	261	88
Number of meters tampered with	319	106
Number of meter by-passes	174	58
Number of illegal connections (not yet registered)	145	100
Number of illegal cases investigated & confirmed	899	300
Unauthorized Consumption II		
Illegal consumption cases/active connections (%)	5	2
Number of disconnected/dormant connections	6,854	500
Number of disconnected/dormant connections inspected	1317	600
Fines levied from illegal cases (*1000 KES)	400,000	732,314
Fines paid (*1000 KES)	300,000	732,314
Customer Meter Accuracy I		

Metering ratio (%)	100	100
Number of meters tested	300	1570
Number of faulty meters detected and/or reported	450	450
Meters under-registering > 5% (at low flows) (%)	5	1
Meters over-registering (%)	3	0
Customer Meter Accuracy II		
Number of static meters	450	100
Number of (static/over/under-registering) meters serviced	450	50
Number of (static/over/under-registering) meters replaced	99	50
Metered connections for which the meter was serviced or replaced (%)	100	100
Number of stolen meters	43	2 0
Active Leak Detection		
Km's of 20'', 16'', 14'' and 12'' completed (Km)	6.5	100
Number of leaks detected 12''-20''	3	20
< 12'' (up to 4'') completed (Km)	30	80
Number of leaks detected < 12''	600	400
Pipeline Management and Maintenance		
Number of isolated DMAs (with a water balance)	2	15
All district meters calibrated in the last 6 months (yes=1, no=0)	1	1
Number of leak locations recorded with GPS in GIS	0	500
Speed and Quality of Repairs		
Number of leaks and bursts reported (total)	800	500
Number of leaks and bursts repaired (total)	800	500
Average stoppage time (hours)	1	0.5
Average repair time (hours)	6	4
Pressure Management		
Number of sampled points for low pressure	5	15
Points with pressure levels < 1 bar (%)	2	0
Asset Renewal		
Length of pipelines renewed (Km)	6	20

**Moving target to 35% or below by 2016 June*

4 PERFORMANCE IMPROVEMENT STRATEGIES AND ACTION PLAN

4.1 Institutional Strengthening

Table 5. Action Plan for Institutional Strengthening

Goal	Strategic Actions	Due Date	Funding Source and Cost		
			Utility	Gov't	External
Engage public on utility management	Empower public on knowledge of their water rights, roles in illegal consumption control	DECEMBER 2015			
	Investigate, confirm and publicize customers consuming water illegally	JUNE 2015			
	Develop consumer guide books on customer-relations based info., NRW management and other roles of the public	JUNE 2017			
Improve efficiency in the NRW Management team	Provide transportation and tools essential for the NRW management team	JUNE 2015			
	Recruit the Leak detection and control Technician and strengthen team	DECEMBER 2014			
Capacity building staff for better performance	Undertake training on hydraulic modeling	JULY 2015			
	Meter management training for supervisory team	JUNE 2015			
	Undertake training on asset management tool	AUGUST 2015			
	Train the customer-care and field staff on customer handling and data management	FEBRUARY 2015			
	Hold a workshop on metering policy and standards of metering processes	DECEMBER 2015			
	Undertake training for O&M Team on data management	JANUARY 2015			
	Exposure visit and Training of Trainers on NRW Management and best practices (to Nyeri preferably)	JUNE 2015			
	Organize a NRW Workshop for field operatives - NRW Management and best practices	JUNE 2015			
Develop and actualize operations documentation	Develop manual of NRW Management and implement	DECEMBER 2015			
	Review the current NRW strategies and streamline with the NRW Management manual	AUGUST 2015			

	Develop NRW Management standard procedures	AUGUST 2015			
	Review current standard operating procedures for metering, new connections and O&M teams	DECEMBER 2015			
	Capacity build the leak detection team through training and exposure in peer companies	MARCH 2015			

4.2 Asset Management and O&M Improvement

Table 6. Action Plan for Asset Mangement and O&M Improvement

Goal	Strategic Actions	Due Date	Funding Source and Cost		
			Utility	Gov't	External
Quality assurance in mensuration of productions	Procure and install EMF Meters for 14", 24" and 6" Kajulu lines	JUNE 2016			
	Undertake calibration of all bulk meters	DECEMBER 2016			
	Install bulk meters to isolate 10No. zones (2@ zone for 5No. zones) within the supply area	JUNE 2015			
	Undertake NRW Activities to clean up the district areas	JUNE 2016			
	Implement the caretaker approach to district areas	JUNE 2016			
Pressure management, supply network rationalization	Procure and install pressure gauges and data loggers in the network	JUNE 2015			
	Procure and install Reservoir Level Indicators	DECEMBER 2015			
	Undertake hydraulic modelling	JUNE 2015			
	Real time management of pressures and reservoir levels within the networks	DECEMBER 2015			
Network infrastructure fortification and/or improvement, apparent water loss management	Demarcate hydraulic boundaries (through hydraulic modeling)	JUNE 2016			
	Undertake an audit of all connections along the main trunk pipe lines	JUNE 2017			
	Pilot introduction of HDPE pipes in the network	DECEMBER 2014			
	Procure an Asset Management tool	JUNE 2015			
	Asset renewal – carry out overhauls of the network as identified from O&M teams operations	JUNE 2017			

	Procure, install, and train on Arc-GIS software, Hydraulic Modelling software and accessories WaterCAD, AutoCAD Civil 3D + 3No. procure High-Performance Computers with back-up – preferably central server for technical operations	DECEMBER 2015			

4.3 Commercial Operations Improvement

Table 7. Action Plan for Commercial Operations Improvement

Goal	Strategic Actions	Due Date	Funding Source and Cost		
			Utility	Gov't	External
Accounts verification and system clean-up, strengthening metering controls integrity	Thorough audit of all accounts in supply system (incl. Fire hydrants, council markets etc.)	JUNE 2015			
	Acquisition of special seals for special accounts especially Delegated Management Model (DMM) Kiosks	JUNE 2015			
	Massive testing and overhaul of faulty and inactive/underactive meters	DECEMBER 2015			
	Install seals on all unsealed meters, develop controls on meter handling and seal requirements	JUNE 2015			
	Review of current metering policy, develop a metering plan/ management schedule	JUNE 2015			
Rationalization of metering (integrated meter management)	Carry out a rapid metering study to identify the most suitable metering technologies & specs for KIWASCO, recommend	JUNE 2015			
	Procure and put in place a meter management software	DECEMBER 2015			
	Acquire a meter test bench, furnish meter management team with appropriate tools, training	JUNE 2015			
Secure metering unit, engage consumers in management	Introduce built chambers for meters for new customers (PILOT)	JUNE 2015			
	Customer-based security of metering units intensify public vigilance on meter security	JUNE 2015			

4.4 Management Information Systems Strengthening

Table 8. Action Plan for Management Information Systems Strengthening

Goal	Strategic Actions	Due Date	Funding Source and Cost		
			Utility	Gov't	External
Billing system management	Billing system clean up – based on consumer accounts audits	DECEMBER 2015			
	Software upgrade in the billing system	DECEMBER 2015			
	Activate inactive analytical applications in billing system	DECEMBER 2015			
Data entry, control and operations management	Review data flow criteria for leak detection and management (ALR chain)	JUNE 2015			
	Train staff on data entries and authentication (especially customer-care and the field staff)	JUNE 2015			
	Put in place working orders and check systems for operations; Develop standard electronic dashboard for all reports and actions (time-based work orders)	DECEMBER 2015			

4.5 Financial Management Improvement

Table 9. Action Plan for Financial Management Improvement

Goal	Strategic Actions	Due Date	Funding Source and Cost		
			Utility	Gov't	External
Expenditure controls – esp. O&M, New Connections and other field-based operations	Establish a break-down of expenditure requirement on tools and equipment (Sectional-based)	JUNE 2015			
	Establish inventory of purchases, orders and expenses on specific equipment and materials (cash flows based on the specific LPOs and LSOs)	DECEMBER 2015			
Financial planning and control	Budgetary allocation on activities as per approved budgets (based on the planned and approved activities)	DECEMBER 2015			
	Develop measures and controls on vote-heads based on departmental voteheads	DECEMBER 2015			
	Automation of finance controls	DECEMBER 2016			

**NOTE: See appendix for cost breakdown*

4.6 Capacity Building

Capacity building of staff in the company is as important as upgrade of technical operation systems. It ensures that the staff members are up to date and more relevant to the day-to-day challenges the utility faces in its operations. The interest of the company is always on the "experienced' personnel, forgetting the potential minds in the midst of them all. The potential is only exploded with capacity building opportunities for the staff.

Status. Staff in KIWASCO, having undergone a number of trainings and job-based workshops, there is a certainty that a sense of direction is evident. With the amount of exposure to technical managerial skills, the ground has been set well for the instilling NRW Management knowledge to the staff. Communication has been made of the importance of company-wise management of NRW as an obligation to all than to an individual.

Impact on NRW Reduction.With a number trainings/capacity building sessions of staff in NRW management and related fields done to ingrain the sense of responsibility in staff, the impact of their efforts is always effective and longer-lasting than most. There is also an opportunity to inculcate the sense of oneness with such that inferiority or superiority complex problems are done away with during trouble shooting for NRW solutions.

Responsibility. The responsibility for training and capacity building lies with the Head of Human Resources and Administration.

Activities. The activities with the aim of developing the capacity of the staff to exploitable levels are as tabled below:

- Develop manual of NRW Management and implement
- Undertake meter management training for meter management team leadership
- Organize a workshop on metering policies and "standard meter processing"
- Undertake training for O&M Team on data management
- Train the trainers on NRW management and best practices
- Organize a NRW workshop for field operatives – NRW management and best practices

4.7 Asset Management and O&M

Active Leak Detection and Control

Active leak detection and control is a very crucial part of NRW management. This is the only way of managing technical losses to the unavoidable annual real losses (UARL) level. It is therefore very necessary to invest in an active detection and control team in the company. The formation and equipping of the team allows it to undertake prioritized overhauls, etc.

Status. KIWASCO at the moment does not have a stable active leak detection and control sub-unit. There only exists the scouting team (one per zone). This is not sufficient in helping the company focus on its main goal, long-term detection and control activities.

Impact on NRW Reduction.The impact of active leak detection and control in the company is long-term and is effective in NRW management. Significant changes made by Active Leak Detection and control leave long-lasting impression of stability in leakage occurrence in the supply network.

Responsibility. The company has embarked on ensuring that there is a functional active leak detection and control unit to detect and control especially underground leaks.

Activities. Below are the different activities that will be undertaken to enable the company to achieve its goals of managing NRW through active leak detection and control to the minimum UARL:

- Establish an quick-response team from off-duty times
- Transport and logistical facilitation for the quick-response team
- Undertake an audit of all connections along the old pipe lines (with active leak detection)
- Re-establish the active leak detection wing of the NRW unit (fully operational with personnel)
- Establish an active leak detection and control plan
- Build capacity of the leak detection team through training and exposure to peer companies
- Publicize KIWASCO telephone lines and other communication lines for the public to report leaks and bursts, establish feedback and acknowledgement mechanisms

Hydraulic Zoning

Currently, KIWASCO has committed to managing NRW through localization of Losses in the supply system. With this in mind, the company has piloted NRW with assistance from partners. The company is now ready to roll out the realizations from the pilot in the entire network beginning with selected areas. This is a slight challenge due to the limited funds and staff. It therefore envisages undertaking this noble activity both with internal resources and willing partners.

Status. There are currently two DMA's in the network fully operational. Apart from about four major DMM areas, the company has set off to isolating other four sub-zones in the supply network.

Impact on NRW Reduction.The DMA's helps the company to have a focused way of handling NRW through localization and addressing the problem in parts and having confidence in the expected results.

Responsibility. KIWASCO is committed to redesign its supply by removing spaghettis and realigning supply lines in terms of hydraulic capacities and consumption regimes.

Activities.The hydraulic zoning of the supply areas will be undertaken in the following ways as tabulated below:

- Complete ongoing GIS mapping with the O&M team
- Procure hydraulic modeling tools

- Procure three computers and software including WaterCAD, AutoCAD, and Civil 3D.
- Capacity building/training of staff on hydraulic modeling
- Hydraulic re-design the supply network system
- Develop hydraulic zones
- Develop district metered areas within the five supply zones (two per zone)

Asset Management System

An asset management system is best for keeping the company assets in check. It assists the company prioritize on the asset replacement especially the network maintenance/overhauls and pumps and their members. The asset management system creates an atmosphere of preventive maintenance rather than corrective maintenance. It allows for the company to prioritize the prior cheaper option of maintenance.

Status. KIWASCO is in need of a full asset management tool to assist with the management of assets in the supply system and production units.

Impact on NRW Reduction.Asset management is a good tool of NRW management because it gives the priorities desired by the company for asset replacement/overhauls, servicing and improvement. Using the asset management tools assists the company in giving the O&M team one-click decision-making platform for the network and production units.

Responsibility. The asset management tool gives the company a good stage to prioritize and manage its assets. To be able to create an atmosphere of responsibility in the company, the asset management tool will realign responsibility throughout especially in the O&M section and electro-mechanical section.

Activities. Asset management will entail a number of activities to be able to achieve the right result in terms of sustainability and effectiveness. The plan for implementation of the action plan is as follows:

- Procure an asset management tool
- Input supply network assets and production assets into tool
- Run asset management tool

4.8 Commercial Operations (revenue generation, illegal use, meter management)

Customer Meter Management

Customer meter management is important to help maximize the utility revenues and minimize losses through the consumer points.

Status. There is currently an existing meter management policy guiding the company, though it is not actively in use. In the interest in managing preventive management, it is planned to have a meter management schedule and a meter management software to curb mishandling of meters and reorganize the whole set-up of meter management.

Impact on NRW Reduction.Implementation of this will minimize losses from the consumer-points. Given that a huge percentage of losses come from this area, it will significantly minimize cases of un-procedural processing of new meters and also meter handling in the field. Meters will hardly exceed their life spans or life in the field due to a replacement schedule.

Responsibility. The implementation of the meter management will be under the coordination of the meter management unit under commercial operations. The company is obligated to take partial responsibility of the meters in the field as well as processes within. It is the obligation of the company to manage meters well so as to avert chances of the meters getting in the wrong hands either consciously or unconsciously.

Activities. Meter management will entail a number of activities to be able to achieve the right result in terms of sustainability and effectiveness. Below is a list of the different activities:

- Procure and put in place a meter management software
- Conduct a thorough audit of all accounts in the supply system, acquisition of special seals for special accounts especially demand management measures (DMM), Kiosks
- Acquire a meter test bench, furnish meter management team with appropriate tools
- Undertake a review of the current metering policy
- Develop a metering plan/ management schedule
- Identify the areas of low pressure and improve on distribution water supply for meter registration
- Introduce built chambers for meters for new customers
- Implement meter replacement policies
- Carry out a rapid metering study to identify the most suitable metering technologies & specs for KIWASCO.
- Investigate, confirm and publicize the list of customers consuming water illegally, take legal action on defiant customers (distress etc.)
- Provide special meter seals & check meters after replacement
- Replicate DMM in informal settlements
- Identify and meter all unmetered consumption points especially fire hydrants, municipal council entities, estates etc.
- Continued sensitization of the general public on the need to stop the vice and intensify inspection.

System Input Calibration Volume Master Meters Calibration

The beginning of proper data handling in a utility starts with measuring system in-put point. The production meters are the main reference instruments in a supply system, without which there would be consistent misrepresentation about the performance of the utility. Currently, meter calibration is undertaken every other financial year. This is inconvenient as the mechanical meters due to their nature of running can become faulty at any time.

Status. Presently, calibration of the company production meters is done through outsourced entities due to inadequacy of the capacity to undertake calibration, which is done through bodies like the KEBS. There is a consistent calibration of the meters, though this is only a six-month periodical calibration. It is therefore necessary to consider undertaking internal calibration of the meters for consistency in registration of the production numbers.

Currently, the company has acquired a number of ultrasonic flow meters. These can be used for calibrating the mechanical meters (not electro-magnetic meters). The meters in the system are not very reliable given that they register 53% over-registration at Dunga and >20% over-registration at Kajulu. The two points are our major sources of water.

Impact on NRW Reduction. It is crucial for the company to ensure that proper operation and calibration and handling of bulk meters in the field to prevent errors in translating numbers they record.

Responsibility. Production meters calibration is the responsibility of the company to ensure correct communication to the utility stakeholders. It is therefore very important for the company to ensure that according to its policies, guidelines and procedures (within and without the ISO) it communicates its performance to the best accuracy possible.

Activities. Meter management will entail a number of activities to be able to achieve the right result in terms of sustainability and effectiveness. Below is a tabulation of the different activities:

- Calibrate Dunga 14" (mechanical meter) semi-annually
- Calibrate Dunga 9" (EMF) every two years
- Calibrate 24" meter (mechanical meter) semi-annually
- Calibrate Kajulu 6" (mechanical meter) semi-annually
- Install EMF meters on production main lines with mechanical meters

Pressure Reducing Valves and Pressure and Flow Recording Data Loggers

Pressure gauges and reducing valves are necessary for managing network pressures in a supply network. Due to high rate of fluctuations in pumping into the system with the high number of dilapidated lines, the company experiences number of leaks and bursts. These disrupt the supply and in turn lead to more bursts and illegal connections. Installation of these fittings will eventually assist with curbing the cases of pressure related bursts by detecting abnormal pressure events.

Status. Currently, there are no pressure reducing valves in place, though, we have pressure switches installed whenever excess pressure arises. There are installed mechanical pressure gauges in the network, though these will have to be replaced by digital gauges that can be managed remotely. This will assist in timely management of bursts and leaks, and make decisions that are network pressure-dependent.

Impact on NRW Reduction. With intelligent network management installations and automatic pressure controlling switches, NRW management will be better controlled.

Responsibility. Installations of the pressure gauges and loggers will be a priority in the company to ensure highly accurate and timely management of network occurrences. Optimum operation of the network is a high-priority issue for KIWASCO and it is with this regard that the company undertakes to minimize disruptions and hence no intermittent supply to the consumers.

Activities. The activities for the installation and monitoring the pressure gauges and loggers are as in the tabulation following:

- Network audit for requirement for pressure gauge and pressure reducing valves
- Procurement of pressure gauges and data loggers in the network
- Installation of pressure gauges/data loggers
- Phased introduction of HDPE pipes in the network

4.9 Management Information Systems

Data Collection and Record Keeping

Methods of data collection and record keeping which will lead to improvement in the estimation of water balance components particularly unbilled authorized consumption, apparent losses and real losses should be devised.

Status. The data collection in the system is such that reliability is not guaranteed. It is therefore important for the Heads of Commercial and Technical Services to devise a tool for verifying the accuracy of the data. Most data inconsistencies are experienced in the reading books and report from repairs and maintenance though efforts have been made to an advanced stage to curb this occurrence, a lot more needs to be done.

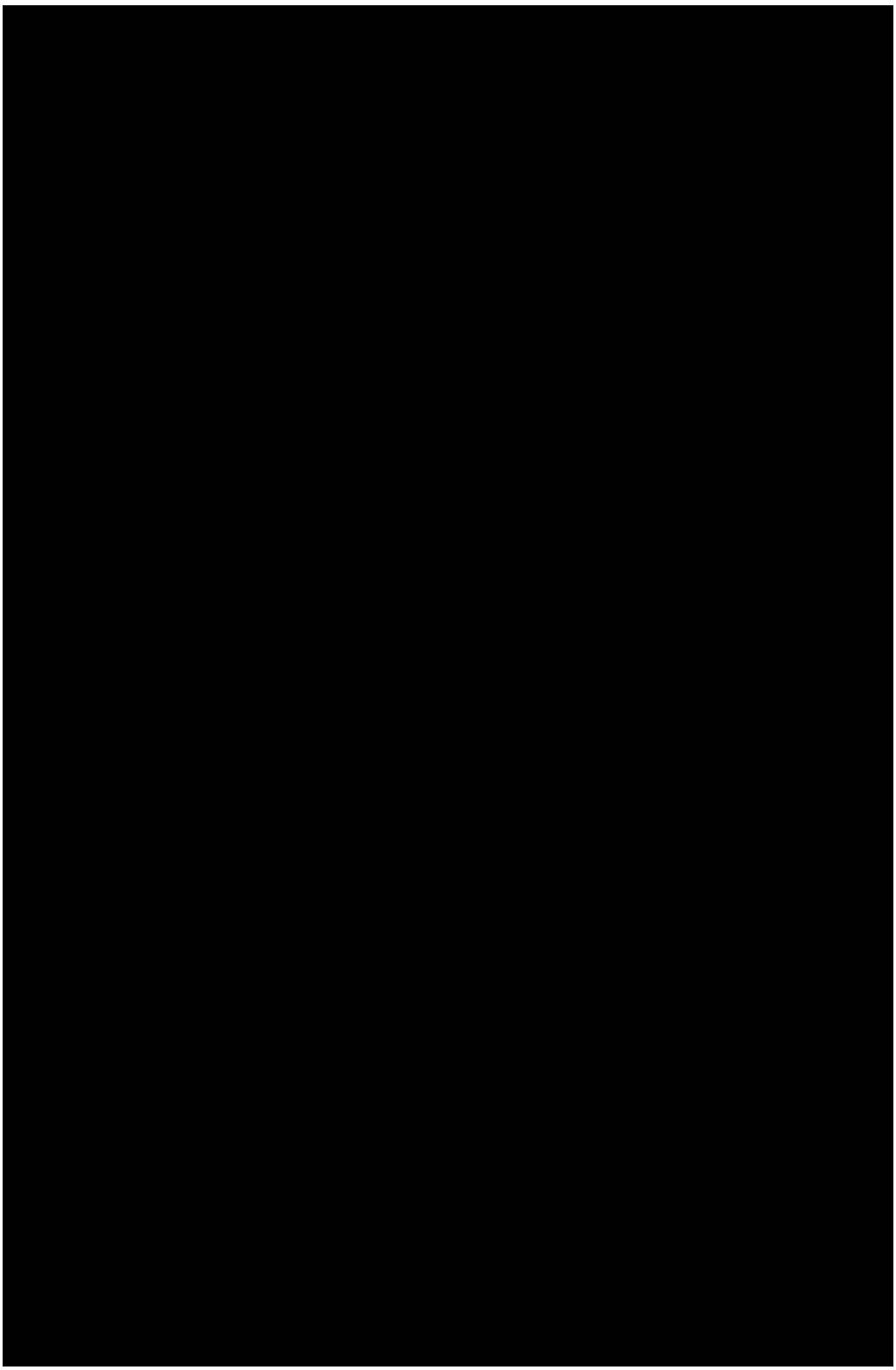
Impact on NRW Reduction.Reliable data is the most important in NRW as a first step towards management. It otherwise would mislead the utility when making decisions geared towards interventions to the Management.

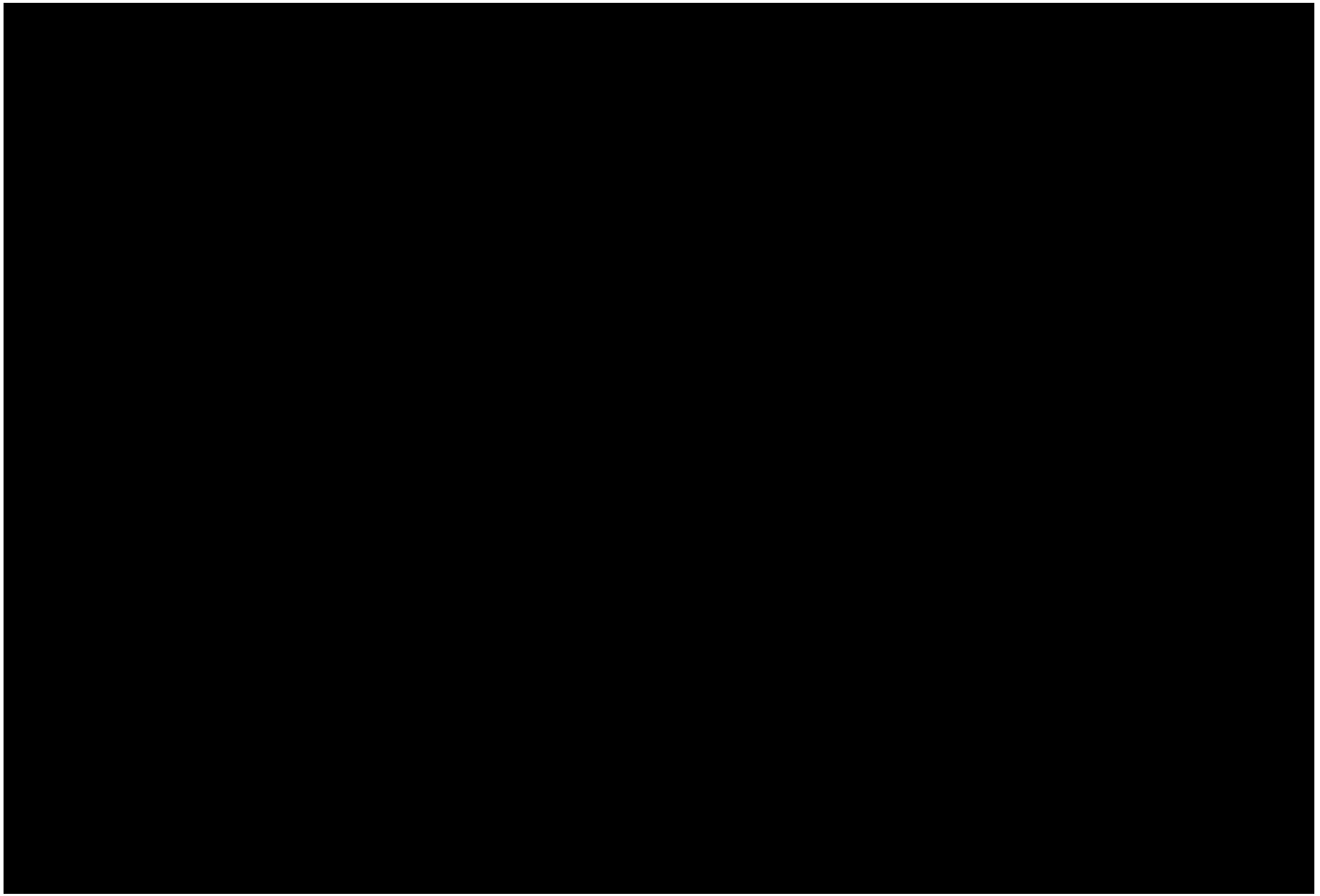
Responsibility. The company is mandated to ensure that its water consumers are satisfied both with the service quality and quantity. It is with this in mind that we take responsibility of ensuring our services are reflected in the quality, accuracy and accessibility of consumer data and company data.

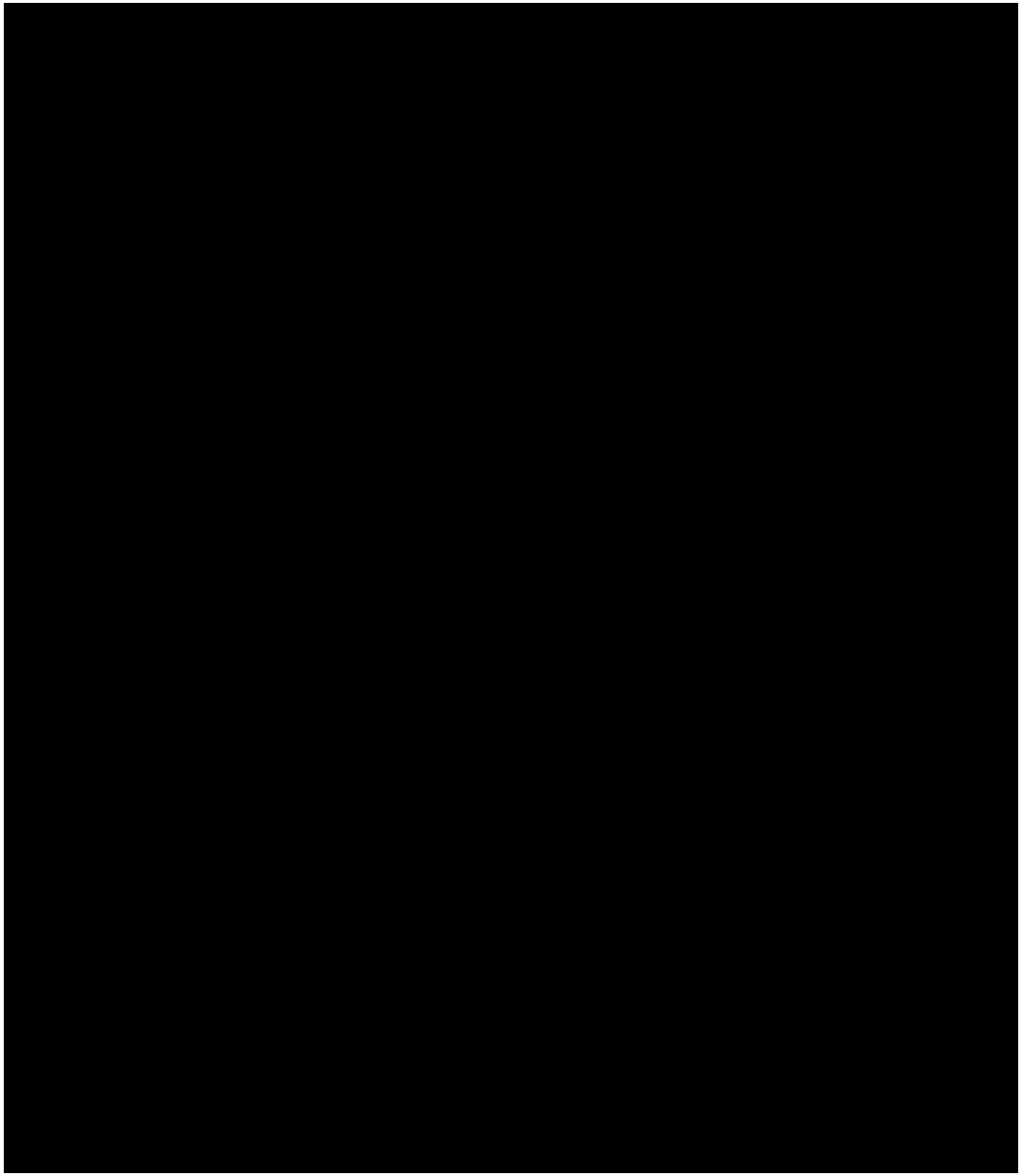
Activities. The activities for implementation of the action plan are as follows:

- Develop a data verification plan for data picked from the field
- Source for software upgrade in the billing system, activate inactive analytical applications
- Establish a performance appraisal system for temporary staff as basis for possible future recruitment
- Train staff on data entries and authentication (especially customer-care and the field staff
- Pilot on smart-metering

5 FINANCING PLAN







6 MONITORING AND EVALUATION FRAMEWORK

6.1 Monitoring Framework

Implementation of Activities

To be able to monitor the efficiency of the team managing this action point, the targets will be ingrained in the Balance score cards. This will inculcate a sense of obligation among the staff responsible for the activities they undertake. Network fittings and installations will be monitored through analyses of leaks and bursts occurrences and prevalence.

The asset management tool will be monitored through analyses in the occurrence in asset failures in the supply network and production units. The asset management will also be included as a part of the obligations of the network and maintenance teams and will be added to the score card. The overall performance of the implemented activities and interventions shall be quantified through the water balance tool provided by the World Bank and the MIS tool. There will also be regular reporting by the team championing the PIP to senior management.

The Caretaker

So as to be able to keep isolated zones in check an under sustainable condition, it has been proven that the best approach is the caretaker approach.

The caretaker will be responsible for the O&M of the distribution system in an assigned DMA.It is the duty of the caretaker to ensure that the DMA is operating smoothly, with service to customers maintained at the defined levels.

Due to the high rate of losses within the KIWASCO Company and the efforts the company is making to fight NRW, it is essential for the company to narrow down on sub-zones in the supply system so as to curb the losses within the shortest time possible, and simplify the efforts to deal with the NRW company-wide sustainably.

The caretaker approach is also good for the company to promote integration between the different departments' operatives on the ground so as to work in a cohesive manner (two for a subzone or two teams with lead members depending on the size and needs, size and complexity of the subzone). Caretakers in KIWASCO shall be fully responsible for the operations in and performance of the DMA's once they are 'cleaned' (cleaning in this context, means isolation of the DMA's, and setting the NRW baseline). This will be done specifically through coordination between the technical team responsible for the zone, and the commercial team responsible for the mother zone with assistance from the NRW team.

The team will also be fully responsible for NRW management within the area in terms of technical and commercial losses. Note that the coordination of the operations team will be on an equal-terms basis where either of the team members will be answerable to his/her immediate supervisor and the team-leader, and one over a period answerable to the oversight team.

Either of the two shall receive reports from the company regarding situations needing addressing, and either handle the situation appropriately (if it is his/her duty) or pass to the teammate or responsible team for action. The two caretakers shall be reporting the progress and operations within the DMA's to the NRW oversight team through the team secretary on a monthly basis and to the company.

6.2 Performance Review and Evaluation Criteria

Over the period of the PIP Implementation, the main tool for monitoring and evaluating the overall performance of the action items is through the Key Performance indicators as in the MIS Tool.
These indicators, with their ultimate targets are as shown in the tabulation below: (NB: these are moving performance targets)

Table 6.2.1: Key performance targets for KIWASCO

Goal Description - Indicator	Unit	**Base Performance (April 2014)**	**PIP Targets (June 2016)**
Non-Revenue Water	%	45	35
General NRW KPI's			
Total water produced (m3)	m^3/Month	19,756,038	29,634,057
Total water sold (m3)	m^3/Month	10,521,234	19,262,137
NRW (%)	Percentage	45	35
Billed revenue - sales(*1000 KES)	KES	33,963,563	79,945,772
Revenue collection efficiency (%)	Percentage	93	96
Data handling customer accountability			
No. of meters read	Number	17,633	31,338
% of meters read	Percentage	100	100
No. of meters gate-locked (unread)	Number	131	100
% of connections gate-locked	Percentage	1	<1

Data errors in billing process			
No. of metered connections	No	17,633	31,338
No. of sampled readings	No	750	1000
No. of sampled readings incorrect	No	75	100
% of meter readings incorrect	%	10	1
Unauthorized consumption I			
No. of meters reversed	No	261	88
No. of meters tampered with	No	319	106
No. of meter by-passes	No	174	58
No. of illegal connections (not yet registered)	No	145	100
Total no. of illegal cases investigated & confirmed	No	899	300
Unauthorized consumption II			
% illegal consumption cases/active connections	%	5	2
No. of disconnected/dormant connections	No	6,854	500
No. of disconnected/dormant connections inspected		1317	600
Total fines levied from illegal cases (*1000 KES)	KES	400,000	732,314
Total fines paid (*1000 KES)	KES	300,000	732,314
Customer meter accuracy I			
% metering ratio	%	100	100
No. of meters tested	No	300	1570
No. of faulty meters detected and/or reported	No	450	450
% of meters under-registering > 5% (at low flows)	%	5	1
% of meters over-registering	%	3	0
Customer meter accuracy II			
% of meters static	No	450	100
No. of (static/over/under-registering) meters serviced	No	450	50
No. of (static/over/under-registering) meters replaced	No	99	50

% of metered connections for which the meter was serviced or replaced	%	100	100
No. of stolen meters	No	43	2 0
Active leak detection			
Km's of 20'', 16'', 14'' and 12'' completed	Km	6.5	100
No. of leaks detected 12''-20''	No	3	20
Km's < 12'' (up to 4'') completed	Km	30	80
No. of leaks detected < 12''	No	600	400
Pipeline management and maintenance			
Number of isolated DMAs (with a water balance)	No	2	15
All district meters calibrated in the last 6 months (yes=1, no=0)	No	1	1
No. of leak locations recorded with GPS in GIS	No	0	500
Speed and quality of repairs			
No. of leaks and bursts reported (total)	No	800	500
No. of leaks and bursts repaired (total)	No	800	500
Average stoppage time (hours)	Hrs	1	0.5
Average repair time (hours)	Hrs	6	4
Pressure management			
Number of sampled points for low pressure	No	5	15
% of points with pressure levels < 1 bar		2	0
Asset Renewal			
Length of pipelines renewed	Km	6	20

**Moving target to 35% or below by 2*

ANNEX E

NON REVENUE WATER REDUCTION PROGRAM IN AFRICA

NATIONAL WATER SERVICES CORPORATION, KAMPALA

JINJA AND IGANGA AREAS NRW AUDIT (DRAFT REPORT)

AFRICA WATER ASSOCIATION (AfWA) AND USAID / FURTHER ADVANCING THE BLUE REVOLUTION INITIATIVE (FABRI)

SUBMISSION DATE: 30 January 2013

DISCLAIMER

The authors' views expressed in this publication do not necessarily reflect the views of the United States Agency for International Development or the United States Government.

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We are also grateful to AfWA, and to USAID's FABRI programme, for providing the funding to support the audit.

Acronyms and Abbreviations

AfWA African Water Association

ALC Active Leak Control

ALR Awareness, Location and Repair

AMPs Asset Management Plans

AMR Automated Meter Reading

AWWA American Water Works Association

BAC Billed Authorised Consumption

BSC Balanced Score Card

CARL Current Annual Real Losses

CAPEX Capital Expenditure

CIS Customer Information System

COM Cash Operating Margin

ELL Economic Level of Leakage

FABRI Further Advancing the Blue Revolution

FY Finicial Year

GIS Geographical Information System

ILI Infrastructure Leakage Index

ISO International Standards Organization

IWA International Water Association

IWMM Integrated Water Meter Management

KPI Key Performance Indicator

LCC Life Cycle Costs

LHE Leakage Handling Efficiency

M & E Mechanical and Electrical

MGLD Megalitres per Day

MNF Minimum Night Flow

NDF Night Day Factor

NRW Non-Revenue Water

NWSC National Water and Sewerage Corporation

O & M Operations and Maintenance

PI Performance Indicator

PPM Preventive Pipe Maintenance

PRVs Pressure Reducing Valves

SCADA Supervisory Control and Data Acquisition

SOPs Standards Operating Procedures

TMA Territory Management Approach

UARL Unavoidable Annual Real Losses

UNICEF United Nations Childrens Fund

USAID United States Agency for International Development

WHO World Health Organization

WOPS Water Operators Partnerships

WTP Water Treatment Plant

Executive Summary

Non-revenue water (NRW) and/or water loss is increasingly becoming a major challenge for urban water utilities especially in Africa. The high levels of NRW coupled with diminishing water resources due to global climate changes have led to low water service coverage in African cities. According to WHO and UNICEF Joint Monitoring Programme of UN MDGs, as many as 343 million people in Africa do not have adequate water supplies. Whereas water utilities have the obligation of managing water supply more responsibly and efficiently on the supply side by reducing water losses, they often lack capacity to do so particularly in African water utilities.

In the above context, the African Water Association (AfWA) in partnership with the U.S. Agency for International Development's Further Advancing the Blue Revolution Initiative (FABRI) has undertaken a three-year program to reduce NRW in 24 utilities in 21 countries in east, central, southern, and west Africa. The NRW program supports capacity building of Task Force members, representing member utilities across Africa, to acquire skills and techniques required for NRW reduction. This approach of "learning-by-doing" by water utility employees ensures sustainable provision of water services through reduction of water and revenue losses. The program has three phases: 1) diagnostic, 2) key action plan recommendations, and 3) monitoring and evaluation.

This report presents the findings of an audit of the Jinja Operations Area of the National Water and Sewerage Corporation, Kampala, Uganda. The approach focused on identifying how Jinja Operations Area is addressing operations and methodologies for assessing, monitoring and reducing NRW. The aim of the audit was to assist the Jinja General Manager and Operations Engineers in future NRW management operations by recommending actions for change or improvement that are practicable and achievable. These recommendations are intended for the utility to review - and to incorporate into the utility's Performance Improvement Plan (PIP)

The audit findings show that Jinja Operations Area has made commendable efforts to both understand and manage NRW:

- Establishing a water balance for Jinja Area and Iganga Branch
- Gaining an understanding of the relative significance of water balance components by collecting and analyzing data
- Acknowledging the part played by other departments in provision of information and data for the water balance
- Establishing a good customer billing and collection department

However, there is scope for improvement to enhance the collection of accurate data and to support the reduction of both physical and commercial losses:

- Setting up a dedicated NRW unit to remove dependency on Kampala for equipment
- Establishing regular customer surveys to identify missing customer connections and to strengthen billing procedures
- Introducing improvements for meter testing and meter replacement

- Improving energy efficiency at pumping stations by carrying out audits on pumping and motor starting procedures
- Ensuring that all bursts and leaks are logged for improved data management
- Amending the design of bulk meter installations to improve meter accuracy

Key recommendations for improvement are listed in Table 0.1

Jinja operations staff have identified issues that require capital investment. A budget has been allocated for:

- Design and installation of District Meter Areas (DMAs) to enhance data collection for leakage management and bottom up calculation of physical losses.

- Installation of pressure reducing valves (PRVs) to reduce burst frequency and leakage

- Purchase of an ultrasonic flow meter and leak detection equipment

Table 1 contains a summary of key recommendations

Table 1 Summary of Key Recommendations

Institutional Assessment

Issue	Recommendation
There is a high dependency on Kampala Water for NRW reduction activities: - Pressure testing - Meter testing - Update of GIS maps - Active leakage detection	Set up an independent and self-contained NRW unit that has links with all other departments

Technical Operations

Issue	Recommendation
Motors in pumping stations are star-delta starting	Carry out an energy audit of all the pumps and introduce soft start mechanism
Not all customer complaints are logged in the call center Most of the reported leakages are in the CBD on service connections	Ensure all leakages and bursts are logged for improved data management and water loss assessment
Bulk meters installed next to fittings	Install bulk meters to follow manufacturer installation guidelines for improved meter accuracy

Commercial Operations

Good billing system in place	Strengthen follow up visits for billing
Meter testing and replacement practice is reactive	More proactive meter testing and replacement Meter installation procedure to be improved
Some Customers missing from data base	Regular customer surveys to ensure that all customers are on the data base
Service connections installation time does not always follow the charter	Installation process should be improved and material made available

Water Balance

Water balances are in place and staff are competent.	But some adjustments are required Use of the "what if" tool to investigate investment in pressure management and DMA management
Surveys are required to verify network data	Network data requires checking to verify MAPL Bottom up approach to verify real losses
Some error margins need checking	Customer categories for meter accuracy to be introduced Surveys for investigating illegal connections and meter tampering to improve the data

1 - Introduction

This section introduces the Non-Revenue Water (NRW) reduction program in Africa and provides an overview of the NWSC's Jinja and Iganga water utility in Uganda, a brief description of the diagnostic audit phase, the objectives and scope of the audit exercise and brief profiles of the audit team.

1.1 Background

NRW is a major problem for water utilities worldwide especially in the developing countries. According to the World Bank study, nearly 45 million m^3 of water is lost daily as leakage (enough to serve nearly 200 million people) in the developing countries and close to 30 million m^3 of water is delivered everyday to customers but not paid for due to metering inaccuracies, theft and corrupt utility employees, costing water utilities about US $6 billion every year (World Bank, 2006). In Africa NRW figures ranging from 5% (Saldanha Bay, South Africa) to 70% (LWSC, Liberia) have been reported (WSP 2009). According to the joint monitoring program of the millennium development goals (MDGs) by WHO and UNICEF (2010), as many as 343 million people in Africa, 477 million people in Asia and 38 million people in Latin America and the Caribbean do not have adequate water supplies. Clearly, this is unacceptable, that where water utilities are starving for additional revenue to expand services to the poor and where water is heavily rationed that it is also heavily wasted. The NRW problem is likely to be compounded by the diminishing water resources, increasing costs of producing water, high rate of infrastructure deterioration, inadequate investment budgets, and increasing global change pressures (urbanization, climate change, population growth). Water utilities are under increasing scrutiny to use water resources more efficiently by reducing water losses in their distribution systems and ensure sustainable service delivery.

To help African water utilities tackle these increasing challenges, the African Water Association (AfWA) in partnership with the United States Agency for International Development (USAID)'s Further Advancing the Blue Revolution Initiative (FABRI) embarked on a three year joint program (2012-2015) to reduce NRW. The program covers 24 utilities in 21 countries in East, Central, Southern, and West Africa. The NRW program is introducing management and technical tools and systems that will enable water utilities – both national water boards and state and city entities – to reduce water losses. The program has three phases: 1) diagnostic, 2) implementation, and 3) monitoring and evaluation. One unique aspect of the NRW program is the involvement of AfWA senior management and members of the AfWA Scientific and Technical Council's NRW Task Force in the day-to-day management and guidance of the program. Fourteen Task Force members, representing member utilities across Africa, will play an increasingly important leadership role over the life of the program and beyond. Initially, Task Force members will participate as members of the Audit Teams that will visit each of the 25 utilities during the next twelve months. Task Force members will also support the implementation, and monitoring and evaluation components of the program. This report presents the work of the taskforce team's diagnostic water audit for NWSC's Jinja and Iganga Areas, a public water utility in Uganda in Great Lakes East African Region.

1.2 Utility Fact Sheet

The Jinja and Iganga Areas' factsheet matrix is presented in Tables 1.1.and 1.2 The utility factsheet provides a snapshot of the utility profile, including key technical and financial information, and management of NRW.

Table 1.1: Jinja Utility Factsheet

NRW UTILITY BASELINE FACTS SHEET - JINJA

1.	**General Information**						
	Utility Full Name: **NWSC - JINJA AREA**			Country: **UGANDA**			
	Ownership: ***Government***			Coverage: **Regional**			
	Number of towns served (for National/regional): **4**			Name of project area: **JINJA**			
	Type of service provided: **water and sewerage services**			Establishment of the utility: *year* **1972**			
	Is there a separate oversight regulatory agency?			YES	**NO**		
2.	**Technical information**						
	Population in the service area: **280,000**			Water service coverage: *(%) 85*			
	Annual Volume of water produced (m^3): **5,096,657**			Number of water connections:	Total: **18,830**		
					Active: **16,028**		
					Inactive: **2,802**		
	Total Water Network Length (km): **509**			Number of employees: **93**			
	Average hours of supply per day: **20**			Water treatment plant capacity utilization: **60%**			
3.	**Financial information**						
	[redacted]						
4.	**NRW Management**						
	Non-revenue water	**871,999**	m^3	Is the network zoned into DMAs?	**YES**	**NO√**	
		19.66	%				
	Is water produced metered?	**YESv**	**NO**	Customer metering coverage ratio:	**100%**		
	Are production meters regularly calibrated	**YES√**	**NO**	Is there a customer meter testing and replacement program?	**YES√**	**NO**	
	Is there a functional NRW Department/Unit	**YES**	**NO√**	Is there a pro-active illegal use investigation program?	**YES√**	**NO**	
	Is the network pressure measured on regular basis?	**YES**	**NO√**	Are there pressure reducing valves (PRVs) in the network?	**YES**	**NO√**	
	Are there leak detection equipment?	**YES**	**NO√**	Is Active Leakage Control practiced (searching for invisible leaks)?	**YES**	**NO√**	
	Is there an asset management plan?	**YES√**	**NO**	Is there an information management system for capturing and managing data on leaks, response time and customer complaints?	**YES√**	**NO**	
	Are annual water audits conducted:	**YES√**	**NO**	Is there an established water balance	**YES√**	**NO**	

Table 1.2: Iganga Utility Factsheet

NRW UTILITY BASELINE FACTS SHEET - IGANGA

1.	**General Information**						
	Utility Full Name: **NWSC - IGANGA AREA**			Country: **UGANDA**			
	Ownership: **Government**			Coverage: ***Regional***			
	Number of towns served (for National/regional): **1**			Name of project area: **IGANGA**			
	Type of service provided: ***water and sewerage services***			Establishment of the utility: **year 1972 but in Iganga since 2008**			
	Is there a separate oversight regulatory agency?			YES		**NO√**	
2.	**Technical information**						
	Population in the service area: **50,450**			Water service coverage: ***(%) 70***			
	Annual Volume of water produced (m^3): **406,964**			Number of water connections:	Total: **2541**		
					Active: **2498**		
					Inactive: **43**		
	Total Water Network Length (km): **104**			Number of employees: **17**			
	Average hours of supply per day: **24**			Water treatment plant capacity utilization: **N/A**			
3.	**Financial information**						
4.	**NRW Management**						
	Non-revenue water	**7,572**	m^3	Is the network zoned into DMAs?	YES	NO√	
		20.43	%				
	Is water produced metered?	YES√	NO	Customer metering coverage ratio:	**100%**		
	Are system input meter regularly calibrated	YES	NO	Is there a customer meter testing and replacement program?	YES√	NO	
	Is there a functional NRW Department/Unit	YES	NO√	Is there a pro-active illegal use investigation program?	YES√	NO	
	Is the network pressure measured on regular basis?	YES	NO√	Are there pressure reducing valves (PRVs) in the network?	YES	NO√	
	Are there leak detection equipment?	YES	NO√	Is Active Leakage Control practiced (searching for invisible leaks)?	YES	NO√	
	Is there an asset management plan?	YES√	NO	Is there an information management system for capturing and managing data on leaks, response time and customer complaints?	YES√	NO	
	Are annual water audits conducted:	YES√	NO	Is there an established water balance	YES√	NO	

1.3 Diagnostic Phase

The diagnostic phase is the first step of the water audit process that assesses the existing situation and whether there is a problem with a utility's water supply system. According to Wallace (1987), "a water audit is a management tool used to evaluate water and revenue losses and if properly utilized, it can help utility managers reduce inefficiencies and plan interventions". In this phase the following questions are asked:

(i) How much water is being lost?
(ii) Where is the water being lost from?
(iii) Why is the water being lost?

Answers to the questions are provided by conducting a "top-down" water audit approach, which is largely a desk top exercise of gathering and analyzing data and information from the utility records on water use and loss (water balance), water supply system and utility management (policies, procedures, information systems, etc.). From this platform of knowledge, intervention measures (action plans) are developed and implemented for reducing water losses.

Reducing water losses not only conserves a scarce natural resource but also improves utility financial viability (increased revenue and reduced repair and energy costs), deferment of capital expenditure for new sources and system expansion to keep pace with increasing demand, saves energy, reduces carbon emissions, thus mitigating climate change impacts and fostering sustainability.

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1.4 Objectives and Scope of the Audit Exercise

The main objective of the audit exercise is to develop capacity and help NWSC's Jinja and Iganga Areas to reduce NRW. The specific objectives of the audit exercise were to:

1. Conduct a water audit (diagnostic phase) in the Jinja and Iganga Areas' water utility in order to quantify and understand how much water is lost, where and why.

2. Propose key action recommendations for NRW reduction.

3. Support the utility in developing a NRW reduction plan (where necessary), monitoring and evaluating progress of action plan implementation.

The program scope is limited to supporting the above key specific objectives and other activities related to achieving the objectives such as developing databases, collecting data for water balance, providing technical NRW and management training, providing NRW technical expertise and institutional support, developing investment plans, developing business plans, linkages and convening meetings with donors, cover travel costs of audit teams & travel to international conferences, convening conferences, cover costs of AfWA conferences, development of communications tools, operator partnerships, fund small number of pilot projects, and establishing DMAs. The program cannot support infrastructure replacements, large scale metering, and acquisition of leak detection equipment.

1.5 Audit Team

The Audit Team comprised of four task force members (Cephas Oguah, John Ruhiu, Malusi Dlamini, and Sonko Kiwanuka), and one NRW expert (Malcolm Farley). The brief biodata of the audit team members is provided in Annex D of this report.

1.6 Report Outline

The report is organized in eight sections, each dealing with a particular aspect of NRW management, thus contributing to the achievement of the program objectives. A brief overview of the structure is given below.

Section 1- introduces the program and provides insight into the problem of water distribution losses and highlights the importance of water loss management. It gives an overview of the magnitude of water losses in the developing countries and specifically for Africa. A brief on the diagnostic phase is provided followed by the objectives and scope of the audit exercise and introduction of the audit team. Lastly, the summary outline of the report is presented.

Section 2 - presents the methodology used in conducting the water audit.

Section 3- deals with institutional assessment including organization set up and legal framework, utility vision, mission and strategies, organizational capacity and management commitment to reduce NRW.

Section 4 - examines operations management including technical operations (infrastructure and network attributes, network asset management practices), and commercial operations (billing and revenue management, customer information systems, and meter management).

Section 5 - presents and discusses the water balance, key water loss performance indicators and validates data accuracy and reliability.

Section 6 - presents key audit findings on institutional aspects, technical operations, commercial operations, and measurement and information management.

Finally, **Section 7** presents the main conclusions of the audit exercise and makes recommendations for key action plans.

Additionally, the report includes the following annexes:

- **Annex A** provides the schedule of the audit exercise
- **Annex B** provides the utility NRW self-assessment matrix
- **Annex C** provides a list of people contacted
- **Annex D** provides brief biodata of the audit teams

2 - Water Audit Methodology

This section describes the methods and tools used during the audit excercise including standard best practice methods; participatory verification approach with the beneficiary utility; discussions, workshops and interviews with utility management at the strategic, tactical and operational levels; and inspection of utility water use and loss records.

2.1 General Approach to the Audit Process

In order to evaluate water use and loss, operational and commercial practices, and institutional structures, a utility fact sheet (Table 1.1) was developed and filled by the utility to provide a quick snapshot of the current utility profile and capacity for NRW management. The WorldBank NRW self assessment matrix and the EasyCalc water balance computational tool were used to establish the amount of water losses and assess technical and managerial capacity of the utility to manage NRW. These three tools were emailed to the utility a week before the audit for completion. This was to make the audit more efficient and save time for field verification. The EasyCalc is a top-down water balance Excel spreadsheet computational tool that is used to quantify water losses based on data gathered from available records. It is based on the International Water Association (IWA) and American Water Works Association (AWWA) water balance methodology (**Figure 2.1**). The IWA/AWWA water balance methodology provides standard definition and terminologies and an array of key water loss performance indicators. The IWA/AWWA water balance methodology has been accepted internationally as best practice and is the most widely applied method by most water utilities for conducting annual water audits. The method defines NRW as the difference between system input volume and revenue water. It is comprised of water losses and unbilled authorised consumption (water for flushing mains, fire fighting, sewer jetting etc.). Water loss is made up of two components: real losses and apparent losses. Real losses refers to the annual volumes lost through all types of leaks and breaks on mains, service reservoirs (including overflows) and service connections, up to the point of customer metering. Apparent losses are the non-physical losses that include customer meter under-registration, unauthorised use, meter reading and data handling errors.

<table>
<tr><td rowspan="8">System Input Volume (corrected for known errors)</td><td rowspan="2">Authorised Consumption</td><td rowspan="2">Billed Authorised Consumption</td><td>Billed Metered Consumption</td><td rowspan="2">Revenue Water</td></tr>
<tr><td>Billed Unmetered consumption</td></tr>
<tr><td rowspan="2">Unbilled Authorised Consumption</td><td>Unbilled metered consumption</td><td rowspan="6">Non-revenue water (NRW)</td></tr>
<tr><td>Unbilled unmetered consumption</td></tr>
<tr><td rowspan="4">Water losses</td><td rowspan="2">Apparent Losses</td><td>Unauthorised consumption</td></tr>
<tr><td>Customer metering inaccuracies and data handling errors</td></tr>
<tr><td rowspan="3">Real losses</td><td>Leakage on transmission and distribution mains</td></tr>
<tr><td>Losses at utility's storage tanks</td></tr>
<tr><td>Leakage on service connections upto customer metering point</td></tr>
</table>

(Source: AWWA, 2009)

Figure 2.1 The IWA/AWWA water balance methodology

Other methods used during the audit process included the following:

- Inspection of water use and water loss records
- Verifying meter testing and calibration records (source meters and customer meters)
- Verifying billing and accounting information
- Workshops and interviews of utility employees
- Field visits for inspecting water supply system installations

2.2 Meetings and Focus Group Discussions

These meetings include the entry meeting and discussions with key relevant managers whose functions have an influence on NRW management. The entry meeting is held on the first day between the audit team and the utility top management. During this meeting, introductions were made berween members, a brief presentation from the audit team on the AfWA/FABRI NRW reduction program highlighting objectives, outcomes and what the program can and can't support. The entry meeting outlined the role of the audit team, which was to:

- Request information
- Collate what is available
- Review what we have
- Analyse gaps in information
- Assess operating practices
- Recommend improvement or change where appropriate

The utility management also made a brief presentation that included the utility profile and mandate, organizational structure, key operational performance indicators, and utility strategic plan. The expectations of the utility's top management of the audit exercise are also discussed in the entry meeting.

The focus group discussions were held with relevant utility employees during the process of gathering, verifying, and validating data. Attendees at the focus group meetings are listed in Annex C.

Figure 2.2 Entry meeting with Jinja and Iganga Senior Directors and Managers

2.3 Field Visits

The field inspection visits were conducted to assess the condition of different components of the water supply system and to verify data records. The field tasks included:

- Inspection of customer meters for proper sizing, installation, and operation
- Checking distribution system operating procedures and repair practices
- Inspection of storage reservoirs for leaks and overflows

2.4 Documentary Review and Data Validation

During the audit exercise various utility documents were reviewed in order to understand the mandate and obligations of the utility and for authentic data acquisition. The documents reviewed included the latest annual reports (often freely available on the utility's website), the utility's vision and mission statement, the customer charter, the policies, tariff structure, and strategic plans.

The EasyCalc water balance worksheets allow water utilities to assess the validity of the data that they input during the audit process. The user defines the error margin (+/- 0-100%) of the input data based on his judgment of input data reliability. The error margin is small if data used is derived from actual measurements and high if derived from estimates e.g. water volume from unmetered sources. A composite is then calculated to reflect the relative degree of validity of the water balance results. The first attempt by a utility to compile a water balance will most likely have high errors of margin and the validity of the water audit should be improved annually by for example metering unmetered water sources and improving operational data management. The validation of water audits is a very important step to ensure that developed interventions are based on reliable and accurate input data.

2.5 Exit Meeting/Workshop

The exit (debriefing) meeting was conducted for Jinja and Iganga staff at the end of the audit process. The exit meeting was held on the last day of the visit to debrief management on the key outcomes of the audit exercise. The aim was to:

- Report on findings
- Make recommendations for changes and improvements to the utility practices
- Assess whether expectations had been met
- Discuss the next steps for the utility's Performance Improvement Plan

It also created awareness of the program and allowed 'ownership' of the process by the utility staff at strategic, management and operational levels. The exit meeting was conducted in a participatory approach from all members.

The debriefing meeting also helped the audit team get feedback on key action plan recommendations from the top utility management and refine the recommendations accordingly in the final audit report.

Figure 2.3 Exit meeting with Kampala, Entebbe, Jinja and Iganga Senior Directors and Managers

3. Institutional Assessment

This section focuses on the utility organizational set-up and legal frame work, vision mission, strategies as well as determining the utility's capacity and management's commitment to reducing NRW. A brief description of the organizational set-up and legal framework of NWSC is given and the remaining sections focus mainly on Jinja and Iganga Area.

3.1 Organizational set-up and Legal Framework

The National Water and Sewage Corporation is a Government Parastatal which was established by Decree No. 34 of 1972. . It is defined by the National Water and Sewerage Corporation Act of 2000, Cap 317, laws of Uganda, and regulated by the Ministry of Water. The Corporation was re-established in 1995 with the main aim of making it financially viable.

The mandate of the Utility is to operate and provide water and sewer services in areas entrusted to it on a sound, commercial and viable basis. Presently the utility provides water and sewer services to 23 towns, called areas under the new utility setup, across the country. It currently has over 300 000 water connections and 20 000 sewer connection. Figure 3.1 illustrates institutional set-up of the utility from Government level to the customer and how it runs parallel with other government water provision bodies.

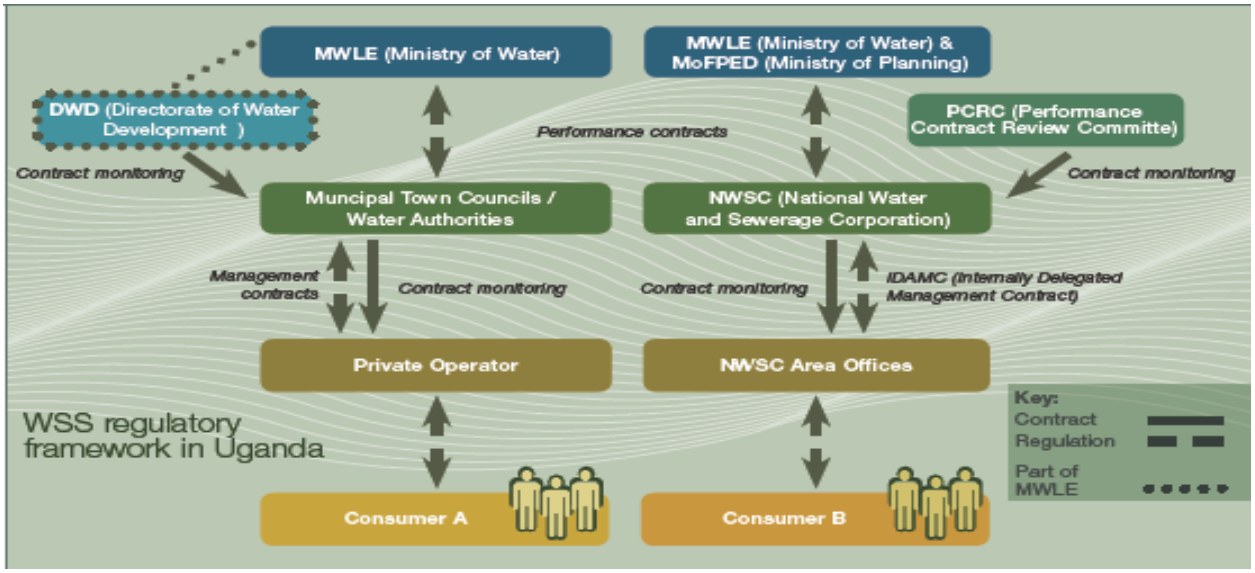


Figure 3.1 Institutional Structure

The organizational set-up, shown in Figure 3.2, is comprised of the Board of Directors, Managing Director (MD) and the six departments which report to the MD's office, these are Finance and accounts, Management Services, Commercial and Customer Care, Engineering Services, Planning and Capitol Development and Institutional Development and External Services. There is also the Internal Audit department which reports to the Board of Directors.

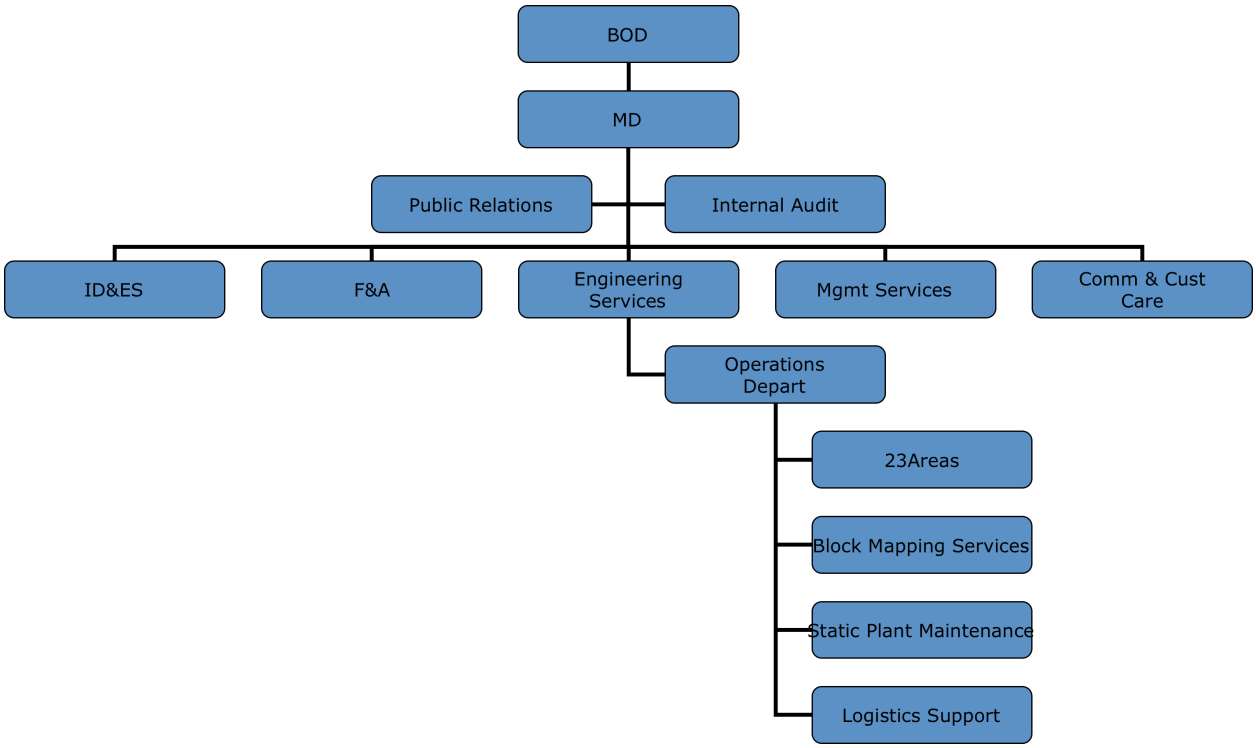


Figure 3.2 Organisational Structure

At the area level the organizational set-up changes as can be observed in Figure 3.2 At this level there is the Area General Manager for Jinja and Area Manager for Iganga. The General Manager is responsible for five sections namely Senior Human Resource Officer, Principal Accounts Officer, Senior Commercial Officer, Principal Area Engineer and Branch Managers.

Senior Human Resource Officer is responsible for office administration, drivers and office and security. Principal Accounts Officer is basically in charge of IT, and managing of finances, including procurement and inventory. The commercial section does the billing and revenue collection. Principal Area Engineer deals mostly with water distribution, treatment plant, sewer services and water losses. There are also the Branch Managers who lead the branches. Branches are subdivisions of the areas for better management and these are further broken down into territories.

The area manager (Iganga) is responsible for commercial billing officer, the Senior Accounts Officer and Commercial officer.

3.2 Utility Vision, Mission and Strategies

NWSC's vision is to be "The Leading Water Utility in the World". The mission of NWSC is to "provide efficient and cost effective water and sewerage, applying innovative managerial solutions to the delight of our customers". The Areas have their own visions and missions which were adapted from the utility's vision and mission. These are, for Jinja, Area vision is to be "among the leading water and sewerage service providers in the world. The area mission is "to

provide water and sewerage services in a commercially viable, socially acceptable, environmentally friendly and sustainable manner.

For Iganga the vision is "*To be an icon among the leading water utilities in the world*". And the mission is "*To provide quality water and sewerage services to customers in an environmentally friendly manner while maintaining our integrity and values"*

Various strategies have been implemented, for both Iganga and Jinja, over the years to improve on service delivery, these include 100 days, SEREP, I and II, APC, STRETCH, OMM, IDAMC and Raving Fans. Currently the PACE programme is in place. This programme ensures continuous improvement by close monitoring and evaluations of performance. The Areas have six month action plans which are reviewed every six months.

There is also the territorial management system, which fits in well with the PACE programme; this system ensures that Areas are divided into small, discreet manageable zones. This improves on customer, utility relationship and also gives staff members more responsibility for the smooth operation of the utility. Monthly evaluations are carried out to determine the territories performances and NRW is one of the performance indicators.

The Areas have identified NRW as one of their operational challenges and further describe illegal use, lack of comprehensive DMA meters, lack of proactive and systematic monitoring mechanism to detect defective meters and inadequate mechanisms in place to analyze customer consumption trends to guide in detecting illegal water users. However from the presented water balance it seems that more effort should be directed towards reduction of physical losses rather than illegal water use. Illegal use accounted for 1% of the total losses.

3.3 Organization Capacity

Jinja Area is operationally independent and provides 100% of Igangas' water requirements. It consists of five departments and an Internal Auditor. There are a total number of 84 staff members and 25% of these are directly involved in pipe repairs. Some of these staff members can be diverted into active leakage management by the provision of machinery/ heavy (bobcat) for excavation and/ or general digging in case of pipe burst. This will not only ensure that there is active searching for leakages (reducing leakage awareness time) but will also improved efficiency and reduce response time.

Jinja and Iganga currently rely on Kampala for most of their NRW reduction requirements including meter testing, investigation for invisible leakages and pressure management, where else Kampala Area appears to be stretched in dealing with its own NRW reduction programme. This leads to a backlog and removes the responsibility from the Area to manage NRW reduction. It could be beneficial for the Area to set up a NRW reduction unit. This will assist in making the Area completely responsible for their NRW reduction programmes.

Jinja area is managing to reduce NRW through the territorial management system. This allows for staff members to proactively investigate illegal connections, spot and repair pipe leakages, be hands on all operations at territorial level. Territories even have their own performance targets

and NRW reduction is one of them. This management system may be improved by being able to quantify the amount of water that is provided in each territory, that way it will be easy to know which territories are losing the most water and focus on NRW reduction can be directed to those territories. There is also a need to realign customers to each territory as misalignment of billing with territories has been identified as one of the challenges facing this management system.

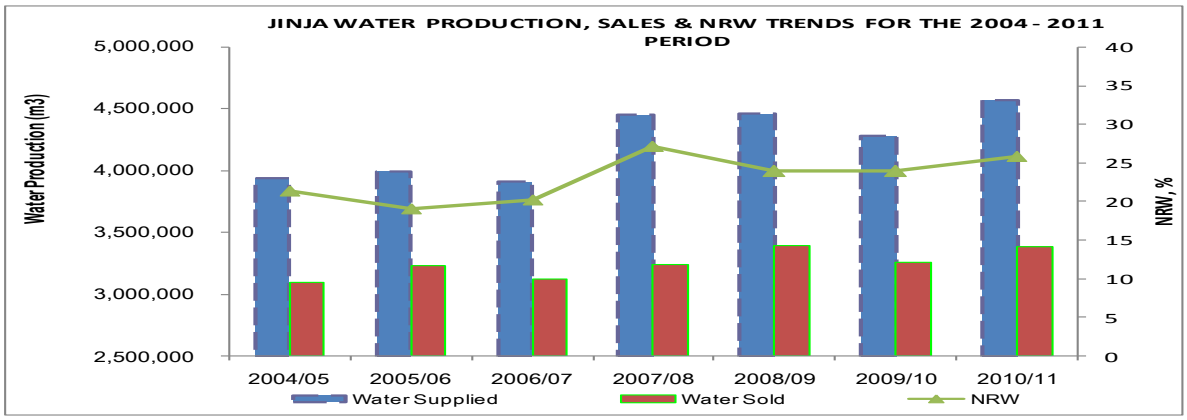
Jinja area has processes and procedures which are very well documented and stored. This help in the transfer of information and general maintenance of systems and infrastructure. There are also well managed information systems such as GIS, Customer Management System. However the GIS system in Jinja appears to be only used to update pipe network extensions. This system can be integrated with Customer Services System to provide more information of pipe bursts and leakages.

The staff from both Areas appeared to be very knowledgeable and informative on issues on NRW. There is a clear communication between billing and maintenance sections in completion of the water balance which is very commendable. This shows that NRW is not viewed as an issue for only the maintenance staff.

3.4 Management commitment to reduce NRW

The management of Jinja is committed to reducing NRW. This can be seen by the various strategies they have put in place. These include the incentives given for good performance in the territories, raising NRW as a KPI in evaluation of performance, they have a toll free call centre (calls routed through Kampala), NRW reduction appears directly and indirectly in their investment plans under the PACE programme, use of WB Easy – Calc model for calculating NRW.
However there appears, from the review of the PACE action plans, that they do not put emphases on NRW reduction rather they most focus on revenue collection strategies. Out of the two PACE documents reviewed total percentage investment towards NRW reduction was less than 10%, it is suggested that management considers increasing investment on NRW reduction to realize the value of NRW reduction.
Although NRW is one of the KPI's it was not clear how much weight it carried in the total distribution of the incentive.

Figure 3.4 shows the NRW trends for the past seven years.



4. Operations Management Assessment

This section evaluates the infrastructure and network characteristics, asset management practices, infrastructure and network documentation and network management.

4.1 Technical Operations Assessment

The main water source is Jinja WTP where treated water is pumped into a service reservoir before distribution. Iganga which is a distance of 40Km away from Jinja is supplied via a DN 150 to a service reservoir with a mechanical zonal meter to measure the volume of water supplied to the Area.

Figure 4.1 Jinja WTP Pumping Station

4.1.1 Infrastructure and network characteristics

The water treatment facility in Jinja; Wabukuba WTP was initially designed in the 1940s but has undergone through series of renovations and expansions to improve both quality and quantity.
The last expansion was in 1998 when a clarifier was installed. The treatment plant has a design capacity of 300,000m3/d. the current production is 200,000m3/d being the volume produced to meet the current demand. Hence the treatment works is at 60% utilization.
The booster stations are also relatively new having been built in the last five years. These facilities are well managed with no noticeable leakages either at the production meters or transmission mains.
There are terminal and service reservoirs located on high ground to command large supply zones. These receive water via rising mains in bulk before releasing into the distribution network.

The pipe network is constituted of various types of materials such as DI, GI, PVC, AC etc.
The age of network before the formation of NWSC was not documented.
However the locations and other network details are documented and the entire network is mapped in block maps which are updated by the block map team.

Tables 4.1, 4.2 and 4.3 give details of the network

Table 4.1: Jinja service reservoirs

Reservoir Name & Yr of construction	Location	Capacity (M3)	Elevation (MSL)	No. and size of outlets	Bulk meters	Remarks
Walukuba	Walukuba - Masese	4,000	1202	1 No. DN 250 1 No. DN 150	DN 150 Backwash meter	- DN 250 supplies town - DN 150 Backwash
Rubaga	Rubaga	24,000	1250	1No. DN 350 1No. DN 250 2No. DN 300 1No. DN 150	- DN 200 – Zonal BM for Njeru - DN 200 – Zonal meter No. 1 for Bugembe - DN 150 – Zonal Meter No. 2 for Bugembe - DN 300 – Iganga Meter	- 1No. Supplies Town center and Njeru - 1No. Town center and Bugembe - 1No. Bugembe (Mpumude) - 1No. Iganga
Nakibizzi (2002)	Nakibizzi	1,000	1295	2No. DN 100	DN 150 – Pumping main to Nakibizzi Reservoir	-Nakibizzi BM on Booster pumping main

Table 4.2: Iganga area reservoirs

Reservoir Name **and year of construction**	Location	Capacity (M3)	Elevation (MSL)	No. and size of outlets	**Territories served**
Bulanga(1995)	Bulanga	40	1500	2no DN 100	T4
CMS(2006)	CMS	40	900	2no DN 150 and 75	T4
Main tank(2006)	Old Kaliro rd	900	1500	2no DN 200	T1,2,3
Kaliro rd (2006)	Kaliro rd	180	900	1no DN 100	T3

Table 4.3: Transmission and distribution network

Type of pipe network	**Length of pipeline (Km)**	
	Jinja	Iganga
Transmission Mains DN 300 - 350	3.0	40.0
Transmission Mains DN 150 - 300	107.0	1.4
Primary Mains DN 50 - 100	399.0	1.0
Total length	509	42.4

4.1.2 Asset management practices

NWSC is developing an asset management policy which is currently in draft form.
Currently there is no noticeable or documented asset management practice safe for routine rehabilitation of infrastructure.
The Headquarters does however maintain an asset register for all Corporation assets and in the year 2008 conducted a revaluation of all assets. As this did not establish the condition of assets the corporation is developing a consultancy for asset condition survey.
Meanwhile it would be good practice to record details on condition of all pipe and fittings replaced in the field as this information will be found useful during the condition survey. This would be in the form of pipe size, material, nature and cause of failure, location from where it was retrieved and pressure before break.

4.1.3 Infrastructure and network documentation

The infrastructure for Jinja and Iganga is documented in block maps, network layouts, Auto CAD drawings, schematic WTP layout.
The Areas do not have a GIS platform but can view and print block maps through a link with the headquarter GIS which is elaborate.
Any updates made on these maps in form of extensions, renewals, new connections are updated by the block mapping team.
The updated networks may however be held by the Area office in hard copies for a while before they are eventually updated in the GIS by the HQ team.

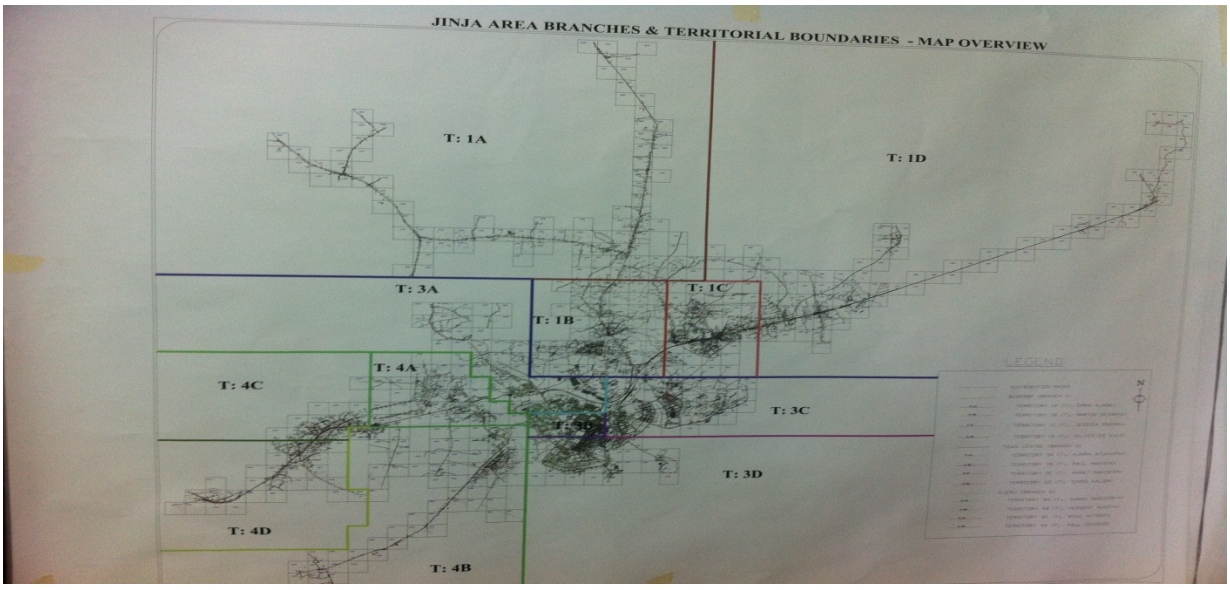


Figure 4.2: layout of Jinja network infrastructure and territorial boundaries

4.1.4 Network management

Both Jinja and Iganga operate in much the same way using Territorial teams made up of a Territorial leader, Marketing assistant and a plumber. Additional labour is outsourced if needed and as dictated by the nature of the problem to be solved.
Water supply to various areas is metered using bulk mechanical meters in chambers. These were observed to have been installed within close proximity of valves and bends without observing best practice for meter installation. This introduces errors due to turbulence and the meter does not measure accurately.
Customer complaints are reported via the call center and the staff. It was noted that some complaints reported by the staff were not always captured through the call center and were never logged. This has the effect of understating the number of cases reported.

It is important to note that although the accepted response time to leak repairs is 6 hours, there are cases where response time exceeding 5000hrs has been recorded. Though this is as a result of not closing the events as explained, it renders the data not authentic for proper analysis of water losses.
There was no evidence for management information system to quantify water loss between the leak reporting and repair time.
Due to the high pressures in Jinja, a supply line is closed at night in one leak prone area to stem water loss when night pressures would be highest (Figure 4.3). This would suggest there is real need for pressure management in such an area otherwise the old pipes need replacement. A pressure control valve would be suitable to reduce the closure and opening of valve which wears it and cause network deterioration.
A close observation of the burst/leak data revealed that the service connection breakages were much higher than mains breaks.

Figure 4.3 Jinja supply line closed at night

Table 4.4: break frequency analysis

Nature of leak/burst		Year\Number of burst/leak		
		2010	2011	2012
Mains Burst		9	3	1
Mains leak		13	5	6
Service connection leak		215	201	207
Total breaks		247	209	214
Break	(breaks/month)	21	18	18
frequency	Breaks/km/yr	0.49	0.41	0.41

This analysis is carried out based on the leaks logged in at the call center. Other leaks reported by staff and customers at the office have not been captured in the system. These have been captured manually in the customer complaints book and are assigned directly. Completed leak repairs are not all logged either in the book or in the system.

This would mean that even the response time to such leaks is difficult to track and does not encourage speed in leak repair.

It was therefore not possible to carry out a proper analysis of the break frequency of the leaks. The low break frequency is a clear indication that only a fraction of leaks and bursts are captured in the data base. Nevertheless pipeline systems having an average annual pipe break ratio per 100 km of less than 40 are considered to be in an acceptable state (Pelletier et al. 2003). Pipes are replaced as and when they leak or burst.

It is important to note that pipe replacement is costly and cannot be justified by using a single criteria of water saving. A multi-criteria approach (supply reliability, social convenience, water quality, etc.) is recommended before a replacement programme is instituted. The Asset management policy under development within the corporation will no doubt guide such a programme.

Figure 4.4 Perforation on old ½ inch pipe

Figure 4.5 Encrustation of the ½ inch pipe removed from the CBD during a leak repair exercise

The existing zones are large and may not be suitable for NRW assessment. Consideration for installation of pilot DMAs is a possible area for improvement.

Hydraulic modeling which currently does not exist could be considered alongside the installation of DMAs where hydraulically discrete zones would help control leakage through pressure management and Minimum Night Flow analysis.
In the case for Jinja and Iganga no data was available of mains and service line replacements. The pipes scrap yard did not reveal storage of any old pipes and fittings retrieved from the field after repair. The ½ "pieces observed clearly showed age, encrustation and perforation suggesting the need to replace the service connections in the CBD.

Both Jinja and Iganga were noted not to have pressure loggers and potable flow meters for meter testing and calibration. These are two activities that the areas have to rely on the headquarter team who may not always be available as requested due to work load.

Figure 4.6 shows an analogue pressure logger on a routine pressure measurement by the area.

Figure 4.6 Analogue pressure logger

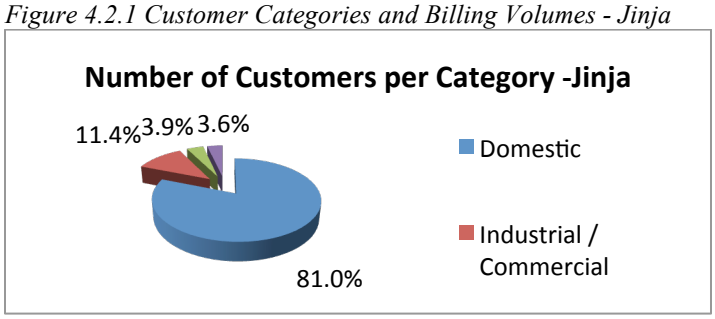
The areas were observed to have an elaborate new connections policy which leaves no room for water loss. Connection materials and labour are provided by the areas and complete connection is made after the customer pays for the connection. Further the applicant is required to have ownership documents and this ensures authentic customer data which is essential for billing. This ensures speedy and quality connections and does not encourage the customer to seek illegal connection. A pro poor connection policy ensures that the informal settlement customer does not have to seek illegal connection. All customers are captured in the data base by the end of the contracting process and hence high billing efficiencies are assured. This section evaluates the water supply infrastructure's capacity and condition with regard to continuous delivery of an acceptable level of service.

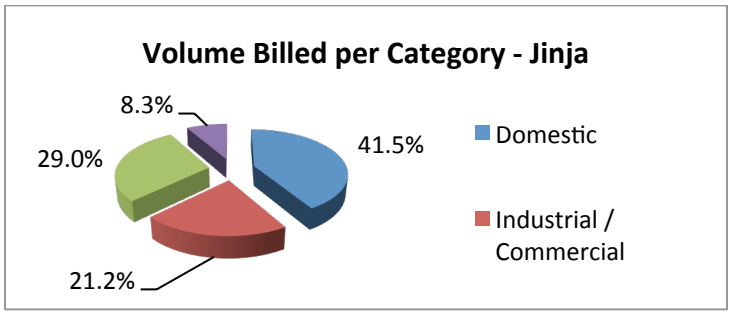
4.2 Commercial Operations Assessment

4.2.1 Billing and Revenue Management Practices

The Jinja Operational Area is organized under three (3) Branches, with each Branch also organized into four (4) Territories. A typical Territory is manned by One Territorial Leader, One Marketing Assistant (responsible for billing and other commercial activities), and one Plumber, (responsible for repair and maintenance on the network). Each Branch is headed by a Branch Manager.
The total number of connections is 16,028. There are 4 categories of customers: Domestic, Industrial / Commercial, Government / Institutional, and Public stand pipes. Whereas the number of domestic customers constitutes 81% of the total number of customers, they account for only 41.5% of the total volume of water billed.

Figure 4.2.1 Customer Categories and Billing Volumes - Jinja





The Operational area of Iganga has a total number of customers of 2,541. Domestic customers constitute 90.8% of the total number and account for 69.8% of the volume billed. The Industrial / Commercial, Government / Institutional, and Public stand pipes customers make up the rest.
All customers are metered, and are billed each month. Both Areas put in a lot of effort to ensure that all customers are metered. Water Supply to informal settlements (such as the Ki-Karamoja in Jinja, who are served by public stand pipes) is metered. The Area office is also metered and billed.
For two of the Branches in Jinja (Town Centre and Bugembe), meters are read and bills produced and delivered to the customer on the spot using a hand-held device .

4.2.2 Customer Malpractices

Jinja reported cases of customer malpractices such as illegal connections, meter by-passes, and tampering of meters. The reports mostly come from informants who are given incentives for providing such information. There is no team in place dedicated to scouting for such cases. Nor is it clear what is done when such individuals are caught.

Billing on the spot has the advantage of saving time in the production and delivery of the bills. Meter reading errors are also reduced since the system requires the reading to be entered three times before the bill is printed. It will therefore be useful to extend spot-billing to the remaining Branch in Jinja as well as Iganga.
Follow up visits should be strengthened. Even though it was reported that the Area Audit team and Branch Managers follow-up to ensure that meter readers enter the correct meter readings, it will be useful to do so in a more structured way. Reports on findings of such follow-up visits should then be prepared, documented, and appropriate actions taken.
There is also the need to reduce customer malpractices through more policing.

4.2.3 Collection

Collection is via banks and mobile money transfers. When customers default, SMS alerts are sent to such customers to remind them that payment is due. Disconnections are sometimes carried out as a last resort. The latest collection ratio (Collection as a ratio of Billing) shows performances of about 91% and 98% for Jinja and Iganga respectively. The main challenge at Jinja has to do with the poor record of payments by the Government / Institutional customers, which constitute about 29% of volume of water billed. Out of total receivables of about 5.7 bn Ushs, Government Institutions owe about 3.8Bn Ushs.
Most African water utilities have difficulties in receiving payments for water supplied to Government Institutions, and this situation is not surprising. NWSC Head Office will have to support the Area to retrieve the arrears owed.

4.2.4 Customer Information System

Customers can have access to the Call Centre via a toll free number where they can lodge any complaints. The Call center keeps records of complaints and tracks it till it is resolved. The Area offices receive these complaints from the call center and act on them. The customer is given aq feedback after the complaint has been resolved.
A look at the nature of complaints as recorded in the complaints register showed that there were very few complaints relating to the commercial operations (typically stolen meter, no bills, reconnection required) when compared to complaints such as leaks and bursts. It was reported that the common type of commercial complaints has to do with disputes about the bills of the customers. With these types of complaints, the customers choose to come to the office rather than call the Call Centre. The fewer commercial complaints suggests that the NRW is more physical than commercial.
Jinja and Iganga rely on Kampala to update their GIS customer information. Sometimes up-dating their GIS customer maps takes time. The proposal to set up an Area office to handle such issues should therefore be pursued.
The company also has a Customer Charter which spells out among others what the company stands for, what the customers should expect from the company and what the company also expects from the customers. This serves as a useful link with the customers.

4.2.5 New Service Connections

The new service connection procedure is relatively simple for prospective customers. Customers whose properties are within 50m of the nearest tapping point receive a subsidy.
One difficulty is that sometimes Jinja is unable to complete the connection after payment by the customer within 3-days as stipulated in the charter. Sometimes it takes 1 to 2 weeks.

The danger here is that a customer might be tempted to carry out their own connection illegally. The Area should therefore ensure that New Connection Materials are always available.

4.2.6 Meter management

Meter Types

Generally, the meters in use are of different types such as Kent, Arad, Socam, and are also of different ages. Procurement of the meters is done centrally, and has to conform to the relevant

Act which governs public procurement. The Area office therefore has little control over the types of meters procured. In order to improve on the quality of meters procured, NWSC now specifies the procurement of velocity and class C meters only. The meters should also be tamper proof, and availability of spares for the following 10 years should be guaranteed after production of the meter is stopped.
Iganga maintains a good record of the customer meters. The information includes Customer Name & Address , Meter Type, Serial No, Size, Date Installed, Age, and Average Consumption. Such information is very useful, especially in meter management, and in serving as an input when the meter policy has to be revised

Meter Testing

The Jinja Area has one portable test kit for testing of domestic meters. Larger sized meters have to be tested in Kampala. It was reported that meters are mostly tested when a customer complains, or there is a reasonable cause to suspect that the meter might be under-registering. There is no consistent schedule for testing of all meters in the field.

Meter Installation

Some of the meters inspected show that they have been correctly installed. Some also were nearly covered. The explanation offered for the state of some of these nearly buried meters was that they were prone to vandalism by virtue of their location. Even though this explanation is acceptable under the circumstances, any field testing of the meter will be difficult to carry out.

Figure 4.2.2 Meter nearly buried .

Figure 4.2.3 Metered public standpipe at Ki-Karamoja

Meter Replacement

A total of 671 domestic meters were replaced during the financial year 2011/2012. This represents only 6.3% of the total of 10,728 active domestic customers or 5.2% on the total number of customers of 12,982. At this rate, it will take about 16 years to replace the meters of all the active domestic customers (or 19.3 years if the total number of domestic customers is considered). Meter replacement is based on verified non-functioning of the meters. Even though it was reported that according to the meter replacement policy, the age of a customer meter should not exceed 15 years, this policy is hardly followed. The company is in the process of reviewing the maximum age of meters downwards to 10 years.

4.3 Key Recommendations

- It will be useful to extend on the spot billing to the remaining Branch in Jinja as well as Iganga
- Though the billing system is generally effective, follow up visits should be strengthened by being done in a more focused and structured manner to minimize customer malpractices. Reports on findings of such follow-up visits should then be prepared, documented, and appropriate actions taken.
- It is essential to ensure that measurements of the meters are as accurate as possible There should be a program to carry out field testing of all customer meters on the average once a year to ensure that readings of the meters are as accurate as possible
- The company should also be more proactive in replacing customer meters to conform to the maximum age specified, rather than replacing meters only when they become defective
- NWSC should assist the Area Office to collect the Government Bills
- Area should ensure that New Connection Materials are always available

5 Water Balance

The water balance is a tool developed to assist water supply providers to keep track of water supplied to an urban water distribution system. It summarizes water balance components and provides accountability of water consumption and losses. Theoretically, all water put into the distribution system must equal water used and lost i.e. all columns of the water balance should be equal.

The water balance analysis should be conducted on annual basis and daily figures can be optained by dividing by 365 days. By using annual figures, seasonal variations in water usage can be ignored (Male et. al. 1985).

5.1 Baseline Water Balance

Both Jinja and Iganga Branch have water balances for the financial year 1 July 2011 to 30 June 2012. The water balance spreadsheet results for the Jinja and Iganga Areas are shown in Figures 5.1 and 5.2

During discussions with the operations engineers it was clear that they fully understand the concept of the water balance and acknowledge the value of having the results for each component – and corresponding performance indicators - to help them prioritise actions to reduce NRW. NWSC is intending to roll out the water balance methodology, using WB Easy Calc, across the other branches.

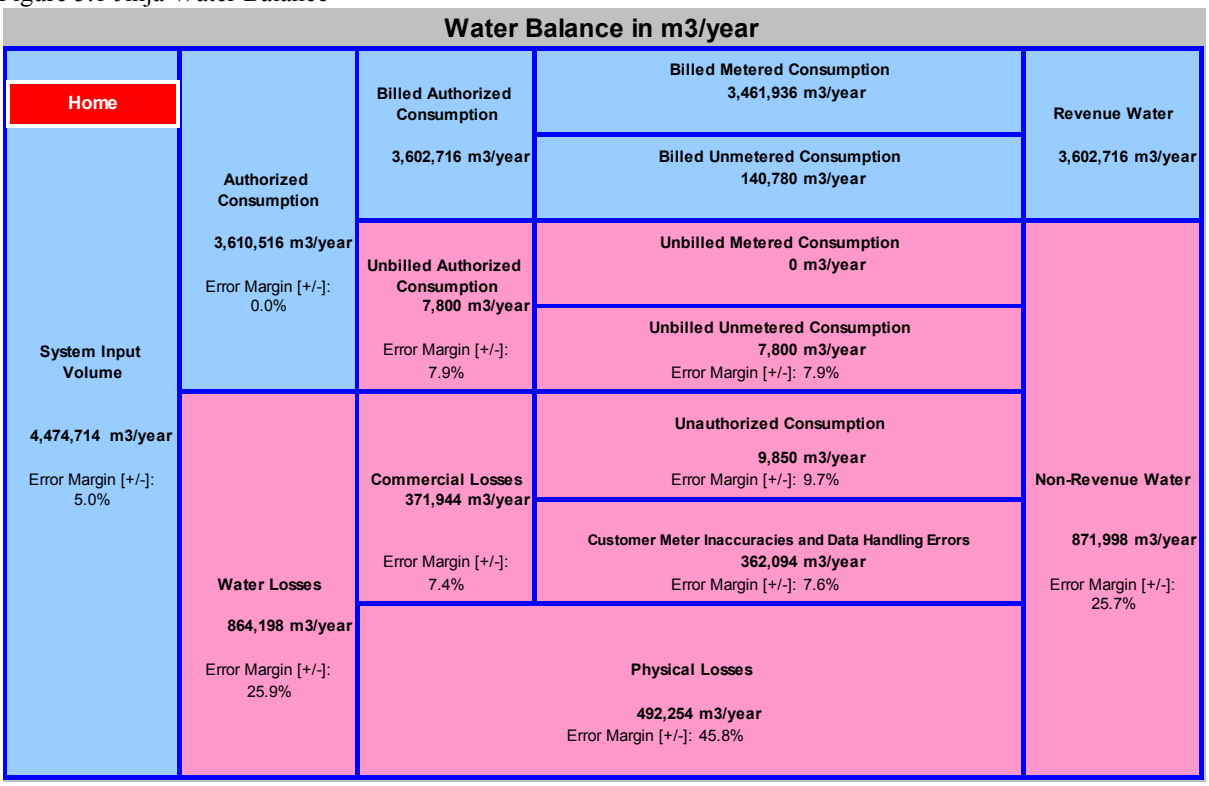
5.1.1 Jinja

Comments on the components of water balance for Jinja are as follows:

Water into Supply. The error margin is 5.0 %. This is an acceptable figure for a mechanical meter
Bulk export of water. This is water supplied to Iganga Branch – also deemed to be accurately metered
Billed metered consumption. This is divided into 4 categories of customer. Volumes are taken from customer billing records and are deemed to be accurate
Billed unmetered consumption is estimated for the same 4 categories, using local knowledge of likely consumption, and deemed to be accurate
Unauthorised consumption. Illegal connections have been estimated from data from suppressed accounts in each branch surveyed. A figure of 20l/day is used, based on jerrican volume. Out of the accounts investigated, illegal or non NWSC customers are identified and extrapolated across branches. The error margin of 15%, based on such extrapolated data seems low.
Other Unauthorised Consumption. These are commercial and other non-domestic users. A figure of 40 l/day (also with 15% error margin) is used in the water balance
Meter tampering. Data for tampering comes from reports by territory marketing assistants. Again, a 15% error margin is applied

The error margins for unauthorised consumption are set at 15% based on local knowledge. These margins seem to low for such estimated values. Suggestions for improving the accuracy of these data are made below. However, the total volume of water in this category is very small.
Unbilled consumption. Volumes used for sewer and mains flushing are estimated. Error margins of 10% seem low without sample flushing times and volumes. Fire fighting volumes are estimated, with a higher error margin of 15%, as the fire service is reluctant to give data on fire hydrant use
Customer meter error. An overall error margin of 8 % is used, based on the data for 10 year old meters that have been tested.
Network data. There is a misunderstanding over the definition of length of customer service connection from the meter to the property boundary. This is currently set at 15.0m, but is anover-estimate, as the length from the meter to the customer tap, not the property boundary, has been used. An underestimate of 15% is used for total length of mains, indicating some uncertainty on the accuracy of mains records.

Figure 5.1 Jinja Water Balance



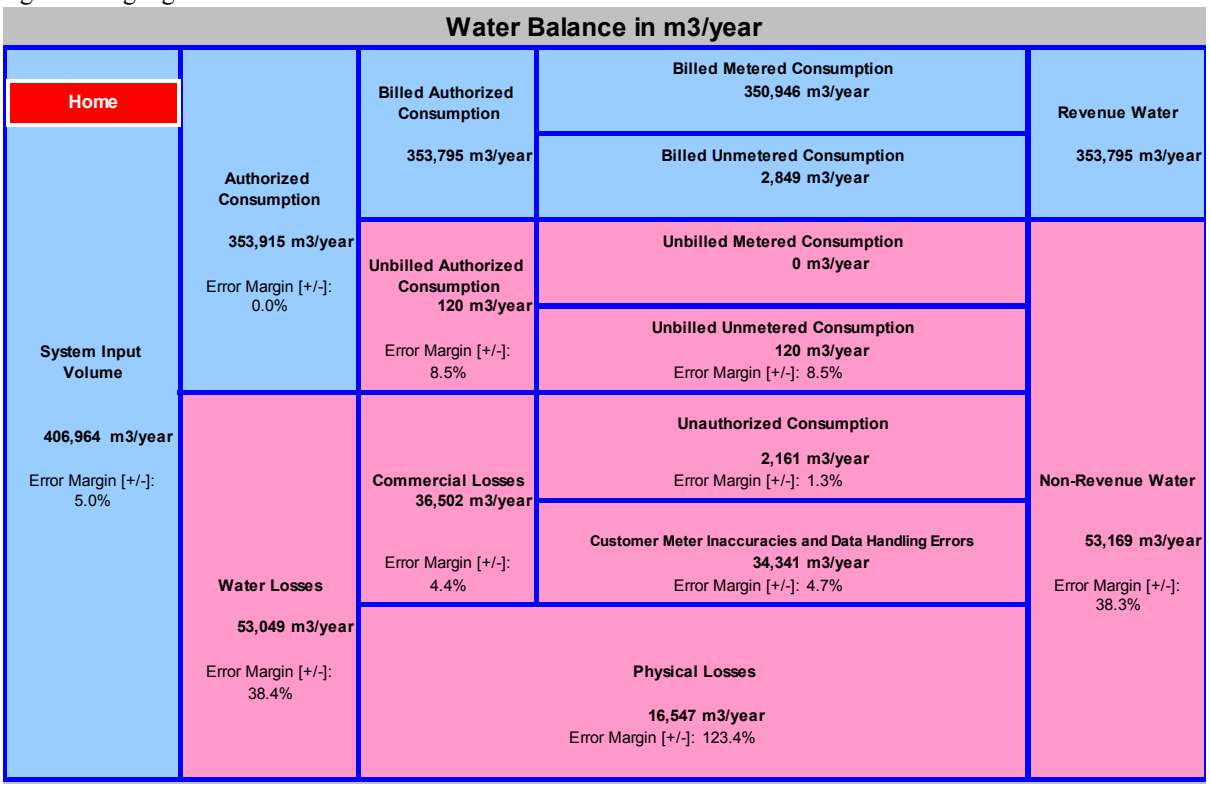
5.1.2 Iganga

Comments on the components of water balance for Iganga are as follows:

Iganga has a relatively new (6 years) pipe network.
Water into supply is via the bulk export from Jinja, with the same meter error margin of 5%.
Unauthorised consumption is correspondingly lower, and error margins of 10% are used for

illegal connections and 15% for meter tampering. The rest of the data inputs and error margins follow the methodology used for Jinja.

Figure 5.2 Iganga Water Balance



5.2 Key Water Loss Performance Indicators

The key performance indicators (PIs) for Jinja and Iganga are reported using the Easy Calc water balance spreadsheet (Figures 5.1 and 5.2)

There are some major anomalies in some in the imput data to the water balance spreadsheet. These have resulted in corresponding anomalies in all the performance indicators, particularly relating to the calculation of minimum achievable physical losses (MAPL) and the resulting ILI. These indicators cannot be seen as a true reflection of the current real losses and commercial losses in the two Areas until the data have been checked, new data input and the balance recalculated. The reliability of the PIs arising from the water balance calculations are discussed in 5.3

Figure 5.3 shows key operational performance indicators used by Jinja and Iganga Areas.

JINJA

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Water Resources

PI Code	Performance Indicator	Value
	WRI - Inefficiency of Use of Water Resources (%)	5

Personnel Management

PI Code	Performance Indicator	Value
	Bursts and Leak Repair Staff (No./1000 connections)	1
	Meter reading Personnel (No./1000 meters)	1
	Illegal Use Management Personnel (No./1000 connections)	0.180

Operational Indicators (7 PIs)

	System Flow Meters Calibration (%)	25
	Leakage Handling Efficiency (%)	92
	Network Length Surveyed (%/year)	#REF!
	Active Leakage Control Repairs (No./100Km/year)	0
	Meter Failure (%/year)	0.0
	Inactive Accounts Ratio (-)	0.2
	Transport Availability (No./100 km)	1.0

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Asset Serviceability Indicators (6 PIs)

	Functional Valve Density (No./100 Km)	39
	Mains Failure (No./100 Km/year)	65
	Service connection failures (No./1000 connections/yr)	6908
	Mains replacement (%/year)	1
	Service Connection replacements (%/year)	0.3
	Meter replacement (%/year)	3.2

Meter Management (3 PIs)

	Meter reading efficiency (%)	100
	Operational Meters (%)	100
	Meter replacement (%/year)	3

Illegal Use Management (3PIs)

	Illegal Use Detection Efficiency (%)	75
	Fines Recovery Efficiency (%)	32
	Illegals found per investigator	1

Economic and Financial (3 PIs)

	Operating Cost Coverage Ratio (-)	2
	Current Ratio (-)	2
	NRW Budget Utilisation Efficiency (%)	30

5.3 Comments on Data Reliability and Accuracy

Although most of the water balance component data have been input correctly, the audit identified some issues that need to be addressed:

- The basis for estimating some error margins
- The categorisation of customer meter errors
- Understanding the definition of customer service pipe length and re-entering the correct value
- Carrying out further research via territory surveys to check estimates for illegal connection
- and meter tampering
- Addressing the category for input of data for customers not yet registered on the database
- Investigating some major anomalies in the results of the water balances, particularly
- relating to the calculation of minimum achievable physical losses (MAPL) and the resulting ILI
- Checking the basis for calculating pipe length in the network, and adjusting if Appropriate
- Carrying out 'what if?' scenarios to justify capital investment schemes such as PRV installation

5.3.1 MAPL and ILI

The main anomaly, in both Jinja and Iganga water balances, is the unusually high value for Minimum Achievable Physical Losses (MAPL). In the case of Jinja the value of MAPL is 932 m3/day, and the value of Current Annual Real Losses (CARL) is 1349 m3/day. In Iganga MAPL is 141 m3/day, higher than the CARL , which is 45 m3/day. This directly affects the ILI performance indicator for each area, 1.4 for Jinja and 0.3 for Iganga. These are clearly erroneous performance indicators. As the calculation of MAPL is based on the network data, as are some of the other PIs which depend on length of main and customer service pipes, investigations into the accuracy of these components are required.

5.3.2 Physical Loss Volume

The figure for Physical Losses is the residual volume once the volumes for authorised consumption and commercial losses has been subtracted from the system input volume. This value can be checked by the 'bottom up' calculation of Physical Losses using DMA daily net night flows aggregated into an annual volume. This calculation can be made once DMAs are in place in the Jinja and Iganga networks.

5.3.3 Customers not yet registered on database

5m3/day for these customers is currently allocated as 'unauthorised consumption'. This is not unauthorised and discussion took place during the audit on if and where this component should be re-allocated. One option is to move it to unbilled authorised use, making a note to this effect in the water balance notes.

5.3.4 Length of customer service pipe

This value, currently 15.0m, should be revised to reflect a more realistic – and lower – length of service pipe between the meter and the customer's boundary.

5.3.5 Meter error

The utility has data on accuracy of customer meters by age, type etc. Each category (the average error for each category (0-5 years, 5-10 years, >10 years etc) can be used to enhance the current estimated error of 8% for all categories.

5.3.6 Illegal connections (domestic and commercial)

As well as current system of looking at suppressed accounts, the utility could consider a pilot area (eg one territory) to survey registered/unregistered customers and to confirm the values of 20 l/day and 40 l/day currently used, which could be an under-estimate

5.3.7 Meter tampering

Estimates of volumes come via territory marketing assistants, and from anomalies in billing data, but again a survey to spot check meters and anomalies (at the same time as checking for illegals) could be a good cross check.

5.3.8' What if?' scenarios to justify future investment

The water balance spreadsheet includes a 'what if' tool, giving the utility an option to adjust a range of parameters (pressure, supply time, network coverage, physical and commercial losses) to examine, for example, the effect of installing pressure reducing valves.
But the first step for both areas should be to check the figures for network mains length and customer service pipe length, as well as other recommended adjustments.

6. Key Audit Findings

This section presents key audit findings focusing on institutional aspects, technical operations, commercial operations and the water balance, related to NRW in Jinja and Iganga Areas.

6.1 Institutional Aspects

The key institutional audit findings were as follows:

- The Areas have identified NRW as one of their operational challenges and further describe illegal use, lack of comprehensive DMA meters, lack of proactive and systematic monitoring mechanism to detect defective meters and inadequate mechanisms in place to analyze customer consumption trends to guide in detecting illegal water users. However, from the presented water balance it seems that more effort should be directed towards reduction of physical losses rather than illegal water use
- The staff from both Areas appeared to be very knowledgeable and informative on issues on NRW. There is a clear communication between billing and maintenance sections in completion of the water balance which is very commendable. This shows that NRW is not viewed as an issue for only the maintenance staff
- The territorial management system, which fits in well with the PACE programme; this system ensures that Areas are divided into small, discreet manageable zones. This improves on customer, utility relationship and also gives staff members more responsibility for the smooth operation of the utility. Monthly evaluations are carried out to determine the territories performances and NRW is one of the performance indicators
- Jinja and Iganga currently rely on Kampala for most of their NRW reduction requirements including meter testing, investigation for invisible leakages and pressure management, where else Kampala Area appears to be stretched in dealing with its own NRW reduction programme. This leads to a backlog and removes the responsibility from the Area to manage NRW reduction. It could be beneficial for the Area to set up a NRW reduction unit. This will assist in making the Area completely responsible for their NRW reduction programmes

6.2 Technical Operations

The key technical audit findings were as follows:

- Both Jinja and Iganga operate in much the same way using Territorial teams made up of a Territorial leader, Marketing assistant and a plumber. Additional labour is outsourced if needed and as dictated by the nature of the problem to be solved.
- Water supply to various areas is metered using bulk mechanical meters in chambers. These were observed to have been installed within close proximity of valves and bends

without observing best practice for meter installation. This introduces errors due to turbulence and the meter does not measure accurately.

- Customer complaints are reported via the call center and the staff. It was noted that some complaints reported by the staff were not always captured through the call center and were never logged. This has the effect of understating the number of cases reported
- Due to the high pressures in Jinja, a supply line is closed at night in one leak prone area to stem water loss when night pressures would be highest (Figure 4.3). This would suggest there is real need for pressure management in such an area otherwise the old pipes need replacement. A pressure control valve would be suitable to reduce the closure and opening of valve which wears it and cause network deterioration.
- A close observation of the burst/leak data revealed that the service connection breakages were much higher than mains breaks
- It was not possible to carry out a proper analysis of the break frequency of the leaks. The low break frequency (Table 4.4) is a clear indication that only a fraction of leaks and bursts are captured in the data base.

6.3 Commercial Operations

- All customers are metered, and are billed each month. Both Areas put in a lot of effort to ensure that all customers are metered. Water Supply to informal settlements (such as the Ki-Karamoja in Jinja, who are served by public stand pipes) is metered. For two of the Branches in Jinja (Town Centre and Bugembe) meters are read and bills produced and delivered to the customer on the spot using a hand-held device
- Jinja reported cases of customer malpractices such as illegal connections, meter by-passes, and tampering of meters. The reports mostly come from informants who are given incentives for providing such information. There is no team in place dedicated to scouting for such cases. Nor is it clear what is done when such individuals are caught.
- It was reported that some customers have roof-tanks and other storage tanks, which means that it is possible that some of the meters might be under-registering. It was also reported that some customers sometimes attempt to vandalise the meters and cause them, to under-register.

6.4 Measurement and Information Management

This has been addressed in each of the previous sections, and particularly in 5.3 – water balance.

7. Conclusions, Recommendations and Key Actions

7.1 Conclusions

The audit findings show that Jinja Operations Area has made commendable efforts to both understand and manage NRW:

- Establishing a water balance for Jinja Area and Iganga Branch
- Gaining an understanding of the relative significance of water balance components by collecting and analyzing data
- Acknowledging the part played by other departments in provision of information and data for the water balance
- Establishing a good customer billing and collection department

However, there is scope for improvement to enhance the collection of accurate data and to support the reduction of both physical and commercial losses:

- Setting up a dedicated NRW unit to remove dependency on Kampala for equipment
- Establishing regular customer surveys to identify missing customer connections and to strengthen billing procedures
- Introducing improvements for meter testing and meter replacement
- Improving energy efficiency at pumping stations by carrying out audits on pumping and motor starting procedures
- Ensuring that all bursts and leaks are logged for improved data management
- Amending the design of bulk meter installations to improve meter accuracy

Key recommendations for improvement are listed in Table 0.1

Jinja operations staff have identified issues that require capital investment. A budget has been allocated for:

- Design and installation of District Meter Areas (DMAs) to enhance data collection for leakage management and bottom up calculation of physical losses.

- Installation of pressure reducing valves (PRVs) to reduce burst frequency and leakage

- Purchase of an ultrasonic flow meter and leak detection equipment

7.2 Recommendations and Key Actions

7.2.1 Institutional Assessment

Issue	Recommendation

There is a high dependency on Kampala Water for NRW reduction activities: - Pressure testing - Meter testing - Update of GIS maps - Active leakage detection	Set up an independent and self-contained NRW unit that has links with all other departments

7.2.2 Technical Operations

Issue	Recommendation
Motors in pumping stations are star-delta starting	Carry out an energy audit of all the pumps and introduce soft start mechanism
Not all customer complaints are logged in the call center Most of the reported leakages are in the CBD on service connections	Ensure all leakages and bursts are logged for improved data management and water loss assessment
Bulk meters installed next to fittings	Install bulk meters to follow manufacturer installation guidelines for improved meter accuracy
DMAs are not fully established	Ensure full establishment of DMAs

7.2.3 Commercial Opererations

Good billing system in place	Strengthen follow up visits for billing
Meter testing and replacement practice is reactive	More proactive meter testing and replacement Meter installation procedure to be improved
Some Customers missing from data base	Regular customer surveys to ensure that all customers are on the data base
Service connections installation time does not always follow the charter	Installation process should be improved and material made available

7.2.4 Water Balance

Water balances are in place and staff are competent.	But some adjustments are required Use of the "what if" tool to investigate investment in pressure management and DMA management

Surveys are required to verify network data	Network data requires checking to verify MAPL Bottom up approach to verify real losses
Some error margins need checking	Customer categories for meter accuracy to be introduced Surveys for investigating illegal connections and meter tampering to improve the data

Annex A: Programme for the Audit

- Team leader – Cephas
    - Responsibilities – Introduce the team and programme
- Roles and responsibilities of each member
    1. Introduction - SK
    2. Methodology and Annex - Malcolm
    3. Institutional assessment – Malusi DLAMINI
    3. 4.1 Operation Management assessment – technical operations assessment – John RUHIU
    4. 4.2 Operation Management assessment – commercial operations assessment – Cephas OGUAH
    5. Key Audit Findings – all
    6. Conclusions – all
    7. team bios – Malcolm
- The Team Leader will introduce the team. He will mention who we are and explain what we are doing, the roles of the utility and task force, what the programme can and cannot support.

4.2 AGENDA – Entry meeting

Prayer
Introductions
Remarks – GM
Audit team presentation
Utility presentation
Clarifications
Closing prayer

4.3 AGENDA – Exit meeting

Prayer
Remarks – GM
Preliminary findings
Utility reactions/ clarifications
Any Other Business (AOB)
Closing prayer

4.4 Programme

		Activity	Responsible	
			Task Force	**Utility**
Day 1: Wednesday 16th Jan	Morning	Courtesy call to the GM Entry Meeting	All All	GM Management Team
	Afternoon	Field visits	All	TBD
Day 2: Thursday 17th Jan	Morning	Water Balance Group Meetings	All Responsible TFM	TBD
	Afternoon	Group Meetings	Responsible TFM	TBD
Day 3: Friday 18th Jan	Morning	Group Meetings/ Field Visits Report Writing	All	TBD
	Afternoon	Wrap-up meeting	All	TBD

Annex B – Utility NRW Self Assessment Matrix for Jinja and Iganga Areas

JINJA AREA: SELF ASSESSMENT MATRIX ON NON REVENUE WATER

	Level / Issues / questions	1 Basic	2	3	4	5 High
1	**Water Balance, Flow and Pressure Monitoring, Mapping**					
1.1	**Water Balance**	We do not establish a water balance	We have tried to establish a water balance but gave up since we don't know the split in physical and commercial losses	We establish a water balance following our own format	We establish an annual water balance in accordance with the international form	We establish an annual water balance in accordance with the international form and also use 95% confidence limits to indicate accuracy bands.
1.2	**System Input Metering**	Most of our system input is not metered	Not all, but > 50% of our system input is metered	Our system input is metered but we are not sure about the accuracy of these (partly old) meters	Our system input is metered with mechanical and/or magnetic flow meters that are rarely calibrated	Our system input is metered with magnetic flow meters that are regularly calibrated
1.3	**Pressure Monitoring**	We do not have any pressure recorders installed	We have a few pressure recorders at pumping stations and treatment plants installed	We have a few pressure recorders at pumping stations and treatment plants installed and sporadically measure pressure in the distribution network with pressure gauges	We have a few pressure recorders at pumping station and treatment plants and sporadically measure pressure in the distribution network with pressure loggers	We have permanently installed pressure loggers and continuously monitor pressure in the distribution network
1.4	**Maps/GIS**	We do not have maps at all	The maps we have are not updated	We have started to update our maps	Our maps are updated but do not include GIS	We use GIS based on updated maps
2	**Leak Repair Records**					
2.1	**Leak Repair Records**	We have no records of leak repairs	The only way to know the number of leaks repaired is to look into the customer complaints book	We keep basic leak repair records that only tell us whether the leak was on a main pipe or a service connection	We keep detailed records that indicate location, pipe diameter, material and type of leak as well date of detection and date and duration of repair	We keep detailed records that indicate location, pipe diameter, material and type of leak as well date of detection and date and duration of repair and have linked this to our GIS
3	**Performance Indicators**					
3.1	**Performance Indicators**	The only PI used is % NRW	We have tried to calculate water loss performance indicators	We regularly calculate physical loss performance indicators	We regularly calculate physical and commercial loss performance indicators	We regularly calculate physical and commercial loss performance indicators and publish them in our annual report
4	**Active leakage control**					
4.1	**Active leakage control**	We only repair visible leaks.	We have leak detection equipment but we do not use it.	We do leak detection occasionally if there is a specific problem in an area.	We have started to do regular leak surveys.	We cover the network by leakage survey at least once a year.
4.2	**District Meter Areas (DMAs)**	We have no DMAs and have no plans to establish DMAs	We have started to establish the first DMAs	The first DMAs are established and we have already the first results	We have several DMAs and check and analyse inflow data sporadically	We have several DMAs and monitor flow and pressure on a regular basis
4.3	**Leak Repair - Distribution Pipes (Repair Time)**	We have no records and therefore don't know how fast our leaks repaired	Our average repair time is more than 7 days	Our average repair time is between 7 and 3 days	Our average repair time is between 3 and 1.5 days	Our average repair time is less than 1.5 days
4.4	**Leak Repair - House Connections**	We have no records and therefore don't know how fast our leaks repaired	Our average repair time is more than 14 days	Our average repair time is between 14 and 7 days	Our average repair time is between 7 and 2 days	Our average repair time is less than 2 days
5	**Customer Metering**					
5.1	**Customer Metering**	We have no customer metering	Only large customers are metered	We have started with universal customer meters but at present not all customers have meters installed	Nearly all of our customers are metered, except public fountains, stand pies and similar.	100% of our customers are metered
5.2	**Customer Meter Replacement and Age**	We have no reliable information on the age of our customer meters	Many of our customer meters are older than 10 years, we have not yet introduced a regular replacement policy	We only change meters if they are obviously not functioning anymore	We have a meter replacement policy but have not been able to change all meters so some of our customer meters are still older than 10 years	We strictly follow our customer meter replacement policy and replace ALL meters every 5 - 7 years
5.3	**Customer Meter Class**	All customer meters are class B	All customer meters are Class B and C	All customer meters are class C	All customer meters are Class C and D	All customer meters are class D
5.4	**Customer Database**	Our customer database has not been updated for a long time	We sporadically update our customer database	We are in the process of updating our customer database	We regularly update our customer database by house to house surveys and checks	We have an updated customer data base that is linked to the GIS.
5.5	**Customer Meter Reading**	We have no special system of controlling meter readers	We only rotate meter readers if we are suspicious of inaccuracies	We regularly rotate meter readers	We regularly rotate meter readers and make often spot checks	Our meter readers use handheld meter reading devices
5.6	**Illegal Connections, meter tampering, bypasses**	We have not made any assessment and have no program to deal with water theft	We occasionally detect illegal connections	We occasionally detect illegal connections and other forms of fraud	We have a thorough illegal connection detection program	We have a thorough illegal connection detection program and also try to identify bypasses

IGANGA AREA - SELF ASSESSMENT MATRIX ON NON REVENUE WATER

	Level / Issues / questions	1 Basic	2	3	4	5 High
1	**Water Balance, Flow and Pressure Monitoring, Mapping**					
1.1	**Water Balance**	We do not establish a water balance	We have tried to establish a water balance but gave up since we don't know the split in physical and commercial losses	We establish a water balance following our own format	We establish an annual water balance in accordance with the international form	We establish an annual water balance in accordance with the international form and also use 95% confidence limits to indicate accuracy bands.
1.2	**System Input Metering**	Most of our system input is not metered	Not all, but > 50% of our system input is metered	Our system input is metered but we are not sure about the accuracy of these (partly old) meters	Our system input is metered with mechanical and/or magnetic flow meters that are rarely calibrated	Our system input is metered with magnetic flow meters that are regularly calibrated
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1.4	**Maps/GIS**	We do not have maps at all	The maps we have are not updated	We have started to update our maps	Our maps are updated but do not include GIS	We use GIS based on updated maps
2	**Leak Repair Records**					
2.1	**Leak Repair Records**	We have no records of leak repairs	The only way to know the number of leaks repaired is to look into the customer complaints book	We keep basic leak repair records that only tell us whether the leak was on a main pipe or a service connection	We keep detailed records that indicate location, pipe diameter, material and type of leak as well date of detection and date and duration of repair	We keep detailed records that indicate location, pipe diameter, material and type of leak as well date of detection and date and duration of repair and have linked this to our GIS
3	**Performance Indicators**					
3.1	**Performance Indicators**	The only PI used is % NRW	We have tried to calculate water loss performance indicators	We regularly calculate physical loss performance indicators	We regularly calculate physical and commercial loss performance indicators	We regularly calculate physical and commercial loss performance indicators and publish them in our annual report
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4.1	**Active leakage control**	We only repair visible leaks.	We have leak detection equipment but we do not use it.	We do leak detection occasionally if there is a specific problem in an area.	We have started to do regular leak surveys.	We cover the network by leakage survey at least once a year.
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5	**Customer Metering**					
5.1	**Customer Metering**	We have no customer metering	Only large customers are metered	We have started with universal customer meters but at present not all customers have meters installed	Nearly all of our customers are metered, except public fountains, stand pies and similar.	100% of our customers are metered
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5.3	**Customer Meter Class**	All customer meters are class B	All customer meters are Class B and C	All customer meters are class C	All customer meters are Class C and D	All customer meters are class D
5.4	**Customer Database**	Our customer database has not been updated for a long time	We sporadically update our customer database	We are in the process of updating our customer database	We regularly update our customer database by house to house surveys and checks	We have an updated customer data base that is linked to the GIS.
5.5	**Customer Meter Reading**	We have no special system of controlling meter readers	We only rotate meter readers if we are suspicious of inaccuracies	We regularly rotate meter readers	We regularly rotate meter readers and make often spot checks	Our meter readers use handheld meter reading devices
5.6	**Illegal Connections, meter tampering, bypasses**	We have not made any assessment and have no program to deal with water theft	We occasionally detect illegal connections	We occasionally detect illegal connections and other forms of fraud	We have a thorough illegal connection detection program	We have a thorough illegal connection detection program and also try to identify bypasses

Annex C: List of People Contacted

1. Focus Group Meetings

Audit Topic	Name	Role
All topics/Exit Meeting	Silver Emudong	GM Jinja
Institutional Assessment	Malusi Dlamini	NRW Task Force member/Audit Team Leader
	Jackie	Senior HR Officer
	Nathan	Principal Accounts Officer
	Adaku	Branch Manager - Bugembe
	Isagara Paul	Area Manager - Iganga

Technical Operation Assessment	John Ruhiu	NRW Task Force member/Audit Team Leader
	Wandwasi Badru	Principal Area Engineer
	Ovola Fred	WTP Overseer
	Mutaawe Lawrence	Technical Supervisor - Jinja
	Stephen	Technical Supervisor - Iganga

Commercial Operations Assessment	Cephas Oguah	NRW Task Force member/Audit Team Leader
	Lydia	Senior Commercial Officer
	John Tibenda	Branch Manager
	Geoffrey	
	Rogers	Branch Manager - Iganga
	Titus	Commercial Officer - Billing

2. Full Attendance List – Opening Meeting

3.

Name	Country	organization	Title
Mbali Matiwane	S.A	Johannesburg Water	Physical Loss Manager
Malusi Dlamini	Swaziland	SWSC	Water Loss Engineer
John M Ruhiu	Kenya	NCWSC	Non Revenue Water Manager
Elly David Onyango	Kenya	KIWASCO	MD
Cephas T Ogwuah	Ghana	GWCL	Chief Manager Business Plan
Mahmood Lutaaya	Uganda	NWSC	M(PM&E)
Sarah Walusimbi	Uganda	NWSC	CM–M/CS
Kaford Allan	Uganda	NWSC	PE–OPS
Komunkyeya Victoria	Uganda	NWSC	Research officer
Sandra Akello	Uganda	NWSC	Trainee/FA
Carolyne Nyangweso	Uganda	NWSC	SE(PM&E)
Okaranon Edmond	Uganda	NWSC	SM–SS
Bangye Sam	Uganda	NWSC	SCOR
Anthony Ojok	Uganda	NWSC	PAE
Wandwasi Badru	Uganda	NWSC	PAE
Isagara Paul	Uganda	NWSC	AM–Iganga
Tom Buyi	Uganda	NWSC	PE–OPS
Susan Nanyange	Uganda	NWSC	STO
Sheba B. Mukiza	Uganda	NWSC	SCRO
Niyoyita Benon	Uganda	NWSC	E-M&E
Silver Emudong	Uganda	NWSC	GM Jinja
Simon Loker	Uganda	NWSC	S E O
Kibirige Joshua	Uganda	NWSC	T/A
Babu Mohammed	Uganda	NWSC	M-R
Charles Ekure	Uganda	NWSC	GM Entebbe
Martin Kalibbala	Uganda	NWSC IREC	M–T&A

Harrison Mutikanga	Uganda	NWSC IREC	WLCM
Rose Kagwa	Uganda	NWSC IREC	SM–ES
Eddy Sendikwanawa	Uganda	NWSC IREC	SNSO
Sonko Kiwanuka	Uganda	NWSC OPS	SMO
Dr. Silver Mugisha	Uganda	NWSC	CM–IDES
Malcolm Farley	UK	FABRI	Consultant
Alfred O.Okidi	Uganda	NWSC	CM–F&A
Kikomeko Samuel	Uganda	NWSC	Eng. WLC
Gisagara Alex	Uganda	NWSC	Ag. MD
Tabaaro K. Emmy	Uganda	NWSC	SEI
Kathy Alison	USA	FABRI	Facilitator

Annex D: Brief Biodata of Audit Team Members

DLAMINI Malusi is the Water Loss Engineer for Swaziland Water Services Corporation. He has 2 years experience in water utility operations and he specializes in leakage management practices including network zoning and pressure management, network hydraulic modeling and network designs. He has keen interest in research particularly asset management of water infrastructure systems. [redacted]

FARLEY Malcolm is a chartered engineer (CEng), a chartered environmentalist (CEnv), a Fellow of CIWEM (FCIWEM) and a Chartered Water and Environment Manager (C.WEM). He is a long-standing member of IWA, and is Secretary of the IWA Water Loss Specialist Group (WLSG). Malcolm has 40 years experience of working with water supply and distribution networks worldwide, working for the UK Water Research Centre (WRc) for 25 years, and, since 1982, specialising in water loss management and leakage control. Malcolm left WRc in 1994 to form his own consultancy, Malcolm Farley Associates. As a consultant to many international water utilities and other organizations including the Asian Development Bank, the World Bank, USAID and the World Health Organisation, he specialises in managing water loss reduction strategies - and conducting training workshops - for water utilities worldwide. He is co-author, with Stuart Trow, of the IWA book - 'Losses in Water Distribution Networks [redacted]

RUHIU John is a Civil Engineer with a Master's degree in Water and Waste Engineering. He is registered with the Engineers Registration Board Kenyan Chapter and is a member of the Institution of Engineers of Kenya (MIEK). John has over 20 years' experience working with water supply and distribution networks and has gained experience in water loss management and leakage control through working with water loss control consultants. He has conducted several NRW reduction training sessions for staff of other local water utilities over the years and is the current head of the Non Revenue Water Department in Nairobi Water and Sewerage Company Ltd [redacted]

SONKO Noah Kiwanuka (SK) is a Sanitary Environmental Engineer with over 23 years experience in the Water, Wastewater Management and Sanitation Sector in Uganda and overseas. He is currently the Senior Manager Operations at Uganda's National Water and Sewerage Corporation. He has additional training in the field of water management, utility regulation, water loss management, asset management, project planning & Management, Procurement, Change Management, Leadership Skills, Bullet Proof Manager among many. He has been involved in applied research in the areas of appropriate low cost wastewater treatment using natural treatment systems; a visiting lecturer at the Makerere University Kampala MSc - Civil Engineering Course. He is the current Chair Uganda Chapter of East African Water Association and non-Executive Partner of WSS Services (U) Ltd. private Water Company [redacted]