Utility Assessment Initiative

Report for:

Aswan General Economic Authority for Water and Sewer

The Utility Assessment Report presents the water Utility with an analytical and objective assessment of its overall performance and achievable performance objectives. In addition, it provides guidelines for the prioritisation and funding of systems and projects necessary to achieve the recommended performance targets.

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1 Executive Summary

A one-page questionnaire regarding macro indicators of water supply operations was completed by the Utility. The given macro-indicators, as well as further assumptions relating to non-revenue water component distributions, were analysed using EDAMS Technology's proprietary Utility Performance Model©. The model yielded a volume and revenue balance and a set of performance indicators that were then used as a basis to calculate expected performance improvements after certain remedial activities have been performed.

In summary the results of the analysis with regard to the current status of the operation and achievable improvements are as follows.

a. *Consumption:* The majority of water is used by private connections. Usage per private connection varies, depending on the type of the connection. The lowest amount is used by metered paying connections, amounting to 753 litres per day and the highest by illegal connections amounting to 1,003 litres per day, the additional water being a result of wastage and internal leakage. Only part of the water usage amounts to revenue water. Even in paying private connections only 70.7% out of the 753 litres per day are billed and paid for, the rest being attributed to unbilled consumption.

b. *New Connections:* There are currently 190,000 connections and 110,000 un-serviced properties. Half of the un-serviced properties are estimated to be illegal connections. As a result of the recovery program a total of 99,000 new connections will be installed; 44,000 to illegal connections that will be found, and 55,000 to currently un-serviced properties.

c. *Production:* Currently production is 93,000 Ml/year. Despite new sales to new connections of 13,707 Ml/year, production will decrease by about 10% to 83,916 Ml/year freeing production capacity for even more new sales.

d. *Non-revenue water (NRW)*, i.e.: water that the Utility produces but does not receive money is currently 62,848 Ml/year or 67.6% of production. The recovery programme will reduce this to 13,669 Ml/year or 16.3% of production. The remaining main components of NRW will be leakage (3.9%), bad debts (5%), unbilled consumption (5.1%) and wastage and internal leakage (2.3% in total). The following comments are made on the main components of NRW.

    1. *Unbilled Consumption:* Unbilled consumption will drop from 24,888 Ml/year to about 4,247 Ml/year by a total of 82.9%. 53% of the drop in unbilled consumption is due to illegal connections being found and the remainder due to meter and meter reading problems rectified.

    2. *Bad debts:* Bad debts will decrease as a result of better debt management (in terms of revenues) from 27.8% to 5.6% of billed revenues.

    3. *Wastage and internal leakage*: Wastage and internal leakage (leakage within the household will drop from 9,137 Ml/year to about 1,909 Ml/year, by a total of 79.5% as a result of improving debt recovery and finding illegal connections.

4. *Network Leakage:* Network leakage will drop from 18,688 Ml/year (20.1% of production) to about 3,304 Ml/year (3.9% of production). This is achievable as it is within the range of recommendations of the International Water Association that sets lower limits of 2.2% to 5.2% for this particular network. As a result of the drop in leakage the night-flow, originally assumed as 33% of production will also drop to 15% of supply.

e. *Financial Implications:* A simplified income / expenditure analysis reveals an unhealthy situation with net income being -204% of billed revenue. This is a result of bad debts (non-payment) being 27.8% of billed revenue and operating costs being multiple of the billed revenue (276%). The recovery program is expected to increase collected revenue by 125% (more than double) from 12.1 million LE per year to 27.34 million LE per year and reduce the loss from 34.3 mil LE/year to 15.98 mil LE/year (minus 55% of billed revenue).

To bring about the Objective improvements the following projects/ work are recommended.

a. *Implementation of Geographical Information System (GIS):* The Utility does not have town planning data with regard to properties. Such a database is very important for validating the customer base and identifying illegal connections. Furthermore the implementation of a GIS system will serve as a base map for capturing network data.

b. *Implementation of a Billing and Customer Information system:* The analysis indicated a need for a system that will address non-leakage components of non-revenue water (NRW). The new system should also have an appropriate debt management function, collection functionality and meter and meter readings analysis functions to help address NRW attributable to bad debts, poor collections and unbilled consumptions due to poor meter condition and poor meter readings. During the implementation of the new system business processes must be looked at and improved to address NRW issues effectively.

c. *Commercial Data Validation:* A commercial data analysis must be carried out to identify problematic data in the existing billing data, and identify illegal connections by comparing billing data to town planning data in the GIS. The analysis must be accompanied with appropriate field investigations. In this exercise it is also important to attribute geographical reference to the connections in the billing system. This can be done through the deployment of Global Positioning Systems (GPS).

d. *Implementation of a network asset management system, network data capture and structuring:* A network asset management system is recommended to ensure data integrity and record keeping and for use for maintenance management, design and planning and financial asset management.

e. *Network data Validation & Network Rehabilitation:* Once network data is captured on the system, using existing maps and reports, a field survey must be carried out to validate the information and identify obvious trouble spots. The exercise can also be used to draw a rehabilitation plan for the network, to address obvious problem areas.

f. *Demand Analysis and Network Optimisation:* Once the network data is available and validated and once demands can accurately be analysed by referring to the billing system the network must be analysed and its operation optimised. For optimisation the network must be rezoned with regard to hydraulic operation, pressure management and mass balancing. The analysis must be accompanied in the field with appropriate remedial work with regard to zoning and minor changes for improving performance.

g. *Network Upgrading:* Network upgrading should not be carried out unless the network is first optimised. If, not capital expenditure can be much higher. Network upgrading might be required to be able to cope with the provision of new connections to un-serviced properties.

h. *Network Monitoring*: Bulk meters should be installed in all newly created zones. It is important that the Utility enforces a bulk meter management program that will include bulk meter validation as well as readings evaluation and correction. Night-flows are also essential in estimating leakage levels whilst indications of operating pressures in the system throughout the day enable the implementation of a pressure management programme that will result in less leakage. The Utility should regularly monitor and record such information.

i. *Improvement of Maintenance Management:* A work and maintenance management information system is recommended to enable efficient maintenance of the system both reacting to problems and in a proactive and preventive manner.

To control costs and to enable the Utility personnel assimilate the new recommended technologies and business processes that will be implemented in the above projects it is recommended that the Utility embarks on two separate projects as follows:

a. The implementation of a Billing and Customer Information system for the entire area

b. The implementation of the remaining projects for a selected pilot region as a test and learning exercise

2 Introduction

The Aswan General Economic Authority for Water and Sewer has identified the need to improve water systems operations, management, data integration and administration, and address reduction and control of non-revenue water, through the implementation of appropriate information technology and appropriate consulting services. The benefits expected from the implementation of such projects include: Shared data, improved quality and accuracy of data, controlled data capture, reduced non-revenue water (NRW), improved customer services and improved maintenance.

The Aswan Authority invited Hydro-Comp Enterprises (Hydro-Comp) to perform a high level assessment of the operational performance of the Utility, presented in this report and at the same time to review the current role and utilisation of information systems and its impact on overall performance levels and offering recommendations for improvements – particularly within the context of Authority's objectives stated above.

Hydro-Comp performed the assessment using its proprietary Utility Performance Model©. Utility management completed a 1-page questionnaire. The model was then used to analyse town planning, commercial and technical macro indicators, such as number of properties, number of metered private connections, percentage debt recovery, fixed production costs and length of transmission & distribution networks. Certain assumptions, especially with regard to the composition of leakage and commercial losses are also made in the model based on EDAMS' expert understanding of Utility business.

The main Utility Macro-Indicators used in the analysis are shown in the adjacent table.

The outcome of the analysis is a volume and revenue balance and a set of performance indicators that was then used as a basis to calculate expected performance improvements after certain remedial activities have been performed. The results of the analysis are presented in this report.

1. Town Planning Statistics

a. Properties	Unit	Value
Formal properties (households)	Number	300,000

2. Commercial & Financial Statistics

a. Connections/Meters	Unit	Value
Private connections - metered individually	Number	190,000
b. Billed Consumption	Unit	Value
Metered private connections	Ml/year	43,000
c. Unbilled Consumption	Unit	Value
Unbilled authorised consumption	Ml/year	0
Unbilled fire testing or usage	Ml/year	430
d. Sales	Unit	Value
Sales to private connections (consumption)	LE/year	16,819,000
e. Debt Recovery	Unit	Value
% Debt recovery from private connections	%	72%
f. Operational & Production Costs	Unit	Value
Fixed production cost	LE/year	4,650,000
Variable production cost	LE/m3	0.200
Fixed distribution cost	LE/year	9,300,000
Variable distribution cost	LE/m3	0.150

3. Technical Statistics

a. Production	Unit	Value
Present total production	Ml/year	93,000
b. Distribution Network	Unit	Value
% of time system is pressurised	%	100%
Length of mains	Km	8,000
Average operating pressure	m	40.0
c. Nightflow (if available)	Unit	Value
Total nightflow	%	33.1%
Total night consumption	%	25.0%

3 Assessment of Current Condition

3.1 Analysis

Analysis is done using the EDAMS expanded version© of the IWA (International Water Association) classification for non-revenue water. The EDAMS classification is based on a NRW breakdown reflecting an understanding of all the different problems of NRW with regard to required remedies, including both commercial and technical problems relating to network or institutional aspects. For each component a detailed volume and revenue calculation is carried out satisfying an overall mass and revenue balance and indices within acceptable and expected limits. The results of the current mass balance are reflected in the table below.

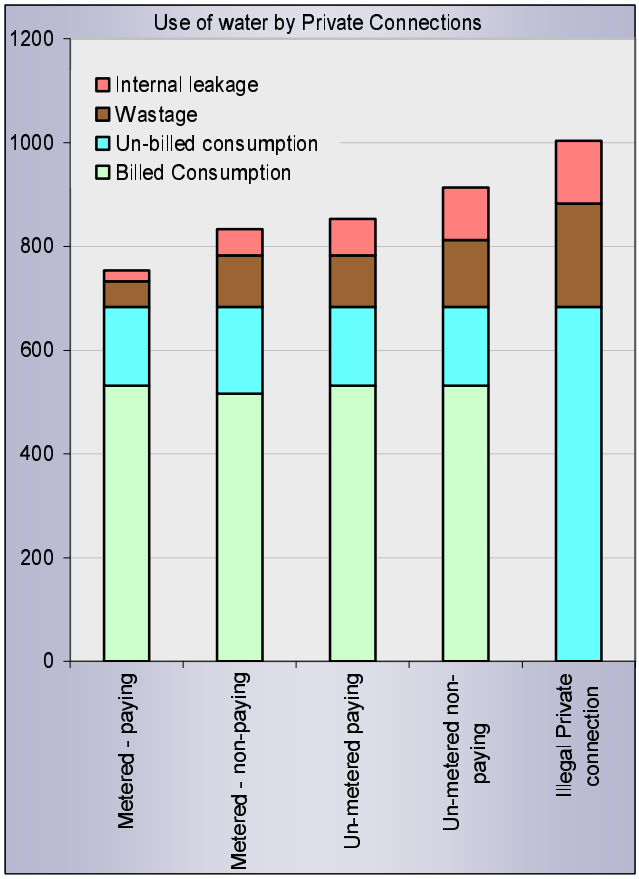
IWA Classification				Expanded EDAMS classification		Ml/year	%
System Input Volume	Authorised Consumption	Billed Authorised Consumption	Billed Metered Consumption	Paying	PC-Consumption	26,647	28.7%
					PC-Wastage	2,503	2.7%
					PC-Internal Leakage	1,001	1.1%
					Kiosks	0	0.0%
					Large Consumers	0	0.0%
				Non-paying	PC-Consumption	9,956	10.7%
					PC-Wastage	1,928	2.1%
					PC-Internal Leakage	964	1.0%
					Kiosks	0	0.0%
					Large Consumers	0	0.0%
			Billed Unmetered Consumption	Paying	PC-Consumption	0	0.0%
					PC-Wastage	0	0.0%
					PC-Internal Leakage	0	0.0%
					Public Taps	0	0.0%
				Non-paying	PC-Consumption	0	0.0%
					PC-Wastage	0	0.0%
					PC-Internal Leakage	0	0.0%
					Public Taps-bad debts	0	0.0%
		Unbilled Authorised Consumption	Unbilled Metered Consumption		govermental,etc	0	0.0%
			Unbilled Unmetered Consumption		govermental,etc	0	0.0%
					Public Taps-lost income	0	0.0%
					Public Taps-bad debt provision		
					fire fighting / testing	430	0.5%
					unbilled auth: bad debt provision		
	Water Losses	Apparent Losses (Unbilled-unauthorised)	Unauthorised Consumption	Illegal / unregistered Connections	Unbilled Consumption	13,707	14.7%
					Wastage	4,015	4.3%
					Internal Leakage	2,409	2.6%
			Lack of meters		Under-billing	0	0.0%
			Customer Metering Inaccuracies	Meter problems	Meter Inaccuracies	0	0.0%
					Broken meters	2,150	2.3%
					Slow meters	2,150	2.3%
					Oversized Meters	0	0.0%
				Meter readings problems	Incorrect readings	4,300	4.6%
					Not All meters are read	2,150	2.3%
					Unidentified Connections	0	0.0%
				Provision for bad debts	for recovered unbilled unauthorised consumption		
		Real Losses	Leakage on pipes		Bad circulation & zoning & high and irregular pressures	5,289	5.7%
					badly corroded pipes	1,511	1.6%
					visible bursts	3,778	4.1%
					major non-visible leaks	4,231	4.5%
					minor leaks	302	0.3%
			Leakage / overflows at tanks			0	0.0%
			Leakage on Service Connections			3,577	3.8%
	Totals					93,000	100.0%

3.2 Consumption Analysis

Although only 43,000 Ml/year are billed to consumers, it is estimated that 74,312 Ml/year reach the consumer. The majority (73,882 Ml/year or 99.4%) are used by private connections.

There are 190,000 known connections, 72% of these are metered, billed and good payers whilst the remaining although metered and billed, do not pay. It is estimated that there are a further 55,000 illegal / unregistered connections. This represents 50% of the estimated number of properties that do not have a known connection.

The manner in which an average individual connection consumes water differs per connection type as shown in the adjacent diagram. The lowest amount is used by metered paying connections, amounting to 753 litres per day and the highest by illegal connections amounting to 1,003 litres per day.



Understanding the composition of water usage per consumer type is important and highlights the need to address different types of consumers in a different manner as well as highlights the repercussions of various actions.

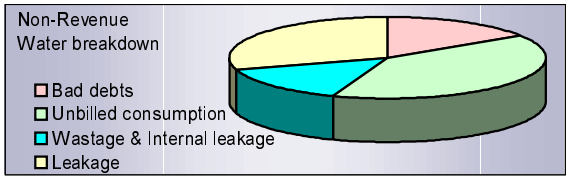
For example: Finding an illegal connection making it legal and making sure that the customer pays will reduce the water usage at that connection from 1,003 litres per day to 753 litres per day (by 25%) as the customer will reduce wastage and be more sensitive to internal leakage in the household.

3.3 Water balance of the Utility

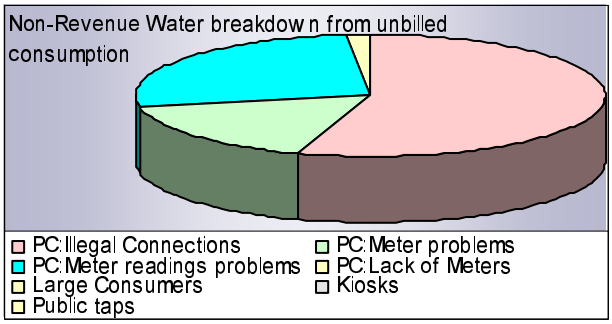
In summary out of a total production of 93,000 Ml/year, 67.6% is non-revenue water (NRW), i.e.: water that the Utility produces but does not receive money for. Un-accounted for water, i.e. water not billed and unknown is 56.4% of production, whilst leakage is estimated at 20.1% of production.

The table and figure below show the breakdown of NRW. The majority of NRW is due to unbilled consumption (26.8%) followed by leakage (20.1%), 10.7% due to bad debts and 10.0% due to unpaid wastage and internal leakage at consumer's premises.

Non-Revenue Water breakdown	Ml/year	%
Total	62,848	67.6%
Bad debts	9,956	10.7%
Unbilled consumption	24,888	26.8%
Wastage & Internal leakage	9,317	10.0%
Leakage	18,688	20.1%



Bad debts are entirely caused by private connections. Unbilled Consumption is due to three main reasons; meter and meter reading problems constituting to about 44% of this amount and illegal connections to about 55%.



Wastage and internal leakage (leakage within the household) is assumed to exist at non-paying and un-metered customers as well as at illegal connections. Approximately 69% of wastage and internal leakage is due to illegal connections, whilst the remainder is due to non-paying private connections.

The total network leakage is a function of the assumed night flow of 33% and night consumption of 25% of night flow. The night flow should have been measured on site and the Utility is urged to do so as this is the only effective way of assessing the extent of leakage and subsequently the extent of apparent (commercial) problems. Network leakage (real losses) can be further evaluated using International Water Association recommendations as shown in the table below. Currently leakage is 20.1% of production, whilst according to the two ideal scenarios, it should be between 2.2% (for TIRL=30) and 5.2% (for ILI=1.0).

description	IWA recom.	calculated
Infrastructure Leakage Index (ILI):	1	3.3
TIRL (litres/day/connection)	30-200	209.0
Leakage per pipe length(kl/day/km)	1.91	6.4
Leakage/ Production	6.0%	20.1%

Also note that the analysis indicates that probably 30% of the leakage can be eliminated if network optimisation is carried out, with regard to re-zoning and implementing operational guidelines, resulting in better circulation and lower pressure distributions.

3.4 Revenue Balance of the Utility

The average cost rate of water is LE 0.50 per cubic meter and the average selling rate for private connection is LE 0.36. This indicates that even if all the NRW problems were addressed, the Utility would still not make a profit by supplying water to private connections at the current tariff. In fact the tariff rate is very low and should be revised.

A simplified income / expenditure analysis, shown in the adjacent table, reveals an unhealthy situation with net income being -204% of billed revenue. This is a result of bad debts (non-payment) being 27.8% of billed revenue and operating costs being multiple of the billed revenue (276%) as well as low selling rates of water being lower than cost rates .

Income / Expenditure statement	mil LE/yr	%
Billed Revenue-consumption	15.489	92.1%
Billed Revenue-fixed charges	0.950	5.6%
Billed Revenue-miscellaneous	0.380	2.3%
Billed Revenue-Sub-total	16.819	100.0%
Less Bad debts	-4.677	27.8%
Collected Revenue	12.142	72.2%
Less Operating Costs	-46.500	-276%
Net Income	-34.358	-204.3%

3.5 Key Performance indicators

The key performance indicators as calculated for the current status of the Utility are shown in a table in the next section, where they are compared with the Objective indicators.

4 Achievable Recovery

4.1 Assumptions for Recovery through rehabilitation and capital works

The table indicates achievable levels of recovery for the different problems contributing to non-revenue water. For example 80% implies that it is possible to recover 80% of the losses attributable to this problem.

To be able to achieve above recovery levels certain institutional and rehabilitation programmes would have to be undertaken. Such programmes are discussed at a latter section.

Using the recovery rates as well as the assumed activities in the capital plan in the model, presents a different operational status for the utility, discussed in the sections that follow.

4.2 New Works required for recovery

A total of 99,000 new connections will be installed to the majority of un-serviced 110,000 properties. 44,000 of these are to illegal / unknown connections found (out of a total of 55,000) and 55,000 of these are connections to the remaining known un-serviced properties. Assuming an average length of 7 meters of connection pipe this will imply, an additional length of pipe of 693 km. This assumes that the distribution network exists near the un-serviced properties and that it can cope with the additional demand. It is expected that as a result of these additional connections that the demand will increase by: 13,707 Ml/year.

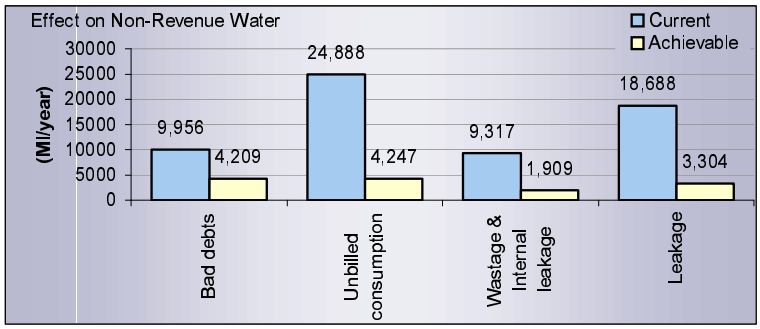
Achievable Recovery levels (after rehab)	recover by
Non-paying consumers - Recovery rate of non-payment	
Consumers	70%
Large Consumers	100%
Govermental, etc (currently not billed)	100%
Kiosks	100%
Public taps	80%
Fire fighting / testing	0%
Illegal & Unregistered Connections found	80%
Meter & Meter reading Problems (commercial operations)	
Meter Inaccuracies	0%
Broken meters	100%
Slow meters	80%
Oversized Meters	80%
Incorrect readings	90%
Not All meters are read	90%
Unidentified Connections	90%
Leakage	
Leakage on Service Connections	90%
Leakage / overflows at tanks	100%
Leakage on distribution pipes	
Bad circulation/ zoning, high /irregular pressures	100%
Badly corroded pipes	90%
Visible Leaks	90%
major non-visible leaks	50%
minor leaks	0%

4.3 Effect of recovery on water balance of the Utility

Despite the increased demand from the new connections, production will drop by 9.8%, from 93,000 Ml/year to 84,000 Ml/year, making further capacity available for supplying new consumers. Non-revenue water will reduce from 67.6% to 16.3%, whilst leakage will reduce from 20.1% of production to 3.9% of production a bit higher than International Water Association recommendations.

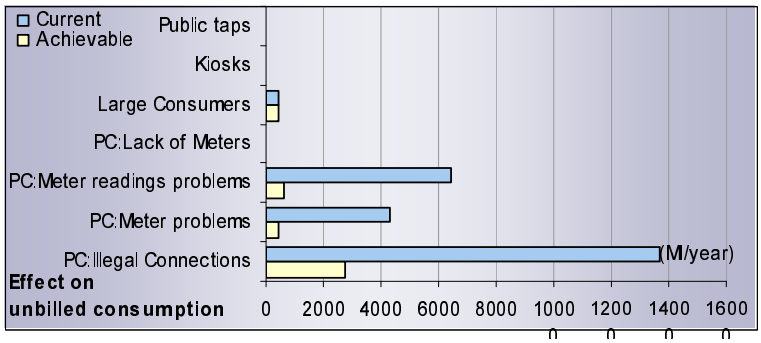
The table and figure below shows in detail the reduction of non-revenue water. Bad debts will reduce to less than half in terms of volumes, unbilled consumption by about 83%, wastage

	Current		Achievable		decrease	
Non-Revenue Water breakdown	Ml/year	%	Ml/year	%	Ml/year	by %
Total	62,848	67.6%	13,669	16.3%	49,179	78.3%
Bad debts	9,956	10.7%	4,209	5.0%	5,747	57.7%
Unbilled consumption	24,888	26.8%	4,247	5.1%	20,641	82.9%
Wastage & Internal leakage	9,317	10.0%	1,909	2.3%	7,408	79.5%
Leakage	18,688	20.1%	3,304	3.9%	15,384	82.3%



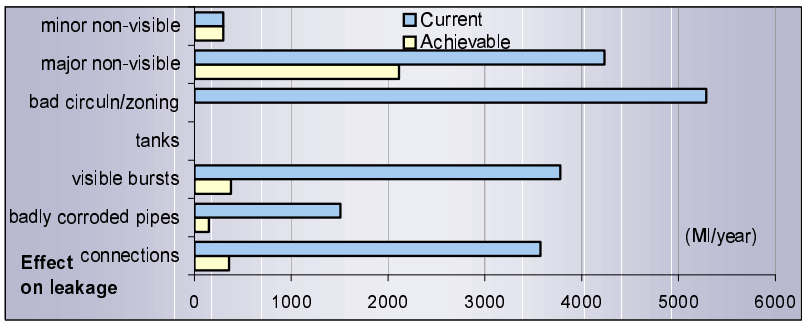
and internal leakage by 79.5% and real losses (network leakage) by about 82%. The main components of remaining NRW will be leakage (about 3.9%), bad debts (about 5%) and unbilled consumption and wastage and internal leakage about 2% respectively.

The adjacent figure indicates a breakdown in NRW attributable to unbilled consumption. Just over half of the drop in unbilled consumption is due to illegal connections found, whilst the remaining is due to meter and meter reading problems.



Network Leakage: The table and figures below indicate a breakdown of network leakage and the resulting effect of the remedial work. Network leakage will drop from 18,688 Ml/year (20.1% of production) to about 3,304 Ml/year (3.9% of production), by a total of 82.3% as a result of

	Current		Achievable		decrease	
NRW from Leakage	Ml/year	%	Ml/year	%	Ml/year	%
Total	18,688	20.1%	3,304	3.9%	15,384	82.3%
connections	3,577	3.8%	358	0.4%	3,219	90.0%
badly corroded pipes	1,511	1.6%	151	0.2%	1,360	90.0%
visible bursts	3,778	4.1%	378	0.5%	3,400	90.0%
tanks	0	0.0%	0	0.0%	0	0.0%
bad circuln/zoning	5,289	5.7%	0	0.0%	5,289	100.0%
major non-visible	4,231	4.5%	2,116	2.5%	2,116	50.0%
minor non-visible	302	0.3%	302	0.4%	0	0.0%

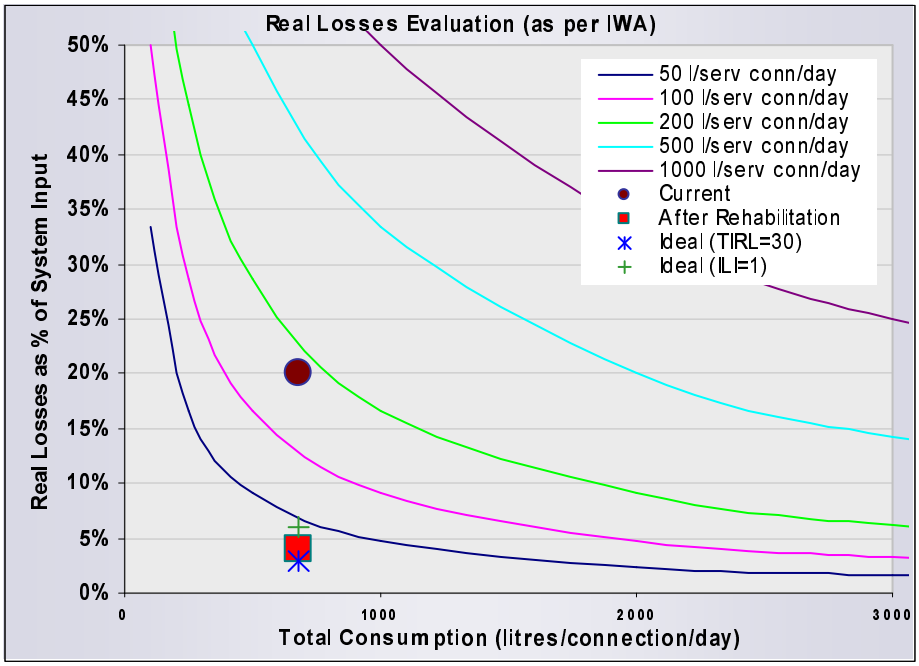


various rehabilitation works. The least drop is assumed in non-visible leakage (50%).

Also note that as a result of the drop in leakage the

night-flow, originally assumed as 33% of production will also drop from 33% to 15%.

With regard to International Water Association's recommendations standards the following comments are made. (a) The current leakage of 269.5 litres per day per connection is reduced to 31.33 litres per day per connection, close to the recommended minimum of 30 and well below the maximum of 200. The ILI (Infrastructure Leakage index) is reduced from 3.9 to 0.9 very close to the recommended minimum of 1.0. (b) The achieved leakage as a percentage of production is 3.9% as compared to the two ideal scenarios as recommended by IWA of 2.2% (for TIRL=30) and 5.2% (for ILI=1.0). The graph below illustrates the current and present leakage position for the Utility within the IWA guidelines.



4.4 Financial Implications of Recovery

The table below indicates the effect of recovery on a simplified income / expenditure statement for water supply operations (sewer excluded). In summary: Collected revenues increase by 125% (more than double) from 12.1 million LE per year to 27.34 million LE per year, bad debts (non-payment) are reduced from 4.7 to 1.6 million LE per year (from 28% to 5.6% of billed revenue) and operating costs from 46.5 to 43.3 million LE per year (from 276% to 147% of billed revenue). The effect of these changes improves the loss situation of the Utility, from -204% to -55% of billed revenue.

	Current		Achievable		increase	
Income / Expenditure statement	mil LE/yr	%	mil LE/yr	%	mil LE/yr	%
Billed Revenue	16.819	100.0%	28.966	100.0%	12.147	72.2%
Less Bad debts	4.677	27.8%	1.626	5.6%	-3.051	-65.2%
Collected Revenue	12.142	72.2%	27.340	94.4%	15.198	125.2%
Less Operating Costs	46.500	276%	43.321	150%	-3.179	-6.8%
Net Income	-34.358	-204.3%	-15.980	-55.2%	18.377	n/a

4.5 Cost rate Analysis

The table below calculates the actual cost rate for the Utility per cubic meter sold and paid for before and after recovery. The cost rate reduces drastically from 1.51 LE per cubic meter to 0.596 LE per cubic meter. This rate represents the rate that the water should be sold at to be able to recover costs, obviously provided that consumers will pay.

				Examples of tariff increase		
	Unit	Current	Achievable	1.fixed	2.rate	3.both
Operating Costs	mil LE/yr	46.500	43.321	43.321	43.321	43.321
less income from fixed charges	mil LE/yr	-0.950	-1.445	-18.034	-1.445	-8.670
Net operating Costs	mil LE/yr	45.550	41.876	25.287	41.876	34.651
Production	Ml/year	93,000.0	83,915.8	83,915.8	83,915.8	83,915.8
Net Cost per m3 produced	LE/m3	0.490	0.499	0.301	0.499	0.413
Non-revenue water	%	67.6%	16.3%	16.3%	16.3%	16.3%
Net Cost per m3 sold	LE/m3	1.511	0.596	0.360	0.596	0.493
* Basic charge in examples:			LE/conn/month	5.20	0.42	2.50

This analysis also reveals that the current selling rate per cubic meter of water of 0.36 LE/m3 will not enable the Utility to recover costs even after the remedial work is carried out. To be able to do so the Utility will have to either increase fixed charges or the selling rate of the water or both. For example costs can be recovered by increasing fixed charges to LE 62.4 per year or by increasing the selling rate to 0.60 LE/m3 or through a combination of both.

4.6 Effect on Key Performance indicators

The table below summarises and compares key performance indicators as calculated for the current status and for the Objective status at the Utility.

Performance Indicators	unit	Current	Objectives	Change
Income/ Expenditure				
Billed Revenue	LE/year	16,819,000	28,965,676	72.2%
Collected Revenue	LE/year	12,142,066	27,340,048	125.2%
Production cost	LE/year	46,500,000	43,320,540	-6.8%
Debt recovery rate	%	72.2%	94.4%	30.7%
Gross profit (yearly)	%	-204.3%	-55.2%	n/a
Capacity				
System Input (Production)	Ml/year	93,000	83,916	-9.8%
Total number of known private connections	number	190,000	289,000	52.1%
Percentage of metered connections	%	100.0%	96.3%	-3.7%
Average actual consumption per private connection	l/day/conn	683	683	0.0%
Length of transmission & distribution network	km	8,000	8,693	8.7%
Non-Revenue Water				
Non-Revenue Water (volume)	Ml/year	62,848	13,669	-78.3%
Non-Revenue Water (% of System Input):	%	67.6%	16.3%	
Bad debts (no-payment)	%	10.7%	5.0%	
Unbilled consumption	%	26.8%	5.1%	
Unbilled Wastage & Internal leakage	%	10.0%	2.3%	
Leakage	%	20.1%	3.9%	
Leakage (Real Losses)- as per IWA		Current	Recovery	Change
Average Daily Real Losses	Ml/day	51.20	9.05	-82.3%
Average Daily Real Losses when system is pressurised	Ml/day	51.20	9.05	-82.3%
Infrastructure Leakage Index (ILI): >=1		3.9	0.9	-77.2%
Technical Indicator for Real Losses (TIRL) 30 - 200	l/day/conn	269.48	31.33	-88.4%
Density of Connections (billed private connections)	conn/km	23.75	36.13	52.1%
Real Losses per length of main	kl/day/km	6.40	1.04	-83.7%

5 Recommended remedial projects and institutional improvement programmes

A separate follow up study identifies and prioritises remedial projects and institutional improvement programs in accordance with the recommended remedial scenario. The objectives of these proposals are the transfer of knowledge and appropriate tools to the Utility for reaching the desired scenario for the entire Utility. The study carries out a budgetary cost-benefit analysis of proposed works, highlighting recovery periods and cash-flow requirements.

In summary the recommended projects are as follows:

To bring about the Objective improvements the following projects/ work are recommended.

a. *Implementation of Geographical Information System (GIS):* The Utility does not have town planning data with regard to properties. Such a database is very important for validating the customer base and identifying illegal connections. Furthermore the implementation of a GIS system will serve as a base map for capturing network data.

b. *Implementation of a Billing and Customer Information system:* The analysis indicated a need for a system that will address non-leakage components of non-revenue water (NRW). The new system should also have an appropriate debt management function, collection functionality and meter and meter readings analysis functions to help address NRW attributable to bad debts, poor collections and unbilled consumptions due to poor meter condition and poor meter readings. During the implementation of the new system business processes must be looked at and improved to address NRW issues effectively.

c. *Commercial Data Validation:* A commercial data analysis must be carried out to identify problematic data in the existing billing data, and identify illegal connections by comparing billing data to town planning data in the GIS. The analysis must be accompanied with appropriate field investigations. In this exercise it is also important to attribute geographical reference to the connections in the billing system. This can be done through the deployment of Global Positioning Systems (GPS).

d. *Tariff study:* Once the town planning and billing information is available and validated, a detailed tariff analysis is recommended, also taking into account socio economic factors such as affordability to establish recommendation with regard to tariff increases to enable sustainability of the Utility.

e. *Implementation of a network asset management system, network data capture and structuring:* A network asset management system is recommended to ensure data integrity and record keeping and for use for maintenance management, design and planning and financial asset management.

f. *Network data Validation & Network Rehabilitation:* Once network data is captured on the system, using existing maps and reports, a field survey must be carried out to validate the information and identify obvious trouble spots. The exercise can also be used to draw a rehabilitation plan for the network, to address obvious problem areas.

g. *Demand Analysis and Network Optimisation:* Once the network data is available and validated and once demands can accurately be analysed by referring to the billing system the network must be analysed and its operation optimised. For optimisation the network must be rezoned with regard to hydraulic operation, pressure management and mass balancing. The analysis must be accompanied in the field with appropriate remedial work with regard to zoning and minor changes for improving performance.

h. *Network Upgrading:* Network upgrading should not be carried out unless the network is first optimised. If, not capital expenditure can be much higher. Network upgrading might be required to be able to cope with the provision of new connections to un-serviced properties.

i. *Network Monitoring*: Bulk meters should be installed in all newly created zones. It is important that the Utility enforces a bulk meter management program that will include bulk meter validation as well as readings evaluation and correction. Night-flows are also essential in estimating leakage levels whilst indications of operating pressures in the system throughout the day enable the implementation of a pressure management programme that will result in less leakage. The Utility should regularly monitor and record such information.

j. *Improvement of Maintenance Management:* A work and maintenance management information system is recommended to enable efficient maintenance of the system both reacting to problems and in a proactive and preventive manner.

To control costs and to enable the Utility personnel assimilate the new recommended technologies and business processes that will be implemented in the above projects it is recommended that the Utility embarks on two separate projects as follows:

a. The implementation of a Billing and Customer Information system for the entire area

b. The implementation of the remaining projects for a selected pilot region as a test and learning exercise