NON-REVENUE WATER REDUCTION STRATEGY
The Bahamian Experience

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IWA System Input:

= Authorised Consumption + Water Losses

- ***Authorised Consumption:***
  - **Billed**
    - **Metered**
    - **Unmetered**
  - **Unbilled* (fire fighting, flushing)**
    - **Metered**
    - **Unmetered**

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*Water Losses**

- **Apparent Losses**
  - **Unauthorized Consumption (illegal connections, theft, etc.)**
  - **Meter Inaccuracies (under registration of customer meters, over registration of production meters)**
- **Real Losses**
  - **Leakage on mains**
  - **Leakage on service connections *(up to customer's meter)***
  - **Leakage/overflow at storage tanks**

NRW = WATER LOSSES + UNBILLED AUTHORISED CONSUMPTION

NON-REVENUE WATER REDUCTION STRATEGY
The Bahamas Experience

Components of NRW in New Providence (2000)

	Tigd	*Tig/year*
SYSTEM INPUT	**8,101**	**2,965,200**
Unbilled Authorized Consumption	20	7,200
Apparent Losses	449	164,300
Real Losses	3,689	1,350,200
NRW	**4,158**	**1,521,700**
***Water Losses** (Real + Apparent)*	***4,138***	***1,514,500***

IWA Performance Indicators

Operational Management of Real Losses

- If connection density greater than 32/mile of mains, use **volume/service connection/day**
- If connection density is less than 32/mile of mains, use **volume/Mile of mains/day**

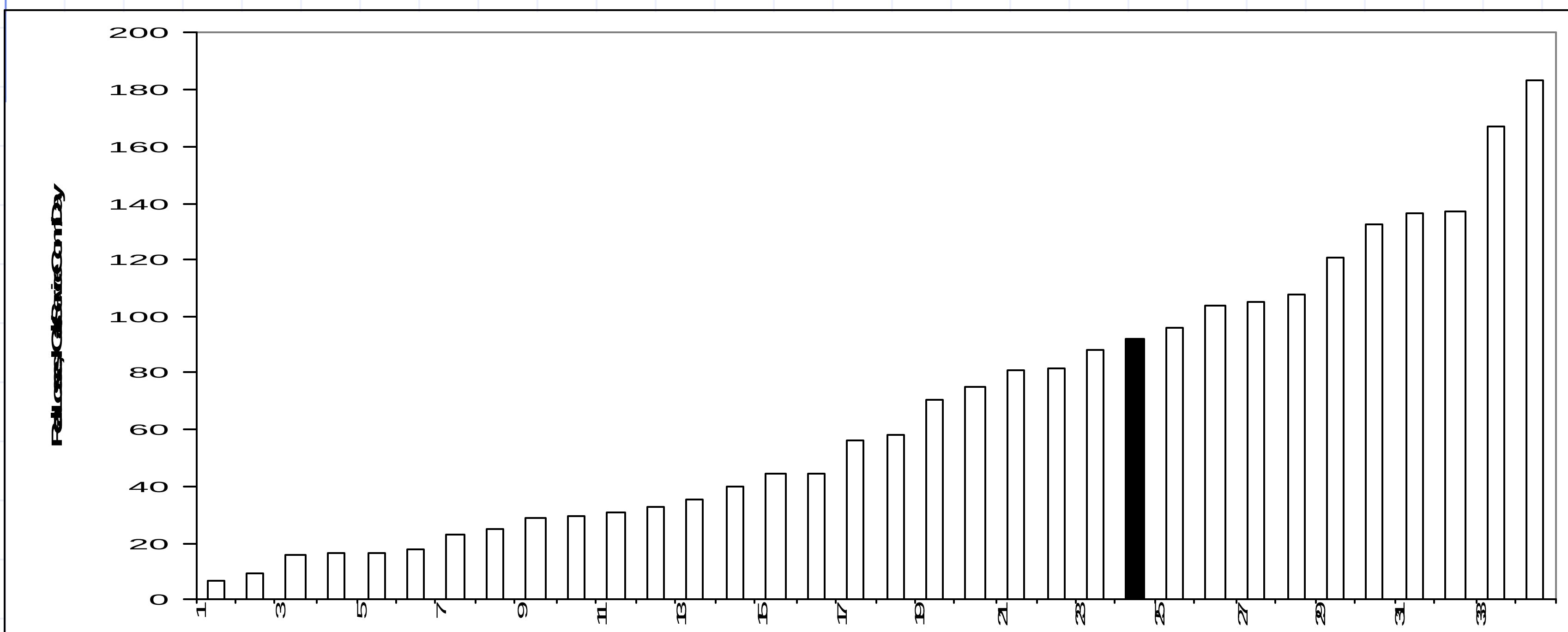
NP Connection Density = 93/mile of mains

IWA – Operational Performance Indicator

NRW on a ‘per service connection’ basis has increased every year since 1995.

Real Losses (2000) = 92 igal/sc/day

Real Losses (vol/sc/day) for 27 International, 7 N.American Systems, & BWSC



Why percentage is inappropriate as the sole indicator for NRW?

- **Strongly influenced by consumption, and by annual/seasonal changes in consumption**.

- **Real Losses** = 92 Igal/sc/day
- **Average Consumption** = 110.3 Igal/sc/day
  includes unbilled authorized consumption and apparent losses)
- **System Input** = 92 + 110.3 = 202.3 Igal/sc/day.

Real Losses expressed as a % of system input volume = 92/(92 + 110.3) = 45.5 %

If consumption changes?

• for England/Wales with average consumption of	121 Igal/sc/day	43.2%
• a German City with average consumption of	375 Igal/sc/day	19.7%
• a Californian system, average consumption of	660 Igal/sc/day	12.2%
• a Nordic City with average consumption of	1320 Igal/sc/day	6.5%
• in Singapore, with average consumption of	1830 Igal/sc/day	4.8%

Concept of Unavoidable Annual Real Losses (UARL)

Leakage management practitioners recognize that it is impossible to eliminate real losses from a large distribution system. There must therefore be some value of 'Unavoidable Annual Real Losses' (UARL) which could be achieved at the current operating pressures if there were no financial or economic constraints. If the UARL volume for any system can be assessed, taking into account key local factors, then the ratio of Current Annual Real Losses (CARL) to UARL offers the possibility of an improved Performance Indicator known as the Infrastructure Leakage Index (ILI) **for real losses**.

UARL Influenced by the following system specific parameters:

- **Density of Service Connections (NP = 93/mile of mains)**
- **Location of Customer Meters relative to street/property boundary (NP = 0; at edge of street))**
- **Average operating pressure (NP = 35psi)**

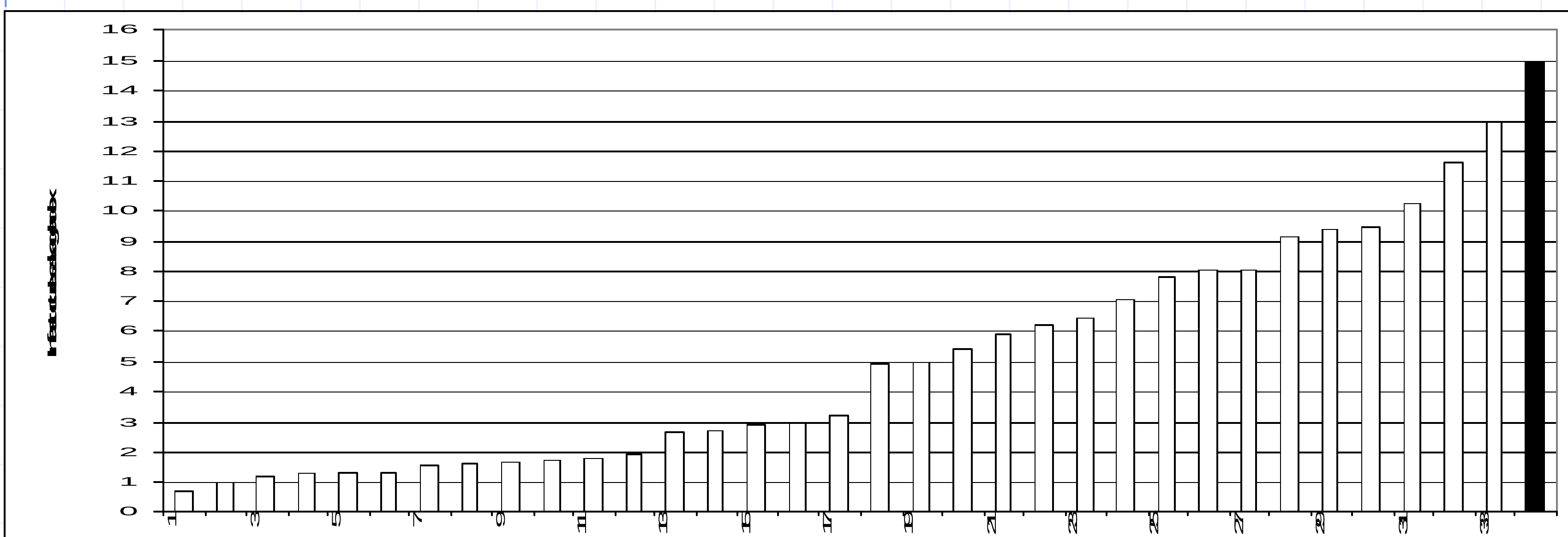
UARL (NP) = 6.08 Igal/sc/day = 0.243Mig/day = 88.7Mig

INRASTRUCTURE LEAKAGE INDEX

- **Current Annual Real Losses = 3.689 Mig/day**
- **Unavoidable Annual Real Losses = 0.243 Mig/day**

Infrastructure Leakage Index (ILI) = 3.689/0.243 = 15.2

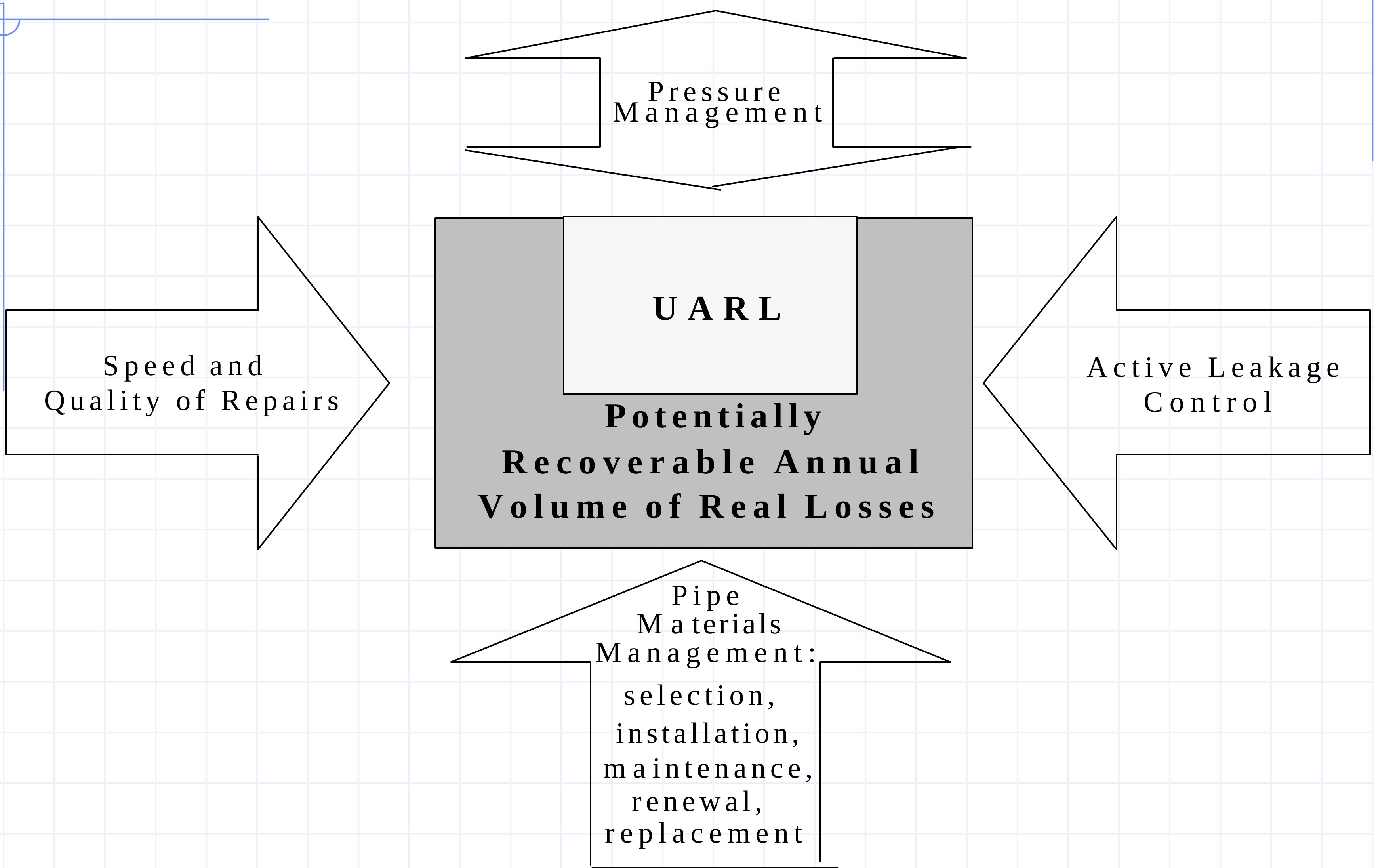
ILI for 27 International, 7 N.American Systems, & BWSC



IWA NRW Detailed Financial Indicator

	Tigd	Tig/Year	$/Tig	$m	% of OpExp
Unbilled Authorised Consumption	20	7,200	5.5	0.04	0.1%
Apparent Losses	449	165,300	15.0	2.46	8.6%
Real Losses	3,689	1,350,200	5.5	7.43	25.7%
	4,158	**1,521,700**		**9.93**	**34.4%**
	ANNUAL OPERATING EXPENSES			**28.87**	

Four Components of a Successful Leakage Management Policy



STRATEGY FOR NRW REDUCTION IN NEW PROVIDENCE, BAHAMAS

Table 1 – Recommendations			
RECOMMENDATIONS		**NRW Component**	**Project Activity**
Ref. No	**Description**	*RL-Real Losses, AL-Apparent Losses*	
1a	Adopt IWA Approach	RL, AL	Twinning/Technical Assistance
1b	Calculate NRW and Set Targets	RL, AL	Meter/Loggers Purchase Meter Sizing/Calibration Baseline Survey/Pilot Project GIS – HTE/WATERCAD Integration Infrastructure Audit/DIP
1c	Monitor NRW trends *(Igal/service/day)*	RL, AL	
1d	Calculate ILI for each DMA	RL	
2a	Delineate Leak repairs in DMAs	RL	GIS – WOMS Integration
2b	Cause for leak frequency on Customer meters	RL	GIS – WOMS Integration
3a	'Best Practice' Pressure Management/Surge recording *(pumped flows, station pressures)*	RL	Meter/Logger Purchase Telemetry Twinning/Technical Assistance
3b	Surge reduction *(electrical/mechanical improvements)*	RL	Twinning/Technical Assistance System Optimisation – PCVs/SCVs
3c	Maximise gravity water supply	RL	Telemetry GIS – WATERCAD integration System Optimisation – HNA
4a	Permanent flow/pressure monitoring *(DMA inlets and critical points)*	RL	Meter/Logger Purchase Telemetry GIS – WATERCAD integration System Optimisation - HNA
4b	Pressure Control *(following Active Leakage Control activities)*	RL	Meter/Logger Purchase Telemetry GIS – WATERCAD integration System Optimisation - PRVs
5	Twinning/Technical Assistance	RL, AL	Twinning/Technical Assistance
6	NRW Reduction	RL, AL	Baseline Survey/Pilot Project Performance-based Contract

Table 2 – Projects				
Project Name	**Description**	**Estimated Cost ($ Mn)**	**Start Date**	**Completion Date**
GIS	This will provide immediate digital data on all NP assets and will be integrated with Customer Service module, network analysis software, and Work Order Management software.	$0.10 $0.40	Sep-02 Mar-03	Dec-02 Dec-03
Telemetry	SCADA system for level and pump controls, flow and pressure recording. The second phase will address remote readout for flow and pressure in DMAs.	$0.20 $0.30	Jul-03 Jan-04	Dec-03 May-04
NRW Equipment	Replacement of DMA meters, Data Loggers for pressure, flow, surge, leak and pipe detection equipment.	$0.90	Oct-02	Dec-03
Meter Sizing / Calibration	Establish economic life of domestic meters and meter replacement policy, testing and calibration program for new meters including field calibration of district meters	$0.25	Jun-03	Dec-03
System Optimisation	Based on network analysis, the project includes maximizing gravity flows and strategic installation of (i); surge relief; (ii) pressure relief; (iii) flow control, and; (iv) pump control valves. Updated GIS compatible network analysis software is also included	$0.20	Jun-02	Sep-03
NRW Reduction: Baseline Survey/ Pilot Project	This includes; (i) establishing the true level of NRW; (ii) reducing NRW in 5 specified DMAs; (iii) establishing new and/or realigning existing DMAs, and; (iv) preparing detailed Terms of Reference for a performance based contract to reduce NRW to an agreed level.	$0.60	Aug-03	Jan-04
NRW Reduction: Performance Based Contract	NRW reduction from the level determined in the Baseline Survey to an agreed level within 3 years. This will include substantial capital works(~$12Mnfor mains renewals)	$23.0	May-04	May-07
Infrastructure Audit	Also called 'District Improvement Plan'. This includes a full audit of infrastructure in NP through a systematic field exercise. It is an attempt to document exactly what assets exist, the condition of those assets, and the rehabilitation/replacement requirements.	$0.30		May-07
Twinning/Technical Assistance	Establish technical relationship with a water authority that has experienced similar problems and which has substantially and rapidly reduced NRW in recent years.	$0.15	Aug-03	Mar-04
	TOTAL	**$ 26.40**		

FINANCIAL BENEFITS

Reducing ILI from 15.2 to	13	11	9.5	8
2002 - System Input (MG)	3,098	3,098	3,098	3,098
Additional Water/Water Saved	210	365	520	675
If additional water is sold **Additional Revenue per year**	**$3,504,174**	**$6,084,726**	**$8,665,278**	**$11,245,830**
If additional water is saved **Savings per year**	**$694,379**	**$1,205,735**	**$1,717,091**	**2,228,447**
Payback Period:				
If additional water is sold	8	4	3	2
If additional water is saved	38	22	15	12

CONCLUSIONS

- IWA has developed several terms, standards and indicators that reflect international best practices. These are encompassed in four main activities: Measure, Monitor, Mitigate, and Maintain.
- NRW Reduction requires a systematic and comprehensive strategy that must address the four components of leak/loss management.
- Operational and financial indicators must be determined, targets set, and reviewed to establish the costs and benefits of NRW reduction.
- From a regulatory standpoint:
    - International standards/best practices must be applied to account for the different systems and conditions, and the unique operational parameters of various utilities
    - NRW reduction targets must encompass and address operational and financial efficiency

BIBLIOGRAPHY

- ***Losses in Water Distribution Networks, A Practitioner's Guide to Assessment, Monitoring and Control, by Malcolm Farley and Stuart Trow (2003 IWA Publishing; ISBN 1 900222 11 6)***