Non-Revenue Water Reduction - an International Update

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Topics of the Presentation:

- choosing the right performance indicator
- outsourcing of NRW reduction – the Selangor (Malaysia) example
- brief notes on the IWA leakage conference in Cyprus
Around the globe one and the same problem ...
too much precious water is lost
great engineers since ever wanted to build huge schemes .....
... and politicians always enjoy opening ceremonies!
that's why we have a major problem:

NRW

(Non-Revenue Water)
# IWA Standard Water Balance

<table>
<thead>
<tr>
<th>System Input Volume</th>
<th>Authorised Consumption</th>
<th>Billed Authorised Consumption</th>
<th>Billed Metered Consumption</th>
<th>Revenue Water</th>
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</thead>
<tbody>
<tr>
<td></td>
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<td>Billed Unmetered Consumption</td>
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<td>Unbilled Authorised Consumption</td>
<td>Unbilled Metered Consumption</td>
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<td>Unbilled Unmetered Consumption</td>
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<tr>
<td></td>
<td>Water Losses</td>
<td>Apparent Losses</td>
<td>Unauthorised Consumption</td>
<td>Non Revenue Water</td>
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<td></td>
<td></td>
<td></td>
<td>Customer Meter Inaccuracies</td>
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<td></td>
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<td>Real Losses</td>
<td>Leakage on Transmission and Distribution Mains</td>
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<td>Leakage and Overflows at Storage Tanks</td>
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<td></td>
<td>Leakage on Service Connections up to point of Customer Meter</td>
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</tbody>
</table>
Traditional PIs for Real Losses

- per property per day
Traditional PIs for Real Losses

- per property per day
- per km of mains per day
Traditional PI's for Real Losses

- per property per day
- per km of mains per day
- per service connection per day
Traditional PIs for Real Losses

- per property per day
- per km of mains per day
- per service connection per day
- percentage of system input volume
Real Losses as % of System Input

VIENNA
(Austria)
8.5 %
Real Losses as % of System Input

LEMESOS (Cyprus)

12.5 %
Real Losses as % of System Input

DUSHANBE
(Tajikistan)

16.2 %
Real Losses as % of System Input

BRISTOL
(UK)

16.8 %
Real Losses as % of System Input

PHILADELPHIA (USA)

25.8 %
Real Losses as % of System Input

MAKKAH
(Saudi Arabia)

31.6 %
The Infrastructure Leakage Index

- a better Indicator
- describes the quality of infrastructure management
- is the ratio of **Current Annual Real Losses** to **Unavoidable Annual Real Losses**

\[ \text{ILI} = \frac{\text{CARL}}{\text{UARL}} \]

- being a ratio, it has no units
The 4 Components of a Successful Leakage Management Policy

- Pressure Management
- Speed and Quality of Repairs
- Pipeline and Assets Management (Selection, Installation, Maintenance, Rehabilitation, Replacement)
- Active Leakage Control

Unavoidable Annual Real Losses
- Potentially Recoverable Real Losses
- Current Annual Volume of Real Losses
- Real Losses

Active Leakage Control
The 4 Components of a Successful Leakage Management Policy

- Speed and Quality of Repairs
- Active Leakage Control
- Pipeline and Assets Management
- Current Annual Volume of Real Losses

- Unavoidable Annual Real Losses
- Potentially Recoverable Real Losses

Pressure Management
ILI and the Economic Level of Leakage (ELL)

- Unavoidable Annual Real Losses
- Economically Recoverable Real Losses
- Economic Level of Leakage
- Current Annual Volume of Real Losses
ILI from 1 to . . . . . . .?

ILI: 1 2 3 5 10

Legend:  
- Unavoidable Annual Real Losses
- Current Annual Volume of Real Losses
ILI from 1 to . . . . . . . ?

Legend:  
- Unavoidable Annual Real Losses
- Current Annual Volume of Real Losses
What's the problem?

- NRW Reduction is 'not a nice job'
- Difficult to do for a public company (limited funds, limited manpower, limited options to motivate staff)
- Could be outsourced very efficiently
- Utility would supervise/monitor the contractor
The Solution:

Performance Based NRW Reduction Contracts
Performance Based NRW Reduction Contracts

An all-inclusive contract with contract payments directly related to target achievement, where the contractor has to reduce NRW in an agreed area by an agreed unit rate per volume NRW reduced (e.g. m3/d).
From Theory to Practice

NRW Reduction Project in Selangor, Malaysia
Selangor Water Supply - basic facts

- Water is produced by privatised bulk water suppliers
- Water is distributed by Selangor State Waterworks Department
- Area covered includes Kuala Lumpur
  - ~ 800,000 hectares
  - ~ 13,000 km of water mains
  - ~ 5 million population
Overall Water Situation

Demand (Mm$^3$/day)

Extraction Limit

2000 2010 2020
NRW Situation in Selangor

- NRW ~ 40% of Total Supply
- ~ 280 million cubic metres per year
- ~ 821 litres per connection per day
- if reduced by 50%: enough to supply an extra 1.8 million people
Water Balance Selangor

Consumption (520 Mm3/yr)

NRW (290 Mm3/yr)

Apparent Losses (95 Mm3/yr)

Real Losses (195 Mm3/yr)
Physical Losses Selangor

- Physical Losses: 195 Mm3/yr
- Excess Losses
- Reported Bursts
- Background Leakage
Selangor NRW Reduction Contract

- A Performance Target Based NRW Reduction Contract in 2 Phases
- Phase 1 09/98 – 03/00 “Pilot Project”
- Phase 2 commenced April 2000 “State-wide Project” (9 years)
Phase 1 Contract Characteristics

Duration 18 months
Start 15 September 1998
Completion 14 March 2000
Contract value RM 17.1 M (US$ 4.5 M)

Performance Targets
- physical losses reduction 10,450 m³/day
- meter accuracy improvement 6,400 m³/day
- Overall NRW Reduction 18,540 m³/day
The contract price includes

- Planning, engineering, leak detection, construction supervision
- Repair materials, meters, equipment
- All required civil, repair and installation works
Physical Loss Reduction Programme

- establishment of NRW zones
- installation of bulk meters and Pressure Reducing Valves
- Component based leakage modelling
- replacement of all leaking service connections
- leak repair
- pressure management
Example from Selangor:
Inflow, pressure and leakage
After leak repair

Flow Rate (l/s)

Pressure (m)

00:00 02:00 04:00 06:00 08:00 10:00 12:00 14:00 16:00 18:00 20:00 22:00
Consumption - before and after

Flow Rate (l/s)
Meter Accuracy Improvement Programme

- selection of meters to be replaced
- Installation of new meters
- detection of illegal connections and report to JBAS
Monitoring

- Flow and pressure measurements PRIOR to any activities
- Measurements to be repeated AFTER completion
- Meter records of replaced meters compared with a three month reading of new meters
Phase 1 Achievements

Performance Targets

- physical losses reduction: 10,450 m³/day
- meter accuracy improvement: 6,400 m³/day
- Overall NRW Reduction: 18,540 m³/day

Achieved:

- 11,429 m³/day
- 9,212 m³/day
- 20,898 m³/day
Phase 2 Contract Characteristics

Duration 9 years
Start April 2000
Completion April 2009
Contract value RM 398 M (US$ 105 M)

Performance Targets

- reduce physical losses by minimum 97,500 m³/day
- improve meter accuracy by minimum 81,450 m³/day
- Overall NRW Reduction 198,900 m³/day
Annualised Savings
IWA Leakage Conference
Cyprus, Nov. 2002

- 3-day specialised conference
- attracted participants from 27 countries
- has facilitated new advances and concepts to stretch the current thinking on
  - real and apparent losses evaluation and
  - strategic solutions
Most interesting topics (I):

- Component based apparent loss modelling (Julian Thornton, WSO)
- Latest findings from North America (AwwaRF study) (Paul Fanner, WSO)
- Introducing DMAs in North America (Ken Brothers, Halifax Regional Water Commission)
- New Water Balance Software, 'Aqualibre' www.aqualibre.info
Most interesting topics (II):

- Tactical planning of leakage reduction (Alex Rizzo, Malta Water Services Corporation)
- Practical experience in applying the ILI (Allan Lambert)
- Water loss reduction in Italy and Greece
- Pressure Reduction in South Africa (Ronnie McKenzie, WRP)
IWA Water Loss Taskforce

- ~ 40 Members from around the world
- Chair: Ken Brothers, Halifax Regional Water Commission (Canada)
- Teams were formed to do further research:
  - Real Water Losses (including ILI/ELL) (Leader: Paul Fanner, USA)
  - Apparent Losses (Leader: Alex Rizzo, Malta)
  - PI and International benchmarking (Leader: Ronnie McKenzie, SA)
  - Leak Detection Practices (Leader: Richard Pilcher, UK)
  - District Metered Areas (Leader: John Morrison, UK)
  - Pressure Management Team (Leader: Julian Thornton, USA)
- Next important IWA Leakage Event: World Water Congress 2004, Marrakech (Morocco)
The Way Forward ??

- is it likely that politicians and media (and the Bank?) will stop using percentages??
- a new indicator is needed which
  - is simple, ideally using percentages
  - takes ECONOMICS into account
- ENE – the Economic Network Efficiency
Calculate the ENE

1. step 1: determine CARL
2. step 2: calculate the economic level of leakage, express as EARL (Economic Annual Real Losses)
3. step 3: calculate the Economic Leakage Index \( ELI = \frac{CARL}{EARL} \)
4. step 4: calculate the ENE:

\[ ENE \ [\%] = \frac{1}{ELI} \]
## Economic Network Efficiency

<table>
<thead>
<tr>
<th></th>
<th>ILI</th>
<th>ELI</th>
<th>ENE</th>
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<tbody>
<tr>
<td></td>
<td>2.0</td>
<td>1.0</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>3.0</td>
<td>1.5</td>
<td>67%</td>
</tr>
<tr>
<td></td>
<td>5.0</td>
<td>2.5</td>
<td>40%</td>
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<tr>
<td></td>
<td>10.0</td>
<td>5.0</td>
<td>20%</td>
</tr>
</tbody>
</table>

**Legend:**
- **Solid black:** Unavoidable Annual Real Losses
- **Dashed black:** Economic Annual Real Losses
- **Gray:** Current Annual Real Losses

**Abbreviations:**
- **ILI:** Infrastructure Leakage Index
- **ELI:** Economic Leakage Index
- **ENE:** Economic Network Efficiency ($= 1/ELI [\%]$)
Thank you.

www.waterlosses.com