Water Loss Reduction: How Low Can We Go?

mathieu.laneuville@mamot.gouv.qc.ca
hdemard@videotron.ca
valentina.estradacote@mamot.gouv.qc.ca
Allan Lambert: www.leakssuite.com

This presentation was made by Mathieu Laneuville at Americana Réseau Environnement, Quebec AWWA Section In Montreal on 23rd March 2017

Presentation Outline

1. **Province of Quebec Context**
2. Unavoidable Annual Real Losses (UARL)
3. Performance Indicators (PI) Fit for Purpose
4. Available Tools & Next Steps

1.1. Province of Quebec Context

Municipalities with water distribution system (WDS)	800 municipalities ▪ 9/10 with less than 5 000 connections ▪ Largest with 260 000 connections
Quebec WDS	43 000 km of water pipes ▪ Leak detection on ¾ of Quebec WDS ▪ 10 000 repairs/year (mostly on mains)
Population served by a WDS	7 M people served
Meters	▪ 40 % of non-residential buildings ▪ 10 % of residential buildings
Annual water balance	8/10 of municipalities

1.2. Province of Quebec Context

Annual water balance

- Indicators evaluation
- Actions orientation

How long can we go ?

- UARL and pressure management

Which PI fit for purpose ?

- %
- ILI
- L/d/connection
- m^3/d/km of main

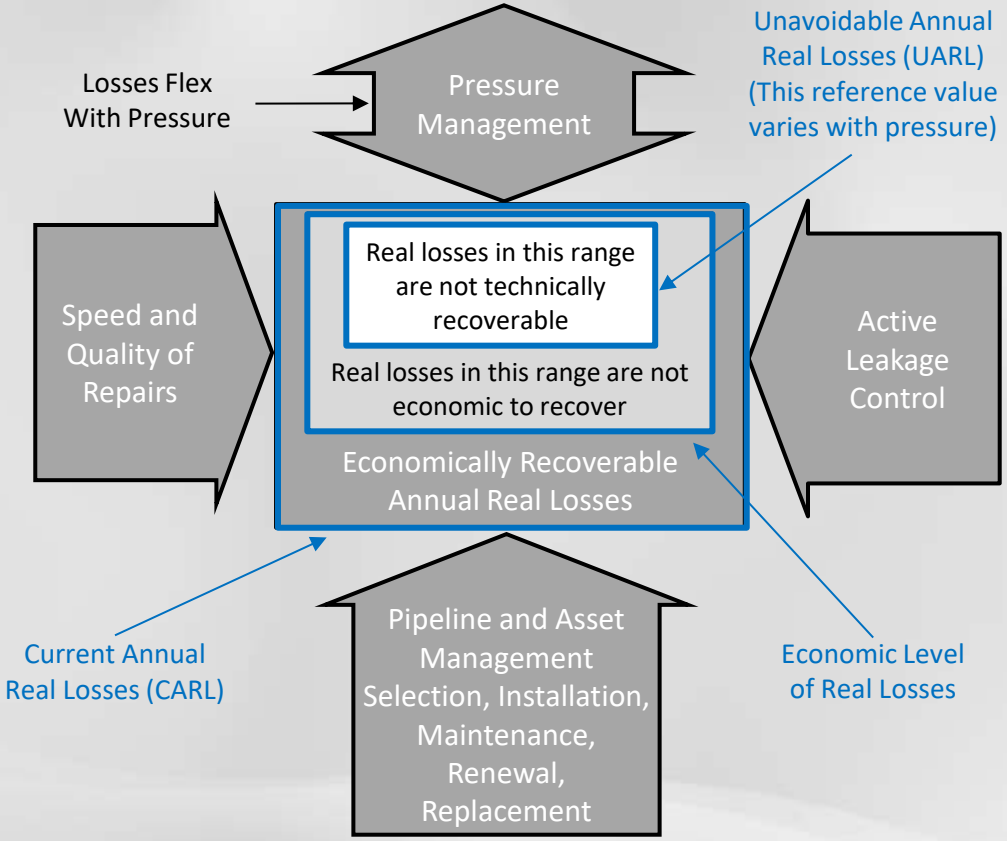
ENSEMBLE on fait avancer le Québec

Québec

Presentation Outline

1. Province of Quebec Context
2. **Unavoidable Annual Real Losses (UARL)**
3. Performance Indicators (PI) Fit for Purpose
4. Available Tools & Next Steps

2.1. Water Loss Reduction



Source : AWWA M36, 2016

2.2. Unavoidable Annual Real Losses (UARL)

UARL = Lower technical leakage limit that could be achieved if all the best current technologies could be applied successfully in a network in good condition

- If < 3 000 connections, it is possible to reach a lower leakage level than UARL formula because of :
  - Night Flow Analysis makes it possible to quickly detect the appearance of leaks and to perceive smaller ones
  - Low Flow Flowmeter Sub-Count
  - Relative uncertainty increases

Source : EU Report, 2015. Austrian Case Study

- It is the variable that makes it possible to calculate the ILI

$$ILI = CARL/UARL$$

2.3. The UARL Formula (1999)

- Coefficients for mains length, number and length of services are based on a component analysis for background leakage, reported and unreported bursts, on mains and services
- Auditable parameters for frequencies, flow rates and durations of different type of leaks on mains and services, use international data and tight targets for average durations
- The flow rates relate to a reference pressure of 50 metres (490 kPa, 71 psi) and are adjusted linearly for other pressures

The formula was tested over several years against data from 27 systems in 20 countries in Europe, Oceania, South America, Asia and North America, before publication in 1999

2.4. The UARL Formula (1999)

Component values of the UARL calculation at 50 metres pressure

Infrastructure Component	Background Leakage	Reported Leaks	Unreported Leaks
Mains	20 L/h/km	0.124 leaks/km/year at 12 m^3/hr for 3 days (864 m^3/burst)	0.006 leaks/km/year at 6 m^3/hr for 50 days (7 200 m^3/burst)
Service connection, municipal side*	1.25 L/h/conn	2.25/ 1000 conn/an at 1.6 m^3/hr for 8 days (307 m^3/burst)	0.75/1000 branch/an at 1.6 m^3/hr for 100 days (3 840 m^3/burst)
Service connection, private side** (15 m average length)	0.5 L/h/conn	1.5/ 1000 branch/an at 1.6 m^3/hr for 9 days (346 m^3/burst)	0.5/ 1000 branch/an at 1.6 m^3/hr for 101 days (3 878 m^3/burst)

* Municipal side : main to curb stop
** Private side : curb stop to meter or property line

Sources : A.O Lambert, Timothy.G. Brown, M. Takizawa, D. Weimer, 2000 and AWWA M36, 2016

2.5. The UARL Formula (1999)

Standard unit values used for the UARL calculation

Infrastructure Component	Background Leakage +	Reported Leaks +	Unreported Leaks =	Total (UARL)	Units
Mains	9.6	5.8	2.6	**18**	L/km of main/d/m of pressure
Service connection, municipal side*	0.60	0.04	0.16	**0.80**	L/conn/d/ m of pressure
Service connection, private side**	16.0	1.9	7.1	**25**	L/km of conn/d/ m of pressure

* Municipal side : main to curb stop
** Private side : curb stop to meter or property line

Sources : A.O Lambert, Timothy.G. Brown, M. Takizawa, D. Weimer, 2000 and AWWA M36, 2016

2.6. The UARL Formula (1999)

$$UARL = (18Lm + 0.8Nc + 25Lc) \times P$$

- UARL = unavoidable annual real losses (L/d)
- Lm = length of water mains (km)
- Nc = number of service connections
- Lc = Nc x Lp (average length of underground connection up to the meter on the private side (km))
- P = average pressure in the system (or in a sector at the Average Zone Point (AZP)) (metres of water)

Presentation Outline

1. Province of Quebec Context
2. Unavoidable Annual Real Losses (UARL)
3. **Performance Indicators (PI) Fit for Purpose**
4. Available Tools & Next Steps

3.1. Performance Indicators (PI)

- PI Goals
  - Track performance for an individual system
  - Technical Performance comparisons of different systems

- Water Losses PI :
  - % of distributed water
  - $m^3/d/km$ of mains
  - L/d/connection
  - ILI

3.2. Water Losses Expressed as % of Distributed Water

Track Individual System

- Strongly influenced by changes in consumption
- Cannot show % reductions in both water losses and consumption in the same period
  (Zero Sum indicator - Play the %s Game)

Comparison of different systems

- A municipality with fewer major users than another has a higher indicator even if their leakage volumes are the same

Simplistic Indicator, because of major flaws to track individual system and for comparison of different systems

Source : http://www.leakssuite.com/kpis-fit-for-purpose/pros-abandon-percents-of-siv

3.2. Water Losses Expressed as m^3/mains km/d

Track Individual System

- Excellent, unless a considerable change of mains length. Implies that most losses are on the mains, so recommended if less than 20 conn/km

Comparison of different systems

- This indicator increases rapidly with connections/km, so performance bands are often set for different connections/km ranges, with discontinuities at ‘steps’

Excellent indicator to track individual system **if less than 20 conn/km**, but not for comparison of different systems.

3.2. Water Losses Expressed as L/conn/d

Track Individual System

- Excellent, unless a considerable change of connection numbers. Implies that most losses are on the connections, so recommended if at least 20 conn/km

Comparison of different systems

- The indicator gradually increases as connection density reduces

Excellent indicator to track individual system **if at least 20 conn/km**, but not for comparison of different systems.

3.2. Water Losses Expressed with ILI (CARL/UARL)

CARL : Current Annual Real Losses

Track Individual System

- Excellent, if all justifiable pressure management completed, as UARL reduces with pressure

When the service connection number is less than 3, 000, it is recommended to consider ILI average over a 3 year period to smooth out the effect of major leaks or weather variation

Comparison of different systems

- The best indicator, designed to take system characteristics into account

It is recommended to quote average pressure alongside ILI when making comparisons

Excellent to compare different systems and to track individual system if all justifiable pressure management completed

3.6. International Leakage Performance Classification System for High Income Countries

Performance

ILI	LPC*	Actions orientation
< 2	A	– Further loss reduction may be uneconomic unless there are shortages – Careful analysis needed to identify cost-effective improvement
2 à < 4	B	– Potential for marked improvements – Pressure management – Better active leakage control practices and network maintenance
4 à < 8	C	– Poor leakage record – Tolerable only if water is plentiful and cheap, even then, analyze level and nature of leakage and intensify leakage reduction efforts
> 8	D	– Very inefficient use of resources – Leakage reduction programs imperative and high priority

* LPC : Leakage Performance Category

Source : http://www.leakssuite.com/concepts/uarl-and-ili/

3.7. Recommended Actions for each LPC range

Recommended Actions for each LPC* range	A (<2)	B (2-4)	C (4-8)	D (>8)
Investigate pressure management options	X	X	X	
Investigate speed and quality of repairs	X	X	X	
Check economic intervention frequency	X	X		
Introduce/improve active leakage control	X	X	X	
Identify options for improved maintenance		X	X	
Assess economic leakage level	X	X		
Review burst frequency		X	X	
Review asset management policy		X	X	X
Deal with deficiencies in manpower, training and communications			X	X
5-year plan to achieve next lowest band			X	X
Fundamental peer review of all activities				X

* LPC : Leakage Performance Category

Source : http://www.leakssuite.com/concepts/uarl-and-ili/

3.8. Summary Table of Water Loss PI Fit for Purpose

Summary Table of Water Loss PI Fit for Purpose

OBJECTIVE	GOOD PRACTICE PERFORMANCE INDICATOR FOR LEAKAGE, FIT FOR PURPOSE						
	Volume per year	litres/ service connection	m^3/km mains	litres/ billed property	% of System Input Volume	% of Water Supplied	Infrastructure Leakage Index, with Pressure
SET TARGETS AND TRACK PERFORMANCE, FOR AN INDIVIDUAL SYSTEM	YES, for large systems	YES*	YES*	YES (UK)	NO	NO	Only if all justifiable pressure management completed
TECHNICAL PERFORMANCE COMPARISONS OF DIFFERENT SYSTEMS	NO	NO	NO	NO	NO	NO	YES
DRAW GENERAL CONCLUSIONS FROM SINGLE OR MULTIPLE SYSTEMS	NO	NO	NO	NO	NO	NO	YES, together with other context factors
* Choose services if connection density > 20/km; if not, choose mains; or base choice on country custom and practice							

Source : http://www.leakssuite.com/concepts/kpi

3.9. Example

Municipality Caracteristics

Connection density	40 conn/km
Average connection length on the private side	0,005 km
Average pressure at AZP	50 m (490 kPa)
Current Annual Real Losses (CARL)	11,0 m³/km of main/d (275 L/conn/d)

Performance Indicators

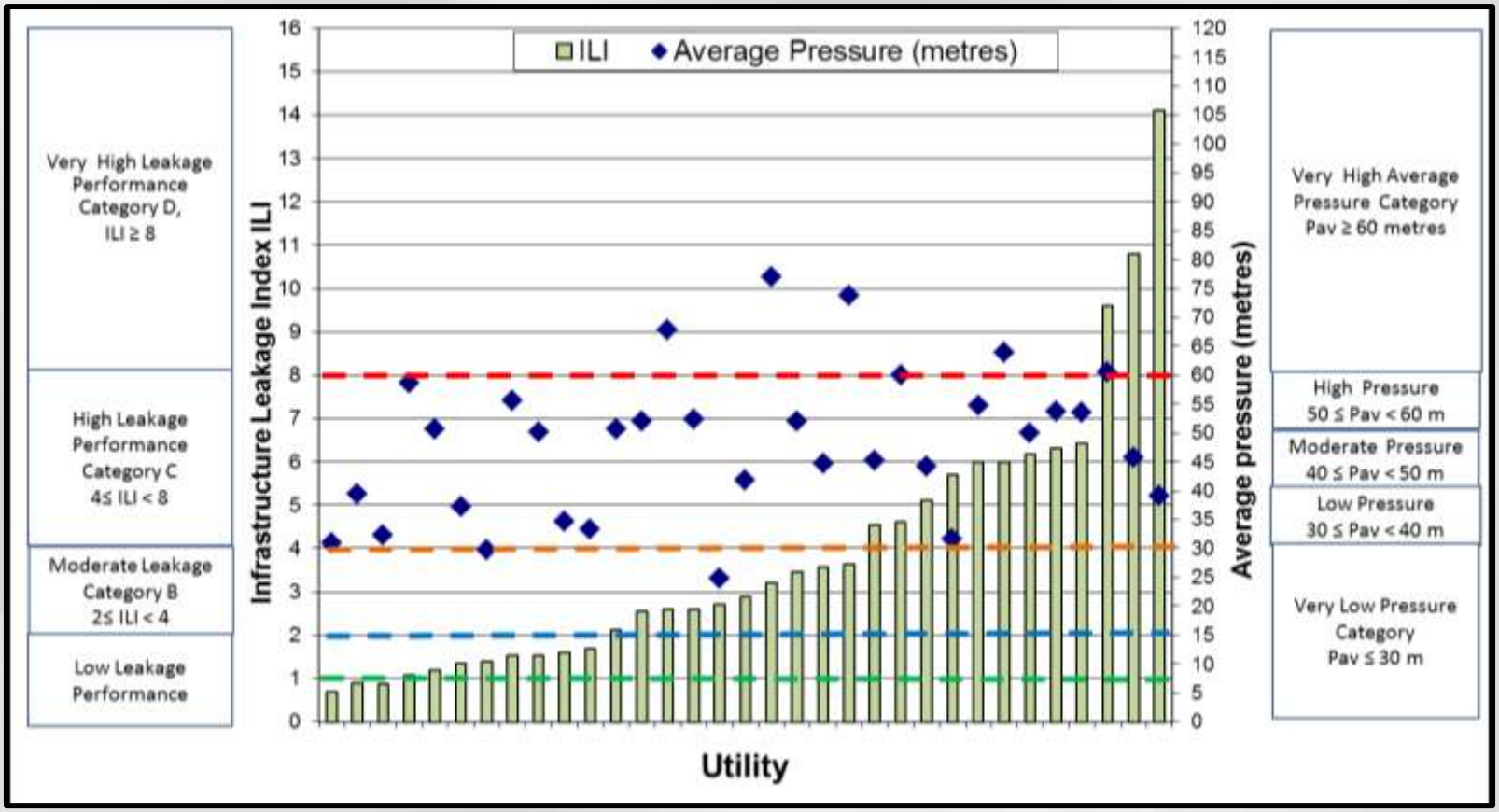
UARL	2,75 m³/km/d (68,8 L/conn/d)
ILI	4,00
Real Losses	11,0 m³/km/d (275 L/conn/d)

- If consumption of 500 L/conn/d : 275/(275 + 500) = 35 %
- If consumption of 2000 L/conn/d : 275/(275 + 500) = 12 %

As of % of water distributed depends on consumption!

3.10. Canadian Data – ILI and Average Pressure

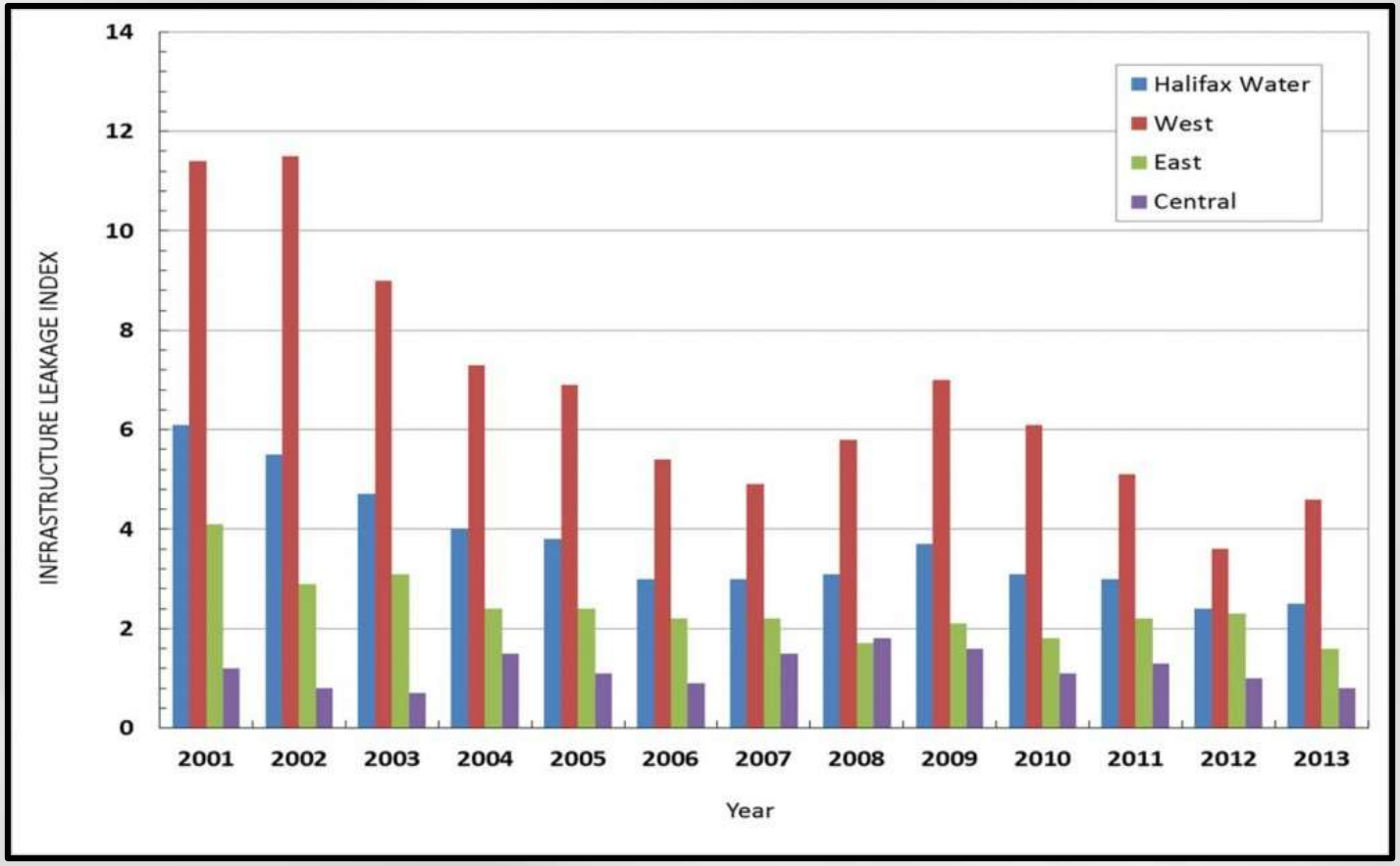
ILI and Average Pressure for 33 Canadian Utilities (2003 to 2014)



Source : http://www.leakssuite.com/global-ilis/canadian-ilis

3.11. Comparison of Sectors ILIs in a Canadian Utility

Comparison of Sectors ILIs in Halifax



Source : http://www.leakssuite.com/global-ilis/canadian-ilis

3.12. Comparison

Residential per capita :

$$\frac{\text{residential consumption}}{\text{number of people served}}$$

VS

Total per capita :

$$\frac{\text{Amount of water distributed}}{\text{number of people served}}$$

- Better comparison between municipalities
- Residential consumption measured in approximately 100 municipalities
- Residential consumption estimated underway in the majority of municipalities
  - by sampling
  - by CMA

Presentation Outline

1. Province of Quebec Context
2. Unavoidable Annual Real Losses (UARL)
3. Performance Indicators (PI) Fit for Purpose
4. **Available Tools & Next Steps**

4.1. Available Tools

Estimate your UARL and your ILI

- Drinking Water Use Form (Distribution worksheet)

Estimate your average pressure

- Excel tool on Pressure Management Profitability (on demand via eautrement@mamot.gouv.qc.ca)

Estimate your residential consumption

- Sampling Excel tool
- CMA Excel tool

Real losses reduction management

- Guide «Water Efficiency and the municipalities» (3.3 section - Real Losses Reduction Management) of Réseau Environnement (in french only)

One-page Summary, Video capsule and French Version of this presentation.

4.2. Next Steps

- Adjustment of the tools and the approach according to the Quebec applications and experiences to come

Thank you for your attention

Questions & Discussion

Quebec Water Efficiency Strategy
Stratégie d'économie d'eau potable

Web Site

eautrement@mamot.gouv.qc.ca

Je consomme eautrement

ENSEMBLE on fait avancer le Québec

Québec