Challenges related to the management of lead service lines, partial lead service line replacements, and lead occurrence in the tap water of large buildings in Canada

CWN Project team:

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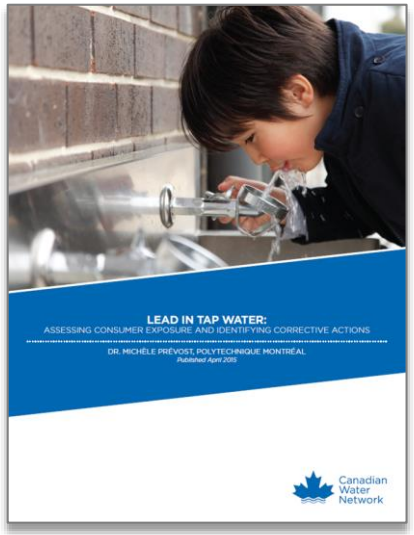
CWN PROJECTS 2008-2015

- **CWN projects 2008-2015:**
  1. ***Developing a Comprehensive Strategy to reduce Lead at the Tap (2008-2012)***
  2. ***Examining Potential Short & Long Term Impacts of Partial Lead Service Line Replacements on Lead Release in Drinking Water Distribution Systems (2012-2015)***
- **Bench, pilot, and full-scale studies on PLSLRs in collaboration with 6 utilities (partner/collaborators)**
- **Partner utilities: City of Halifax, Ville de Montreal, City of Ottawa and City of London**



http://www.cwn-rce.ca/reports/

PROJECT TEAM (2012-15)

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- *Prof. Robert C. Andrews*



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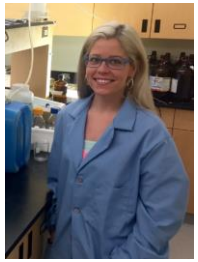
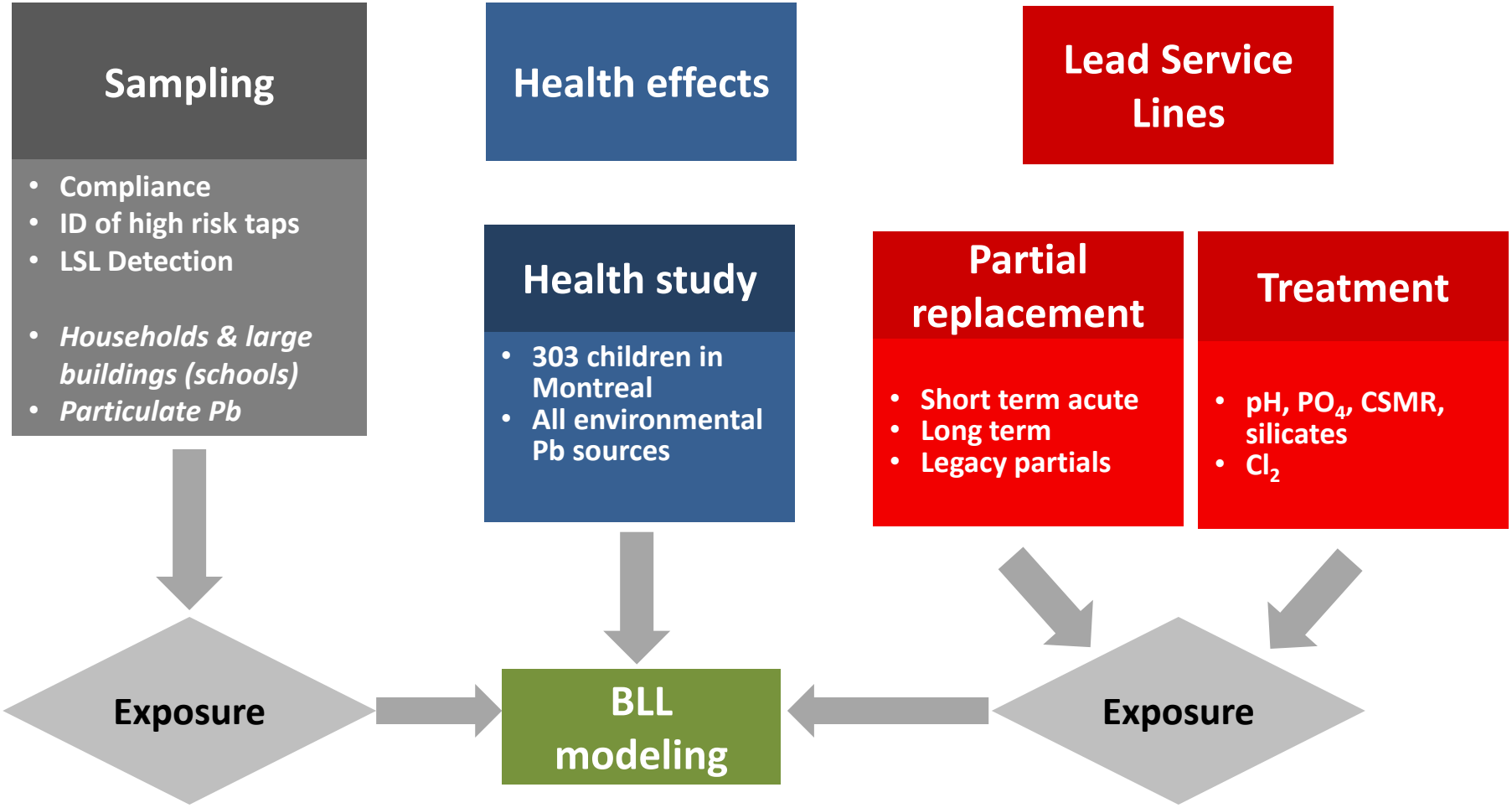
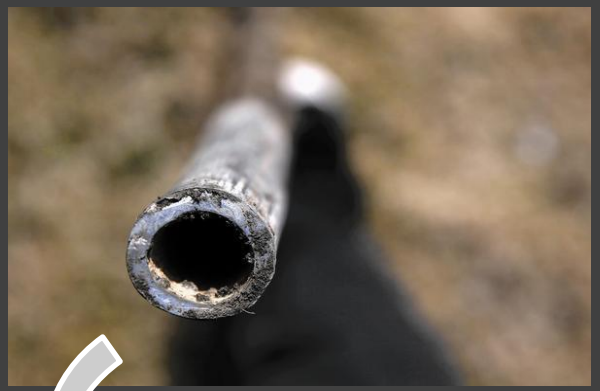



CWN project overview



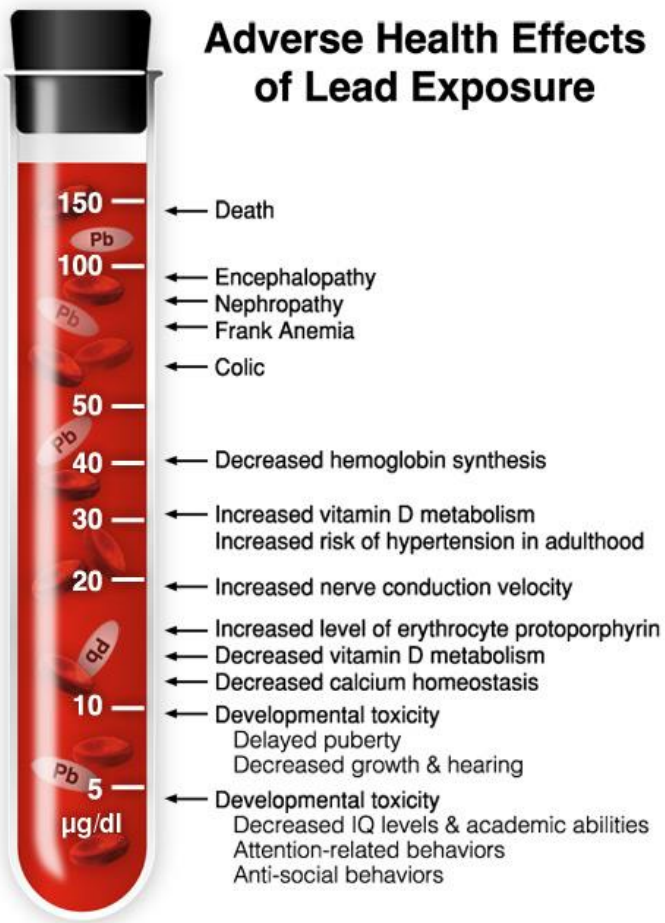
Background:
Challenges, health issues and regulations



Picture sources: http://www.chicagotribune.com/; http://cfjctoday.com/article/513438; http://www.webmd.com/parenting/baby/baby-bottles; http://www.wealthandfinance-intl.com/

CONTEXT

- **Health effects associated with low blood lead levels (BLLs):**
  - **Neurodevelopment and decreased IQ levels in children**
  - **Cardiovascular & renal effects in adults**
  - **CDC threshold reduced at 5 µg/dL**
  - **WHO <u>provisional</u> guideline of 25 µg Pb/kg bw/week removed**
  - **<u>No threshold with no effects</u>**



Source: http://www.ehatlas.ca/lead/human-impact/health-concerns
Adapted from Bellinger and Bellinger (2006)

CONTEXT

Main contributors to BLLs:

- Diet, soil/dust/paint, tap water

Major lead events:

- Extensive school sampling across the US and some provinces
- Flint, MI
- Washington DC
- Montreal & Hamilton epidemiological studies

Recent guidance/regulations:

- Health Canada: State of Science (2013) and Revised Corrosion Guidance expected in 2016
- Lead & Copper Rule (US): Under review (2016)
- Quebec: New sampling regulations (2014)
- American Academy Pediatrics position and BC regulations on lead in schools (2016)

Main contributors to Pb in tap water:

- Households: lead service lines (LSLs)
- Large buildings (schools): solders, fountains, brass fittings, and fixtures

Picture sources: http://www.dailymail.co.uk http://www.nbcnews.com

REGULATIONS

	COMPLIANCE SAMPLING	LEVEL	SAMPLING SITES	SCHOOLS
HEALTH CANADA	1L after **>6h stagnation** OR 4L after 30min stagnation*	0.015 mg/L (90th AL 6hr) 0.010 mg/L (90th AL 30min) **0.010 mg/L (MCL)**	≥50% (6hr) or 100% (30min) **residences** with LSL**	**Addressed separately**
USEPA LCR	1L after **>6h stagnation**	0.015 mg/L (90th AL) **No MCL**	**Single-family homes** (priority) with LSL**, Pb pipes/solders	**Addressed separately (3Ts)**
ONTARIO 170/03	2L after **30min stagnation**	0.010 mg/L (90th AL) **0.010 mg/L (MCL)**	**Single-family and multi-units homes** with LSL**, Pb pipes or solders	**Addressed separately (243/07)**
QUEBEC	Sample after **5min flushing***	**0.010 mg/L (MCL)**	**Single-, 2-, and 3-family homes** (priority) with LSL**, Pb pipes or solders	At least 1 site but <10% of all sites
EUROPE	1L **Random Daytime***	**0.010 mg/L (MCL)**	**Private residences and public buildings** with LSL**	Included

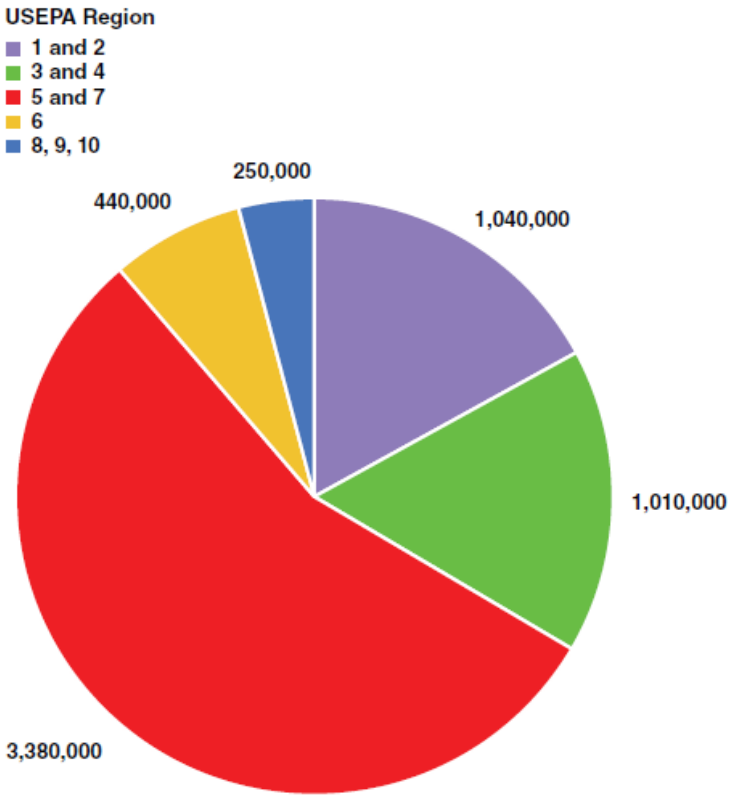
*** Profile sampling (4L after 30min or 6h stagnation) for further investigation of high lead levels**
****Suspected or confirmed LSL since LSL detection <u>NOT MANDATORY</u>**

Key LSL management concepts in Canada

LEAD SERVICE LINES

- **50-75% of Pb in tap water** *(Sandvig et al. 2008, WRF report)*
- **<u>Reliable LSL records not available</u>**
- **Estimations for the U.S.**
  - **30% of U.S. Systems with LSL**
  - **6M people living in households served by a LSL** *(Cornwell et al.)*
  - **Up to 80,000 LSLs estimated in Milwaukee** *(Biedrzycki, 2016)*

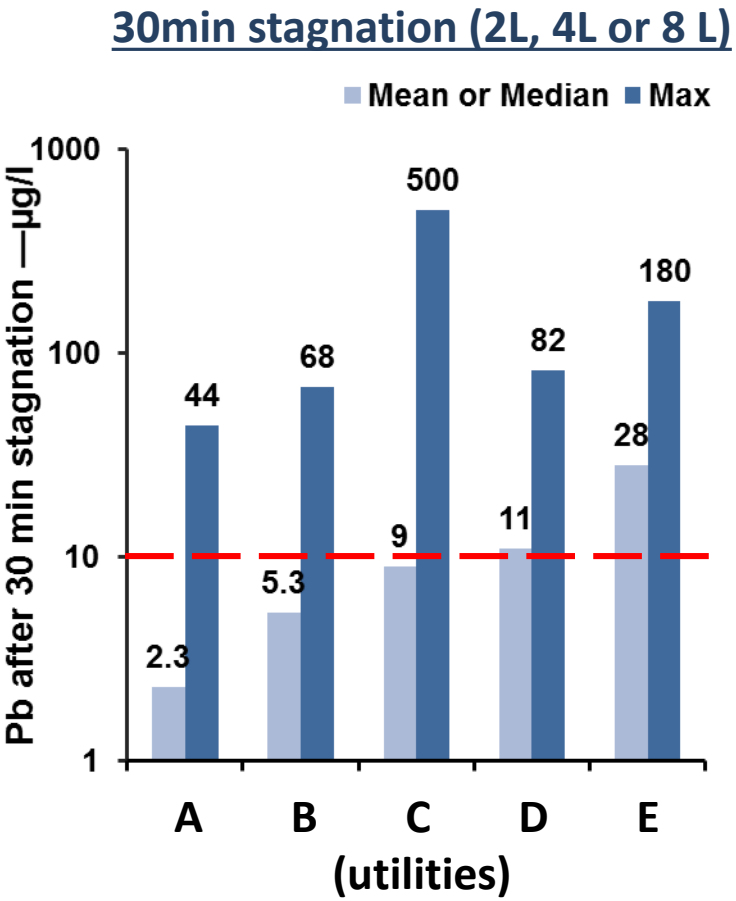
FIGURE 3 National LSL estimate by USEPA regional group



Cornwell et al. 2016, Journal AWWA

Survey of LSL management practices

- **Canadian phone survey (17 utilities):**
  - Installation of LSLs stopped between 1950-1970
  - <50 to 69,000 LSLs spread out in the system or located downtown (<1 to 22%)
  - > 9,000 LSLs for half of the utilities surveyed



Survey of LSL management practices

- **LSL reduction plans selected by the utilities surveyed:**
  - 10/17 opted for corrosion control with orthoP (6) or pH adjustment (4)
  - 4/17 opted for systematic LSL replacement
  - 3/17 with no reduction plan
- **When LSLs are replaced?**

Reconstruction work on the main	16/16 utilities	< $1000 (street excavations)
Request from homeowner replacing his LSL	12/16 utilities	<$5000 (torpedo) $10,000-$20,000 (local excavations)
Emergency repairs (not systematic)	11/16 utilities	
Rehabilitation work on the main	10/16 utilities	
Work on the roadway/sidewalk	6/16 utilities	
In target streets/households at risk	2/16 utilities	-

Adapted from Nour et al., AWWA-WQTC 2015

Survey of LSL management practices

Types of LSL replacements

10 utilities

- *Material type on the private side of the LSL rarely recorded*

- *No specific post-LSLR flushing procedures for most utilities*

PLSLR

REASONS FOR THE NO:

- ✓ Cost: $1000-$6000$
- ✓ Low-income families in old sectors with LSLs
- ✓ No incentives
- ✓ Difficult to coordinate the replacement of the public and private side of LSLs

3 utilities

Full LSLR and PLSLR

REASONS FOR THE YES:

- ✓ Loan, tax rebate, or grant program AND assistance by the utility
- ✓ Full LSLR mandatory
- ✓ Demolition/reconstruction of the households

2 utilities

Full LSLR

Adapted from Nour et al., AWWA-WQTC 2015

PERIOD OF QUESTIONS

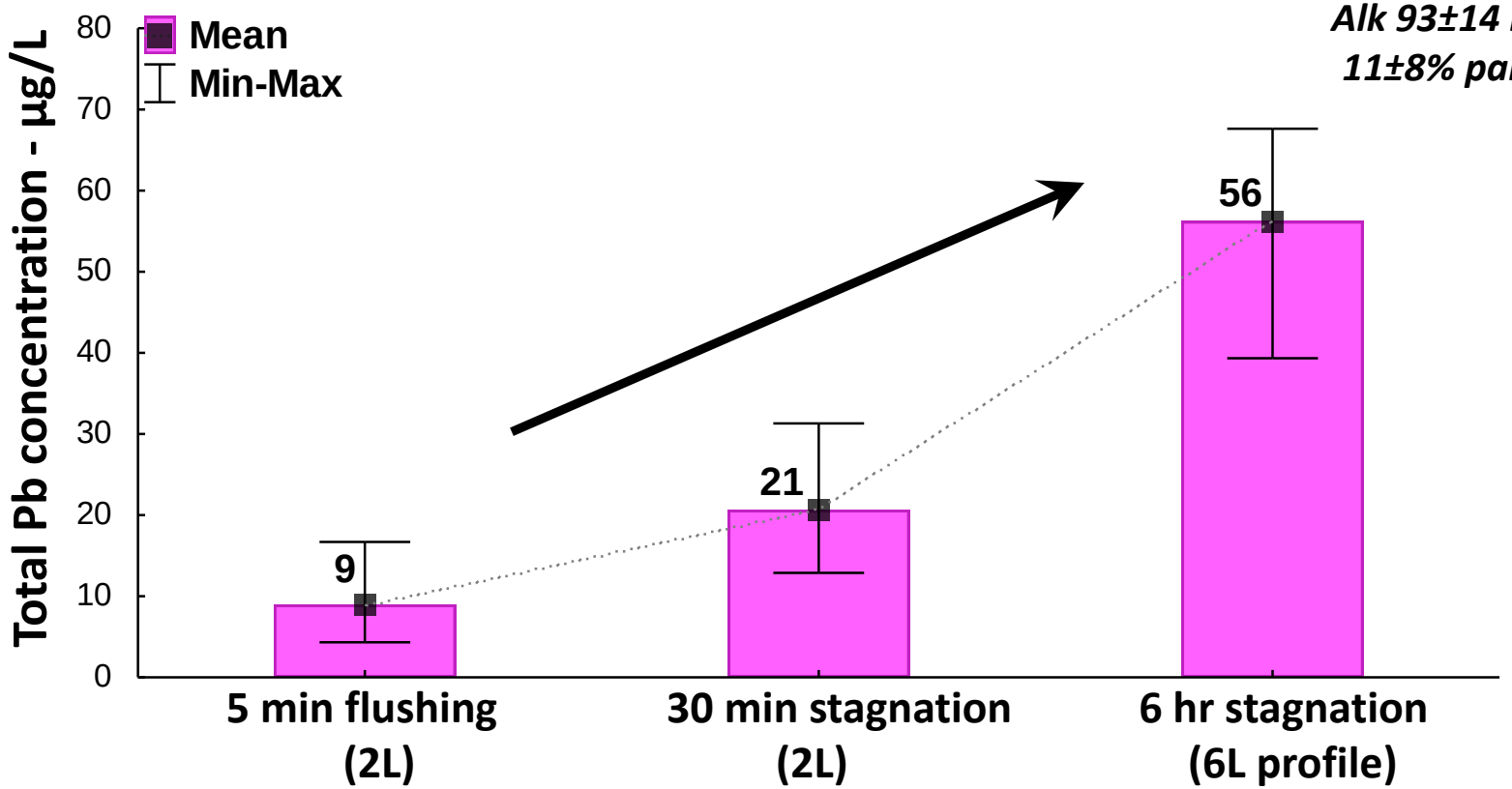
Sampling for lead at the tap: critical factors

SAMPLING

- **Impact of stagnation time**

  e.g. Repeated sampling in 1 household with a full LSL over 1 year, 2L samples, no corrosion control

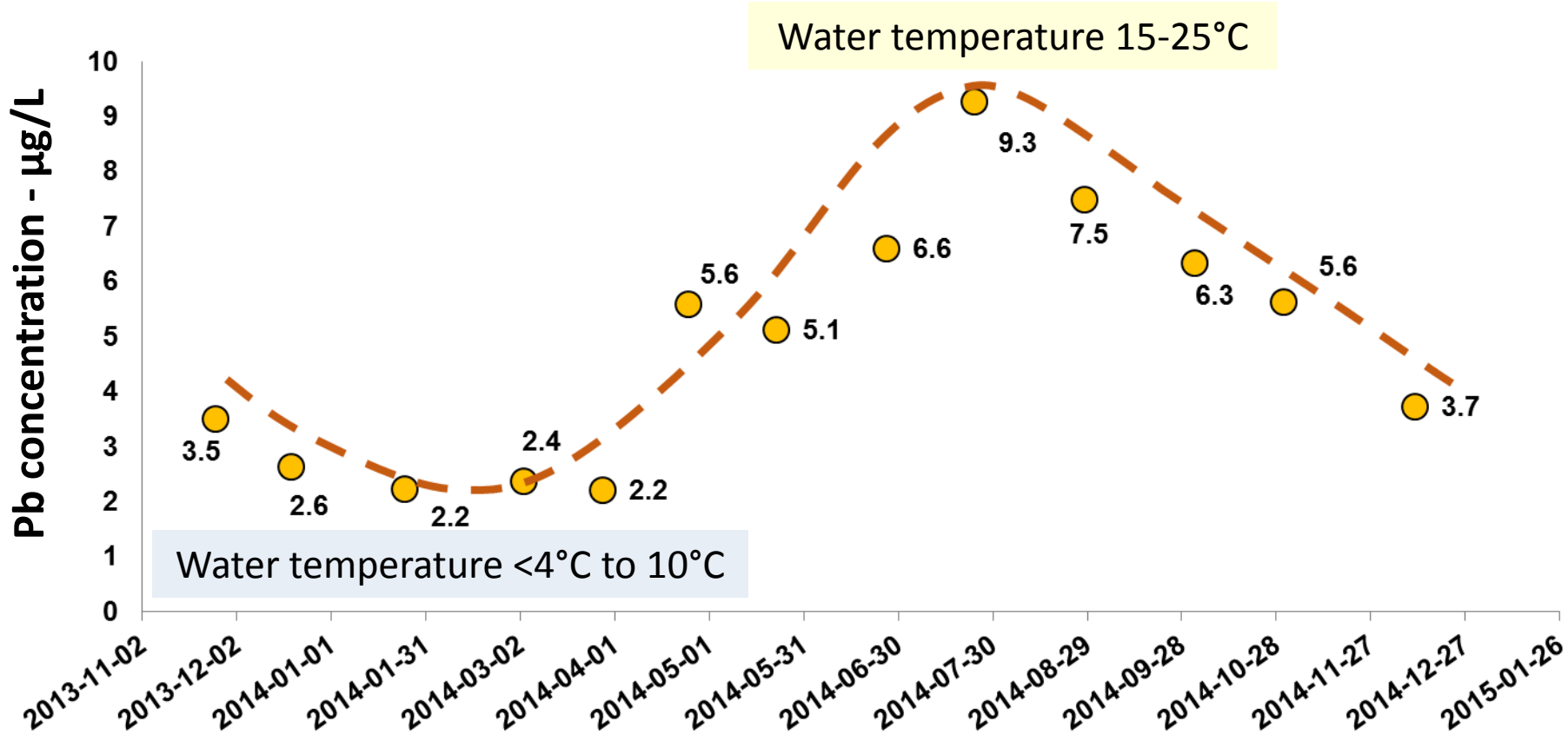
N=10 sampling events
pH 7.8±0.1,
Temperature 9.5±9°C
Alk 93±14 mgCaCO$_3$/L
11±8% particulate Pb



SAMPLING

- **Impact of water temperature**

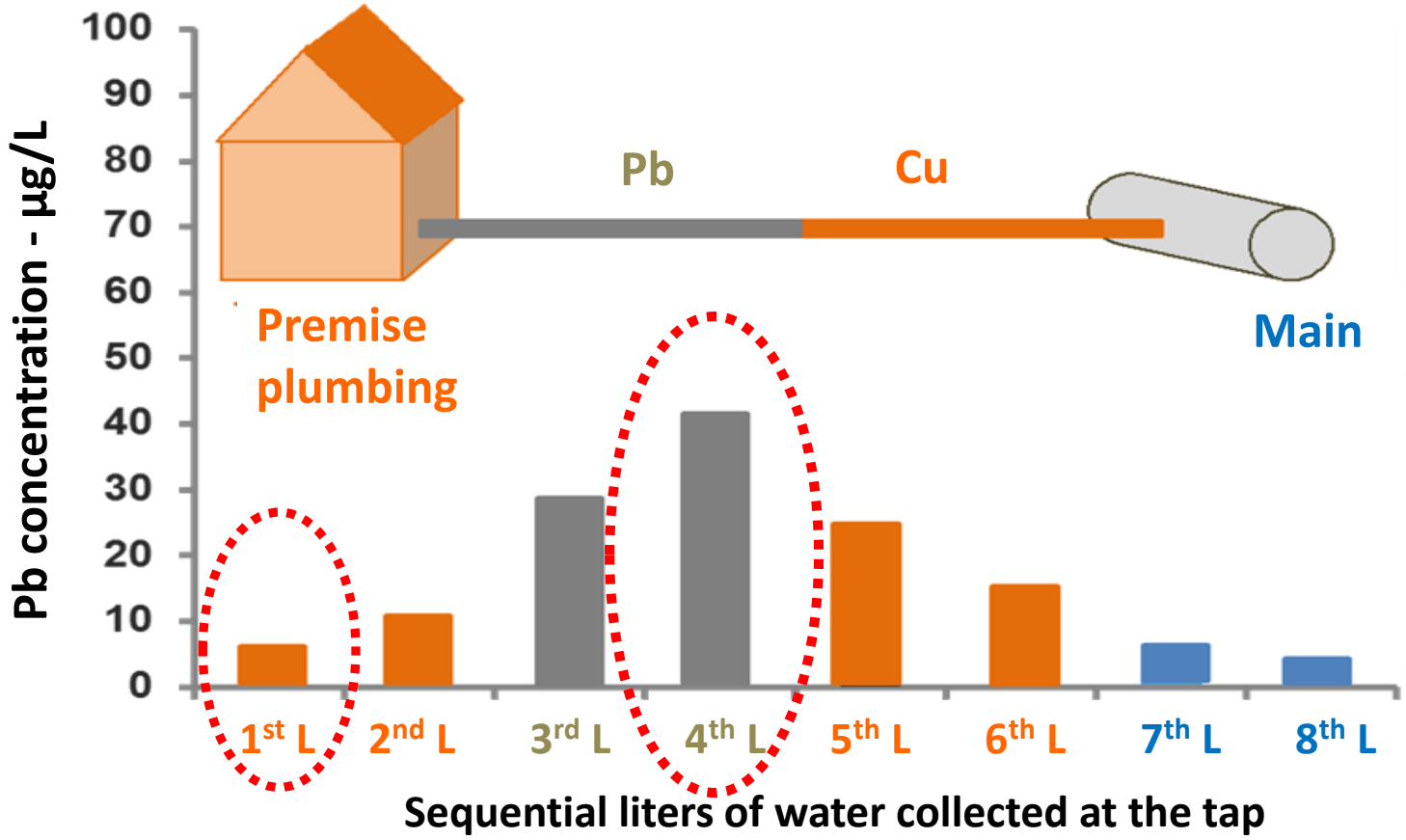
  e.g. Repeated sampling after 5 min of flushing in 1 household



SAMPLING

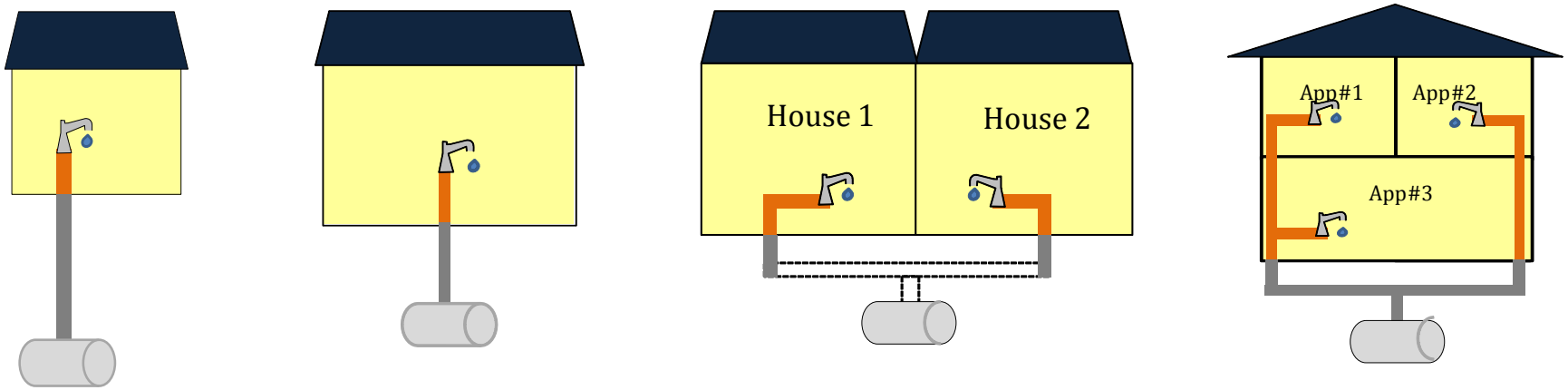
- **Impact of the volume collected**

  e.g. 30min profile sampling in one household



SAMPLING

- **Impact of the type of household**



Wartime homes | **Single-family homes** | **Semi-detached homes** | **Multi-units homes**

- **Shared service line or not**
- **Differences in piping volume (premise plumbing, LSL)**

Adapted from Deshommes et al., Jour AWWA 2016

SAMPLING

- **Impact of the type of household**
  Results in 35 households with LSLs

	Premise piping volume	Service line volume
Wartime	0.6 – 2.6 L	**4.4 – 10 L**
Single-family	**0.5 – 9.0 L**	**1.6 – 10 L**
Semi detached	1.7 – 4.4 L	2.6 – 4.8 L
Two-family	1.2 – 4.7 L	1.9 – 4.0 L
Three-family	**0.5 – 9.0 L**	**3.5 – 8.7 L**

Premise piping + service line = up to 16L

Up to 9L to flush before reaching the LSL

Volume of water in contact with the Pb pipe (10-45 m, ½ to 1 in)

Adapted from Deshommes et al., Jour AWWA 2016

SAMPLING

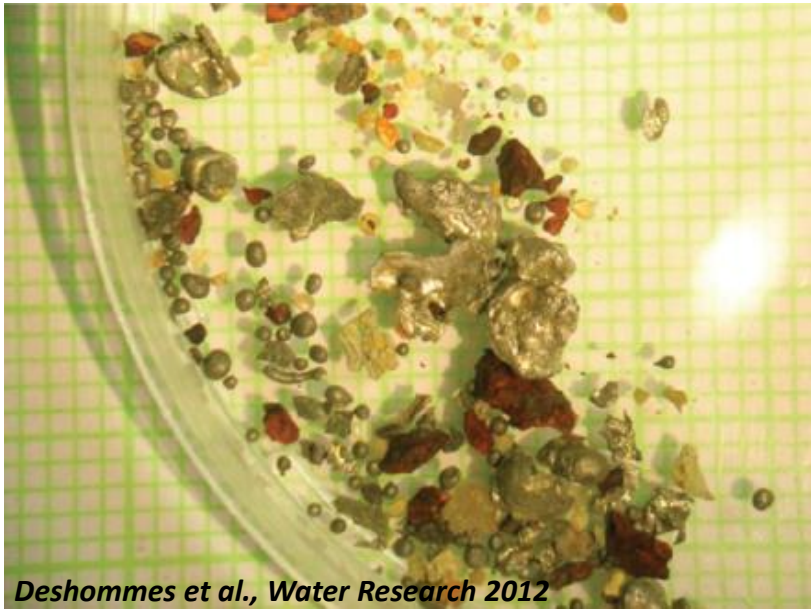
- **Impact of particulate lead**

DISSOLVED LEAD

- < 0.45 µm typically
- Increases with stagnation & temperature
- Up to around 100 µg/L after long stagnations
- Controlled with corrosion control

PARTICULATE LEAD

- > 0.45 µm typically
- Increases with stagnation, flow rate, galvanic corrosion
- Linked to lead spikes (up to 22,000 µg/L measured in large buildings)



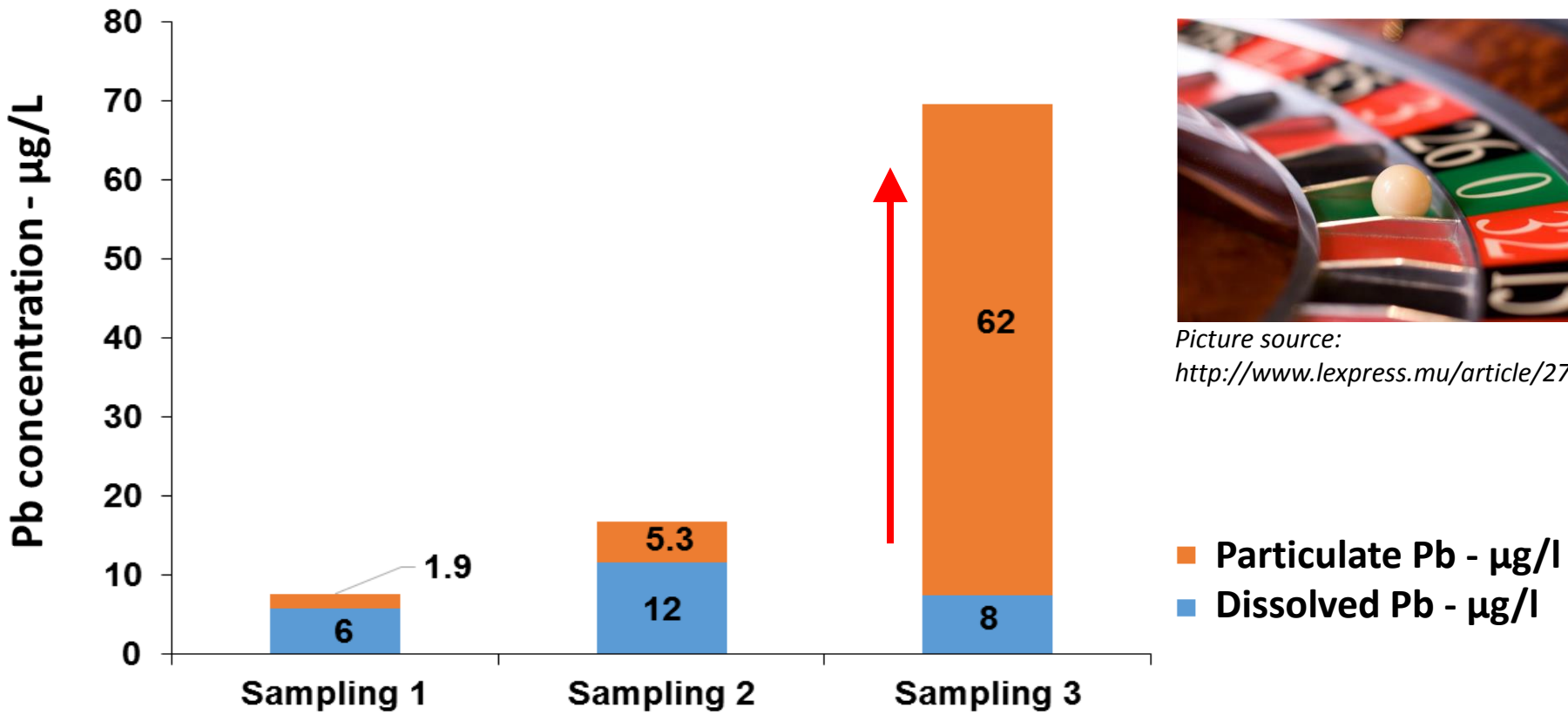
Deshommes et al., Water Research 2012

TOTAL PB =
DISSOLVED PB + PARTICULATE PB

SAMPLING

- **Impact of particulate lead**

  e.g. Repeated sampling in one household (6hr stagnation)



Picture source: http://www.lexpress.mu/article/272275

Picture source: Cartier et al. Journal AWWA, 2012

LSL detection

LSL DETECTION

- **It is essential to locate LSLs however:**
  - **LSL detection is not mandatory**
  - **Absence of reliable records on LSLs (survey)**

Cartier et al. 2012, Journal AWWA

- **Identification mainly based on (survey):**
  - **Households construction year (<1950 to 1970)**
  - **Water main renovation/reconstruction year**
  - **Field investigation:**
    - Inspection in the basement
    - Vacuum excavation at the curb stop valve
  - **Sampling**
    - Regulatory sampling typically
    - 5min flush ≥5 µg/L indicates a high probability of LSL for one utility surveyed (no corrosion control)

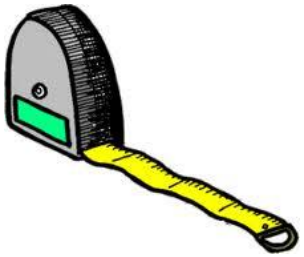
LSL DETECTION

- **LSL detection method applied in Montreal (CWN project 2007-2012):**
  - **Flushing for 5 minutes**
  - **Stagnation of 15 minutes**
  - **Collection of 2 liters after stagnation**
  - **Analysis of the 2nd L (ASV on-site analyzer)**
  - **If Pb >3 µg/L, confirmation of LSL**
  - **96% accurate with onsite excavation confirmation (n = 538 homes)**
  - **Used by the utility every year**

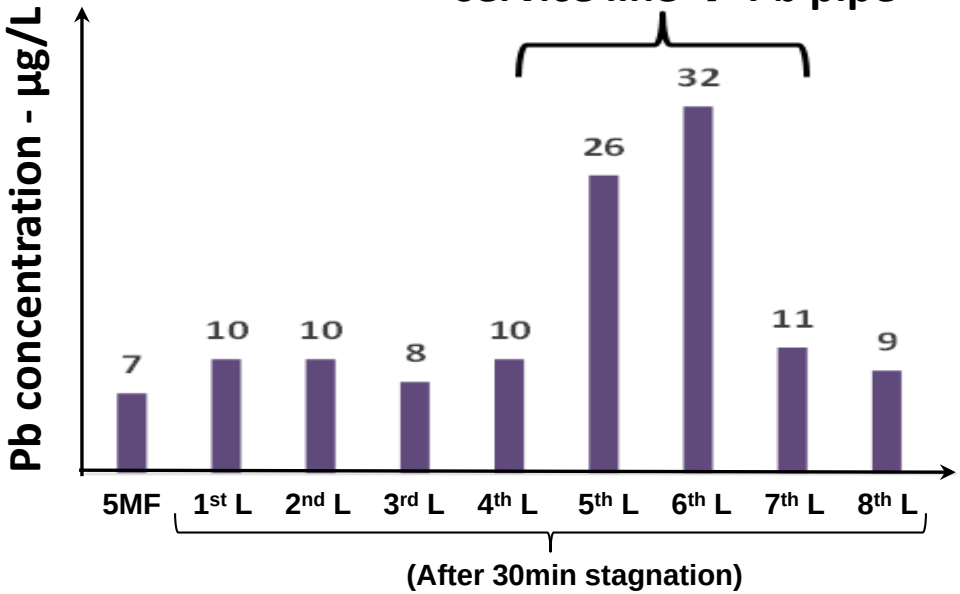
Cartier et al. 2010, AWWA-WQTC

- **Limitations:**
  - **Water temperature (> 20°C), detection limit (2 µg/L), particulate Pb**
  - **No conclusion on the service line configuration**
  - **No information if the household is more at risk for exposure**

LSL DETECTION



Public section of the service line → Pb pipe



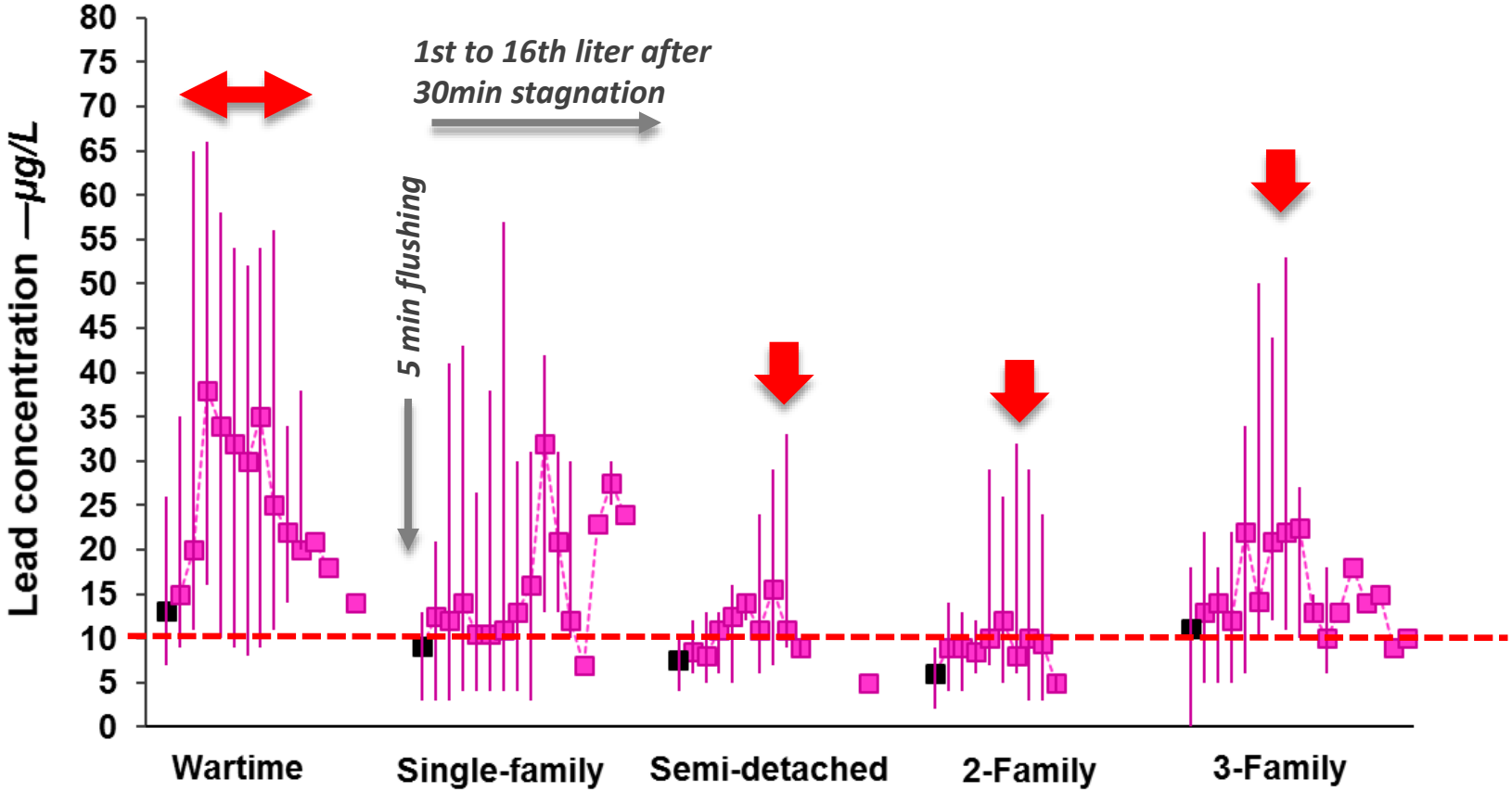
LSL detection study in 35 households in summer:

- **1L after 5min of flushing (5MF)**
- **30 min <u>of controlled stagnation</u>**
- **Piping volume measured during stagnation:**
  - Premise plumbing
  - Service line
- **Collection of 8 to 16 consecutive liters after stagnation (profile)**
- **On-site analysis with ASV analyzer**

→ Confirmation of LSL presence and configuration

LSL DETECTION

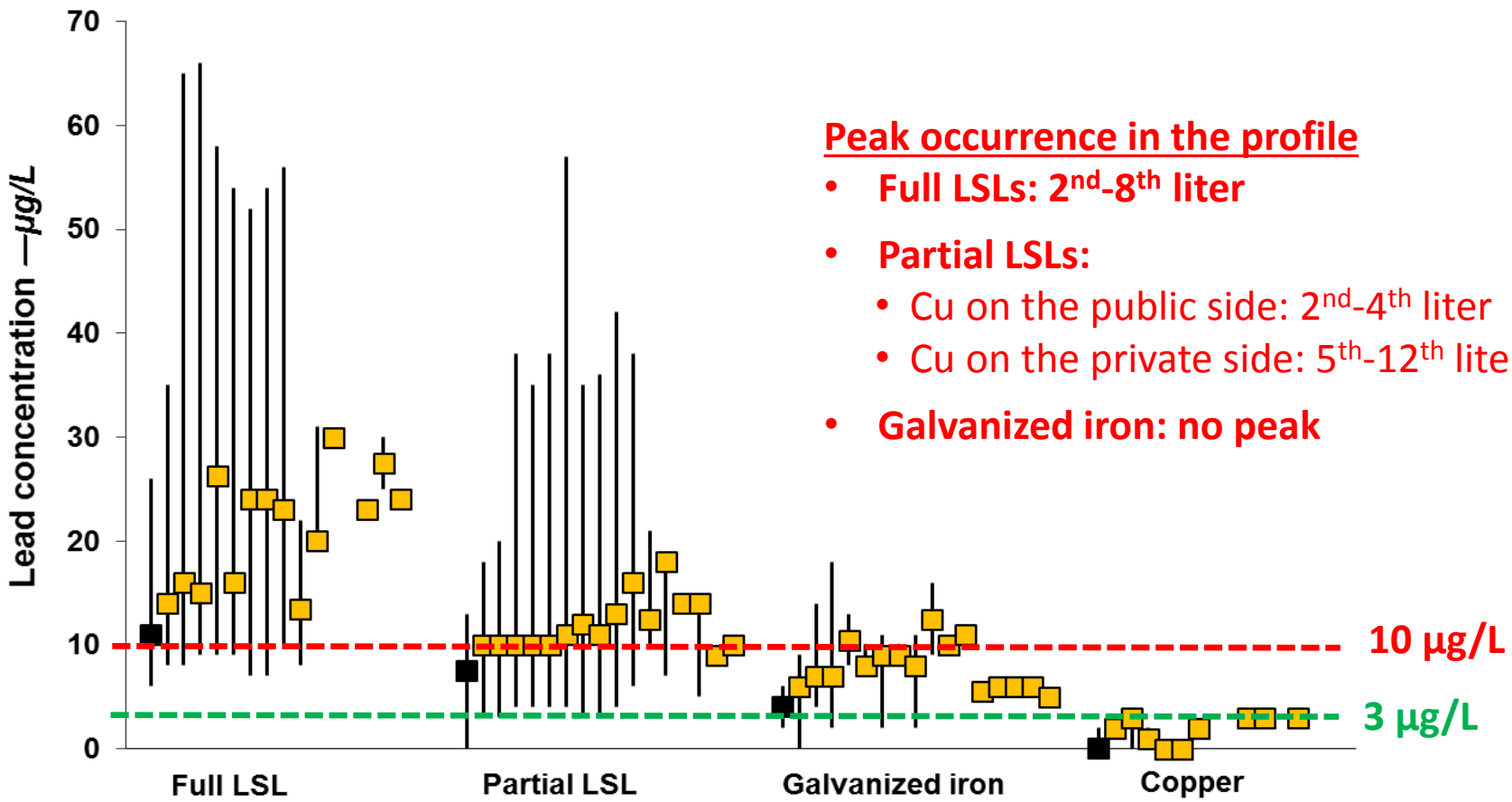
- **Profile sampling per type of household**



Adapted from Deshommes et al. 2016 Jour AWWA; Median (Min-Max) concentration, no corrosion control

LSL DETECTION

- **Profile sampling per service line configuration**



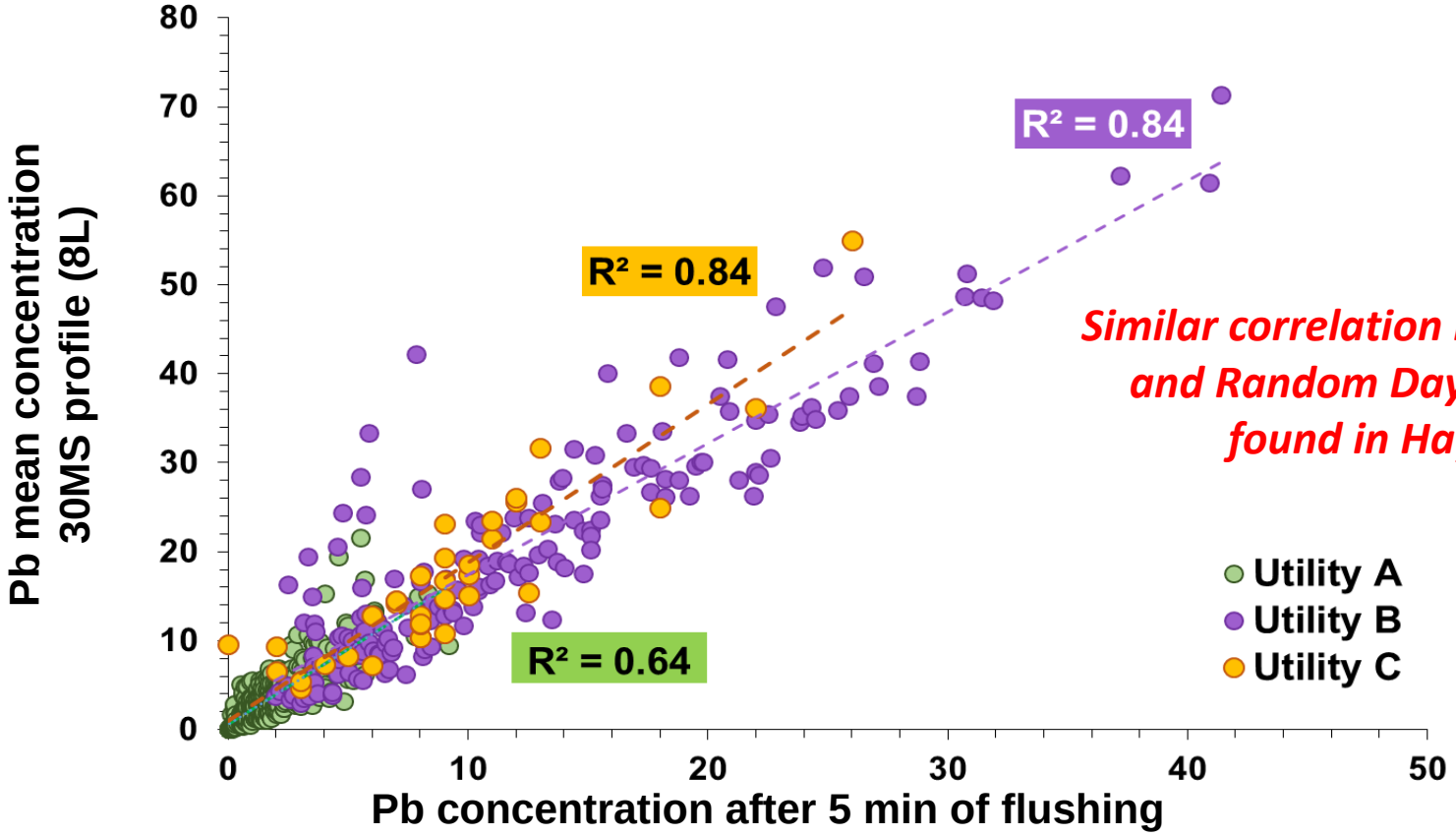
Peak occurrence in the profile

- **Full LSLs: 2nd-8th liter**
- **Partial LSLs:**
  - Cu on the public side: 2nd-4th liter
  - Cu on the private side: 5th-12th liter
- **Galvanized iron: no peak**

Adapted from Deshommes et al. 2016 Jour AWWA; Median (Min-Max) concentration, no corrosion control

LSL DETECTION

- Correlation between profile and fully-flushed concentrations for 3 water qualities



Similar correlation between 30MS and Random Daytime sampling found in Hayes et al. study

Adapted from Desmarais et al., AWWA-WQTC 2014

LSL DETECTION

- **Profile sampling results allow:**
  - **To conclude on LSL presence and configuration**
  - **To identify peak concentrations and validate corrosion control**
  - **To identify homes at risk for consumers' exposure**
    - ***Long LSLs and high frequency of peak concentrations at the tap?***

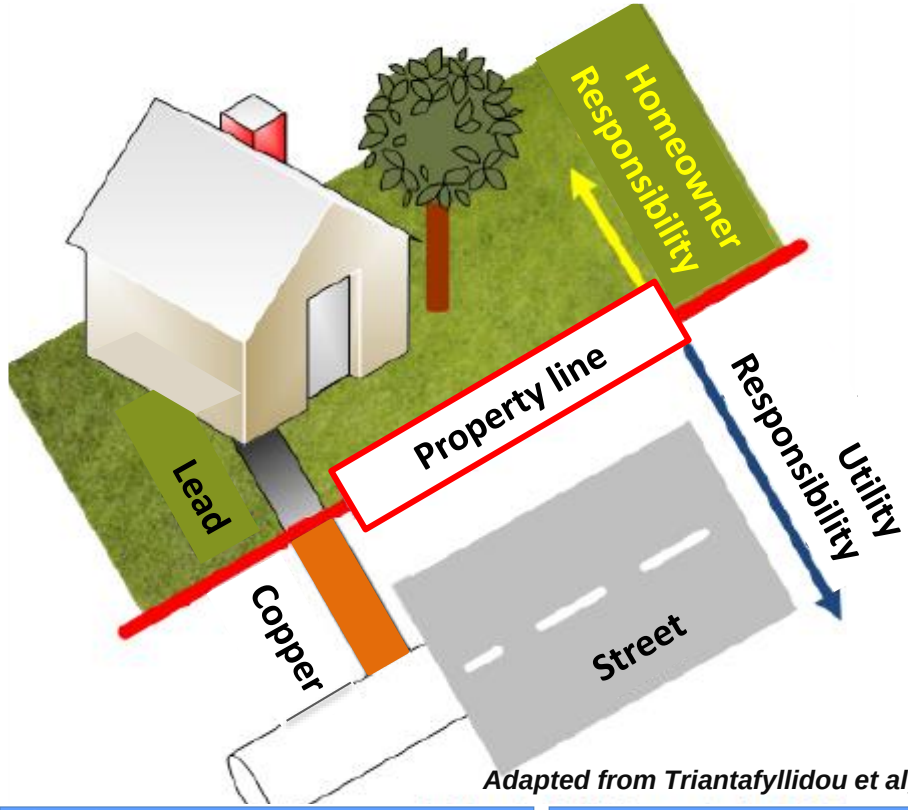
- **Profile sampling results:**
  - **Vary with the type of household and LSL configuration**
  - **Can be successfully correlated to low-cost sampling (5MF, RDT)**

→ **Conduct profile sampling in a few sentinel homes with <u>confirmed</u> LSLs and apply a simplified and low-cost sampling protocol to detect and manage LSLs on a large scale**

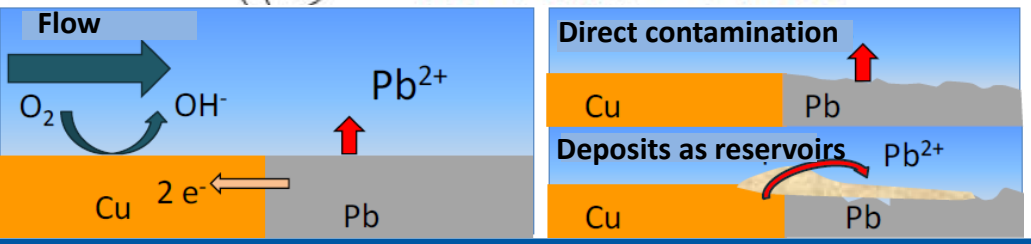
PERIOD OF QUESTIONS

Partial LSL replacements

PARTIAL LSLs



Adapted from Triantafyllidou et al, 2011



- **LSL replacements unavoidable**
- **Shared ownership of the LSL**
  - **Partial LSL replacements (PLSLR)**
- **Potential adverse effects**
  - **USEPA SAB advisory notice on PLSLR in 2011 in the U.S.**
- **Galvanic corrosion:**
  - **Increased particulate lead release (pilot-scale results)**
  - **<u>Frequency and duration</u> of the phenomenon is not validated at full-scale**

PLSLR in the survey

- **Preventive actions taken by utilities:**
  - Inform homeowners of the risk of increased Pb (6/16 utilities)
  - Use of plastic material (fitting and/or pipe, 3 utilities)
  - POU filter offered after PLSLR (2 utilities)
  - Systematic full LSL replacement (2 utilities)

- **Specific flushing procedures applied after PLSLR (5 utilities):**
  - 5 min, 15 min or 60 min
  - One tap or all taps
  - Over 1 day, 1 week, 1 month or 6 months
  - Aerator cleaning


http://www.pittmeadows.bc.ca/

Nour et al., AWWA-WQTC 2015

PLSLR in the survey

- **Homeowner survey in Halifax**

FULL LSL REPLACEMENTS – MOTIVATORS IDENTIFIED
Health concerns (57%)
Known lead in tap water (39%)
Resale value (26%)
Not specified (22%)
Municipalities initiative (22%)
Concern for children (13%)
Influenced by a utility/university representative working on LSL (13%)
Other: no choice/not responsible (9%)
Recommended by neighbour/friend (4%)

Increase homeowners awareness on health effects of lead at the tap

Regulate the LSL replacement at the time of house resale?

Adapted from Nour et al., AWWA-WQTC 2015

PLSLR MONITORING

Full-scale monitoring in Halifax

- **> 100 sites monitored between 2011-15:**
  - Partial and full LSL replacements
  - pH 7.3-7.4, alkalinity 16-20 mg$CaCO_3$/L
  - 1.1 mg Cl_2/L, 0.5 mg/L PO_4
- **Water lead levels measured:**
  - Before LSL replacement
  - 3 days, 1, 3 and 6 months after LSL replacement
- **Sampling for lead at the tap:**
  - Collection of 4 consecutive liters after overnight stagnation (profile sampling)
  - Collection of 1 liter after 5 minutes of flushing

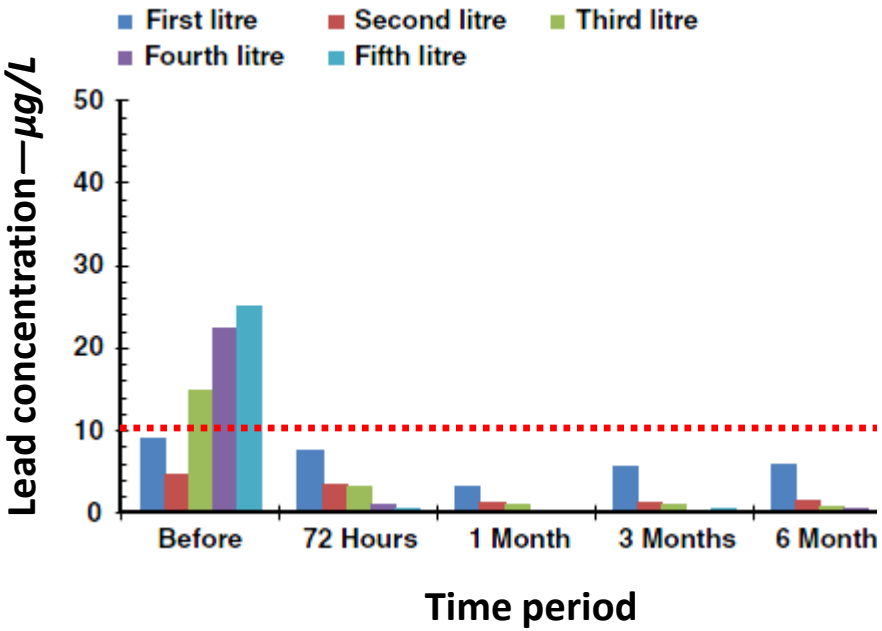
Halifax Regional Water Commission

DALHOUSIE UNIVERSITY

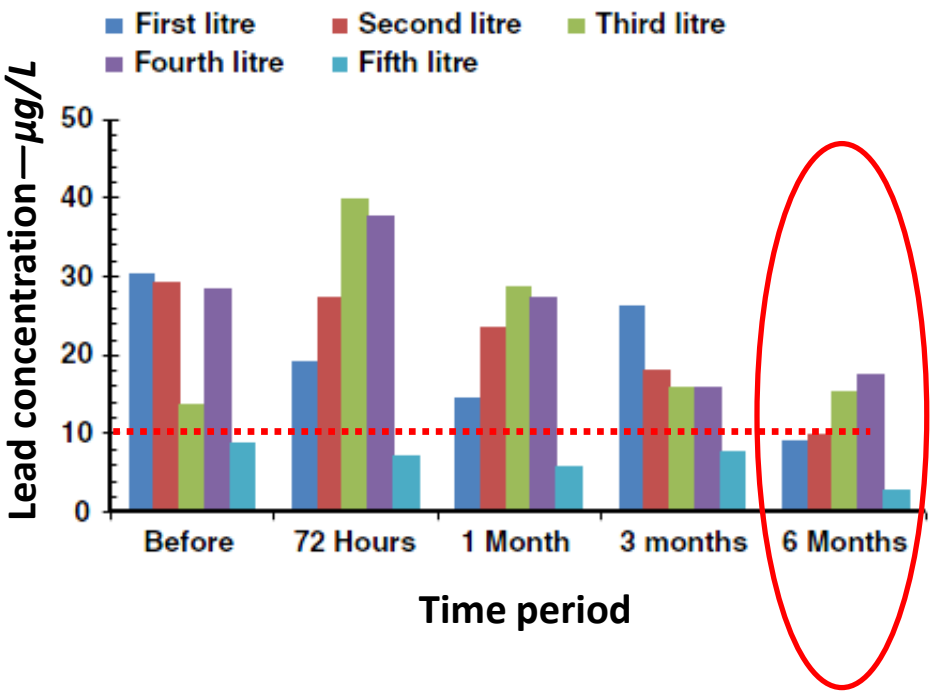
Picture source: http://www.rncan.gc.ca/

PLSLR MONITORING

FULL LSL REPLACEMENTS



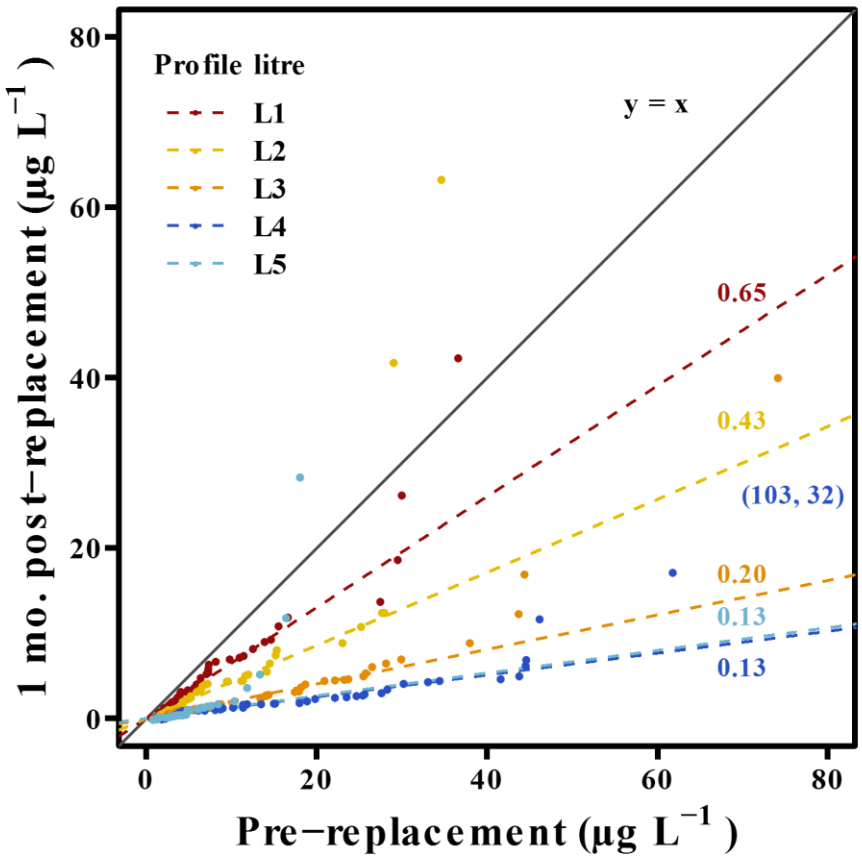
PARTIAL LSL REPLACEMENTS



Camara et al. 2013, Journal AWWA

PLSLR MONITORING

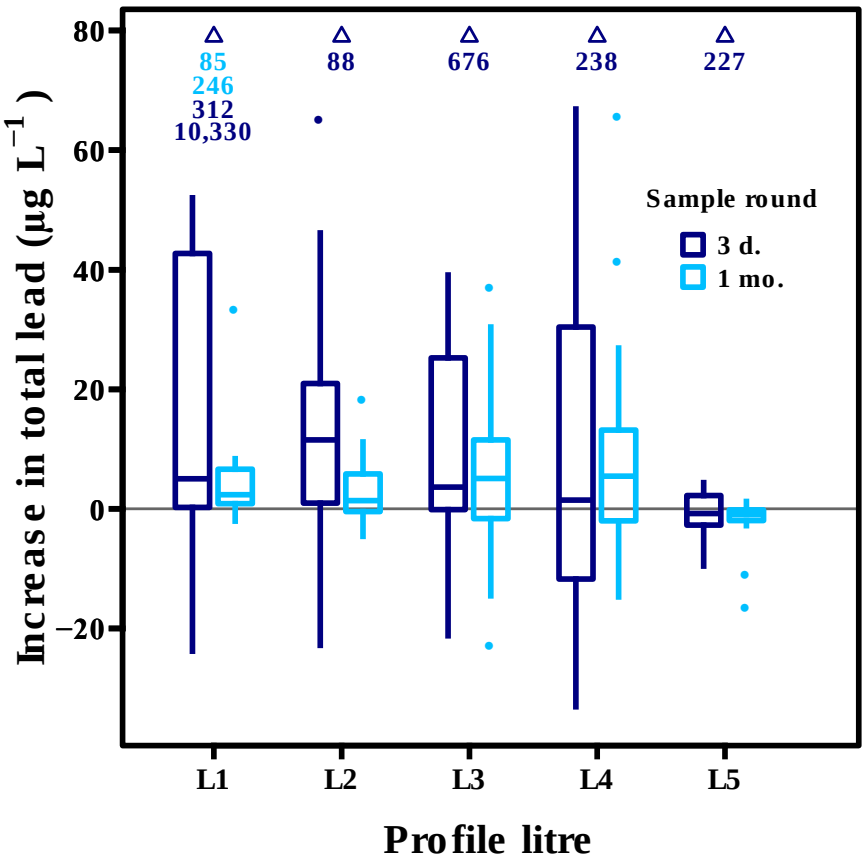
Full LSL replacement effectively reduced lead release from both premise plumbing (often L1 and L2) and LSL (often L3 and L4) within one month



Trueman et al. 2016, Env. Sci. Tech.

PLSLR MONITORING

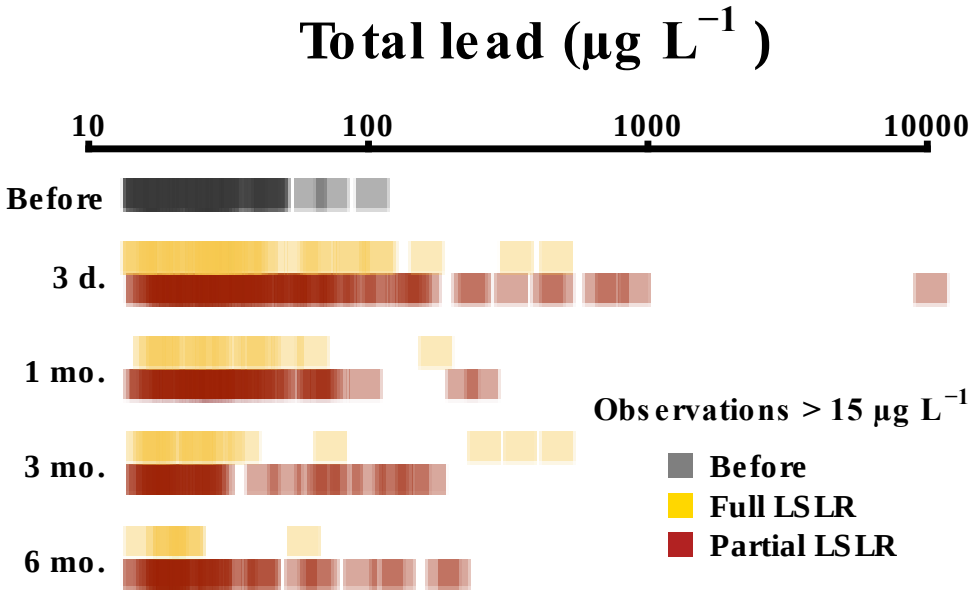
Partial LSL replacement was associated with dramatically elevated lead in standing samples (L1 – L4) 3 days and 1 month post-replacement



Trueman et al. 2016, Env. Sci. Tech.

PLSLR MONITORING

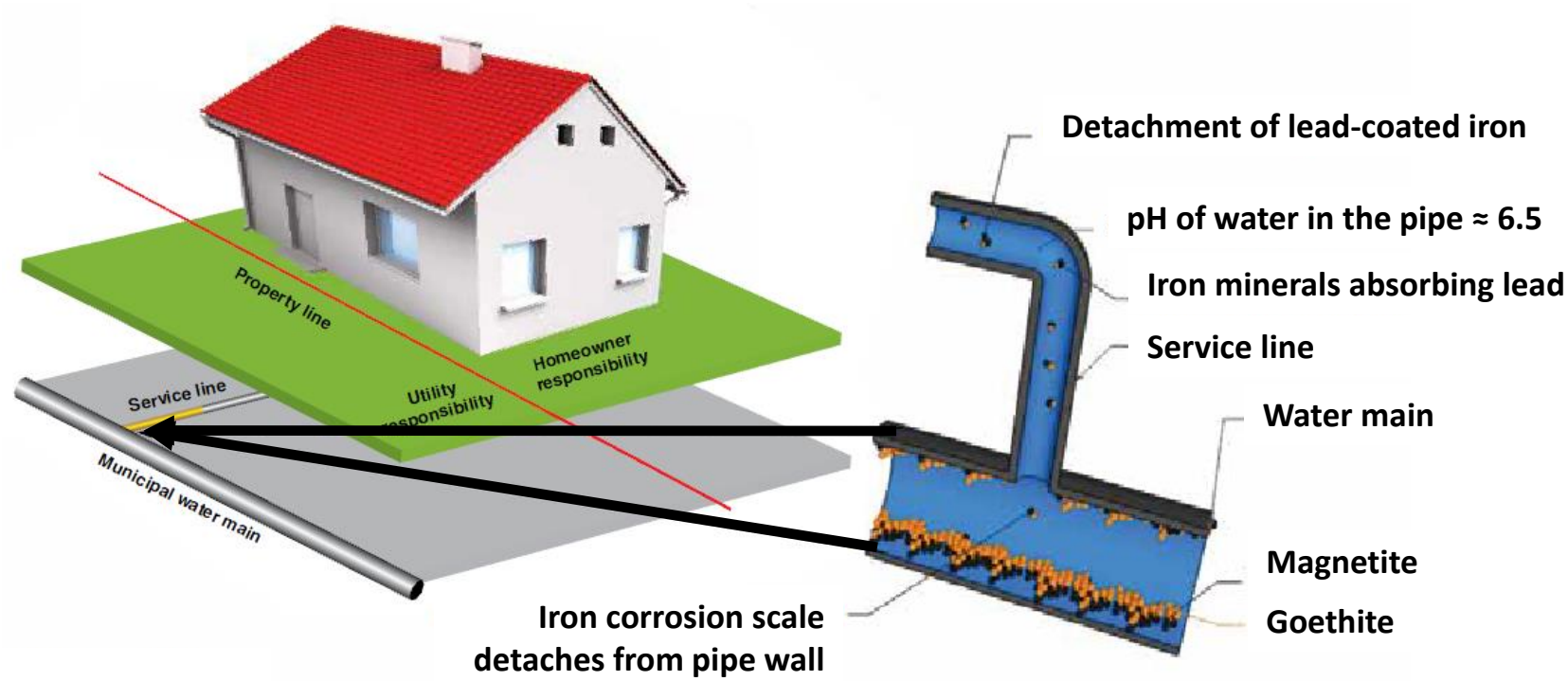
6 months after partial LSL replacement, 27% of 1st draw lead levels were > 15 µg L^{-1} (compared with 13% pre-replacement)



Trueman et al. 2016, Env. Sci. Tech.

PLSLR MONITORING

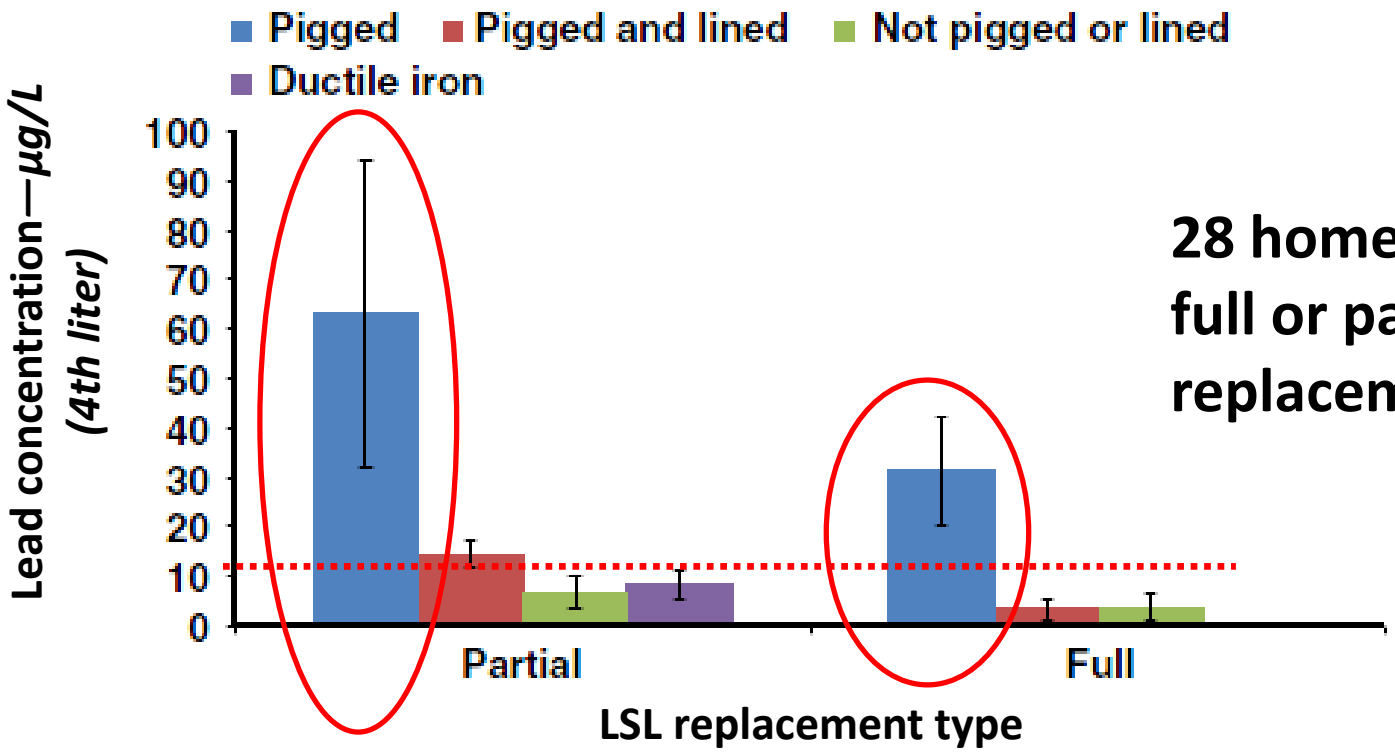
Role of water main in lead release



Camara et al. 2013, Journal AWWA

PLSLR MONITORING

Role of water in lead release

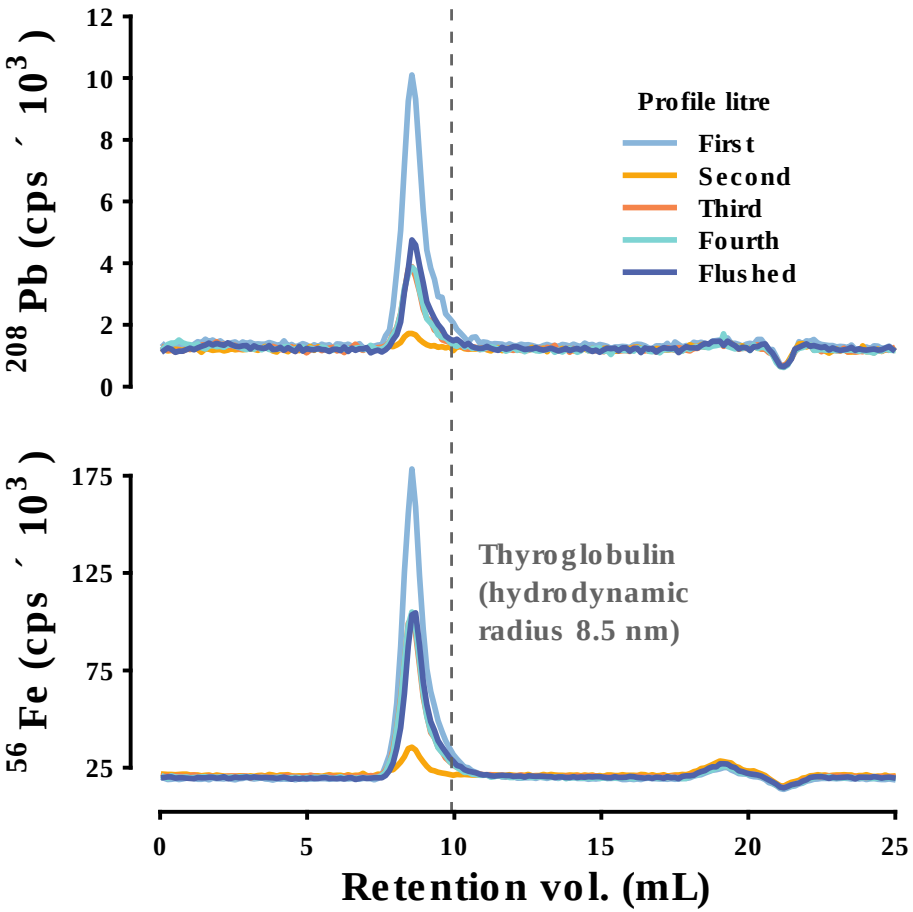


28 homes with full or partial LSL replacement

Camara et al. 2013, Journal AWWA

PLSLR MONITORING

- **Characterizing colloidal lead by size-exclusion chromatography with ICP-MS**
  - **23 residential sites with full LSLs, partial LSLs, or recent full LSL replacements**
  - **Colloidal lead and iron strongly correlated under various separation conditions**



Trueman and Gagnon. 2016, J. Hazard. Mater.

PLSLR MONITORING

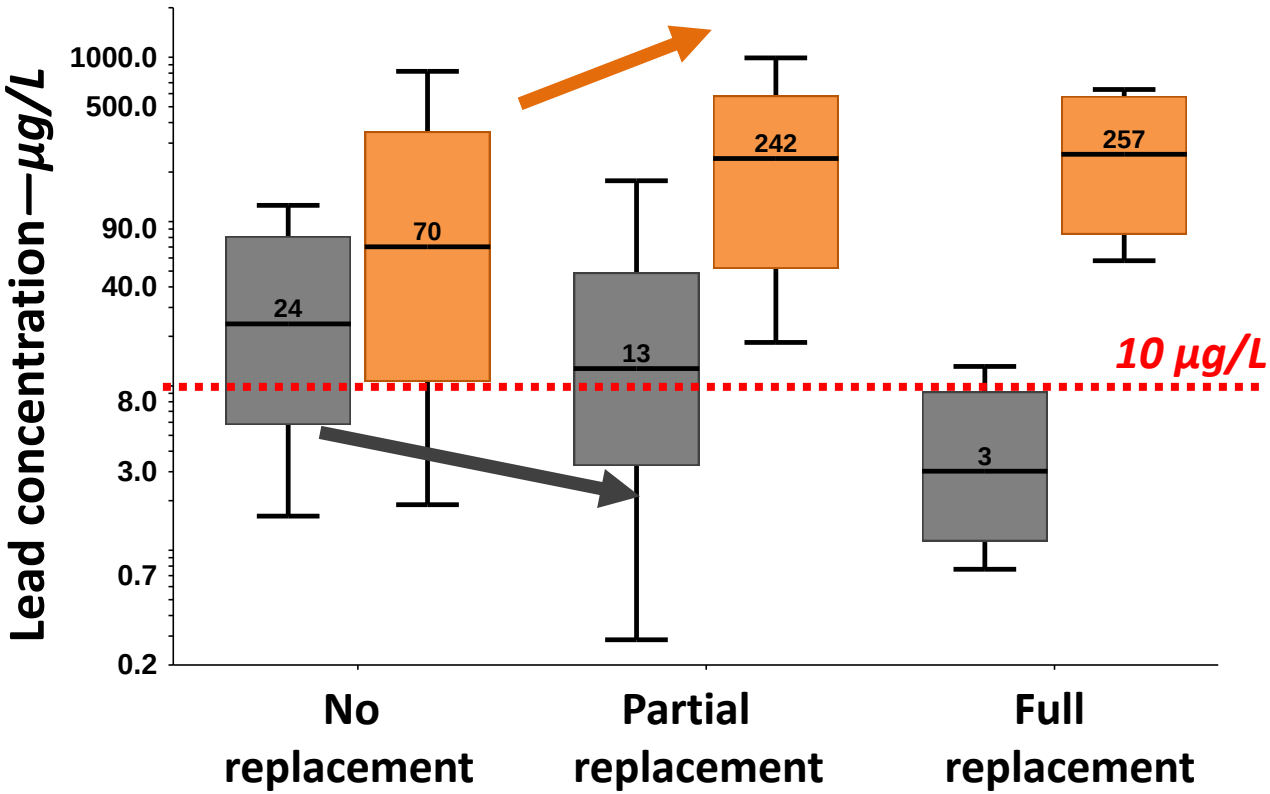
Full-scale monitoring in Montreal

- **34 sites monitored over 2 years:**
  - Before/After partial LSL replacement
  - Homes with full or partial LSLs
  - No corrosion control, pH 8.0, alkalinity 85 $mgCaCO_3/L$
- **Sampling for lead at the tap:**
  - Collection of 6-16L after overnight stagnation (profile sampling), a sample after 5 min of flushing, and a sample after 30 min stagnation
- **Online point-of-entry filtration monitoring of particulate lead release from LSL**

Picture source: http://www.quebec511.info/

PLSLR MONITORING

- **Concentrations in tap water over 2 years (all combined)**



Short-term increase over 2 weeks after PLSLR, slight decrease over 2 years

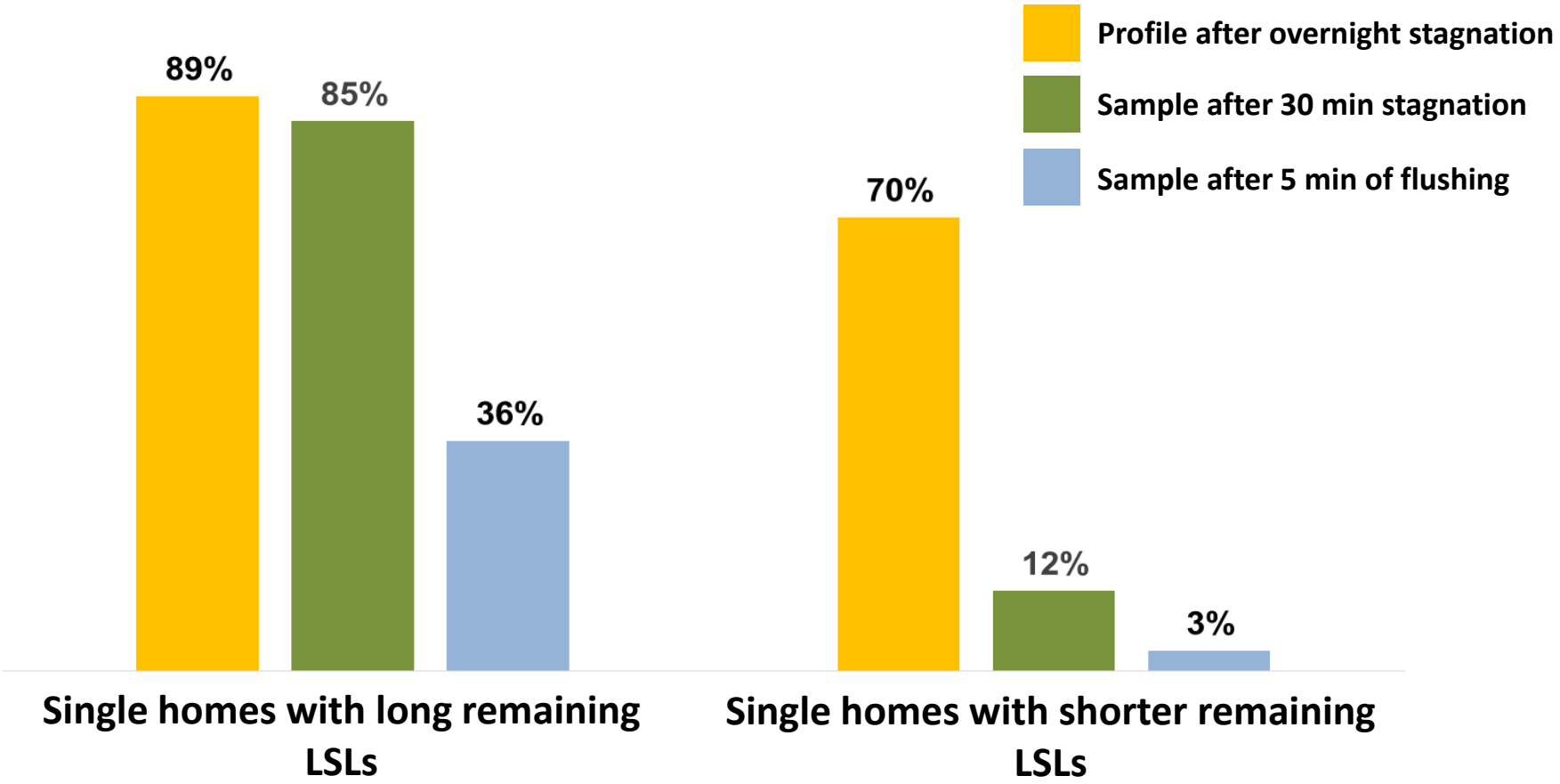
Low concentrations of particulate lead measured for all categories of service lines with sampling and POE monitoring

Lead

Copper

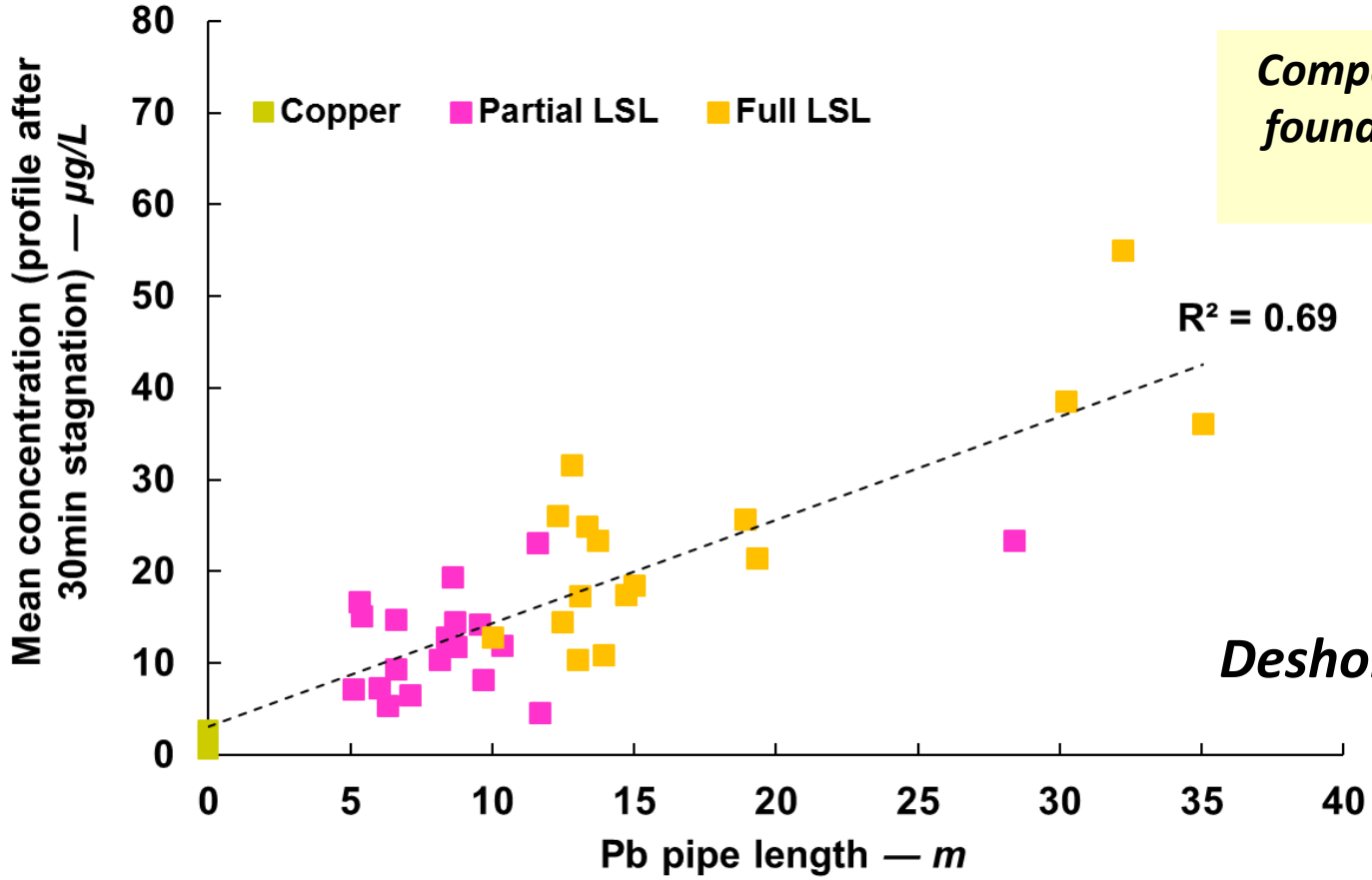
PLSLR MONITORING

- **Fraction of samples exceeding 10 µg/L in PLSLR**



PLSLR MONITORING

- **Impact of the length of remaining LSL**

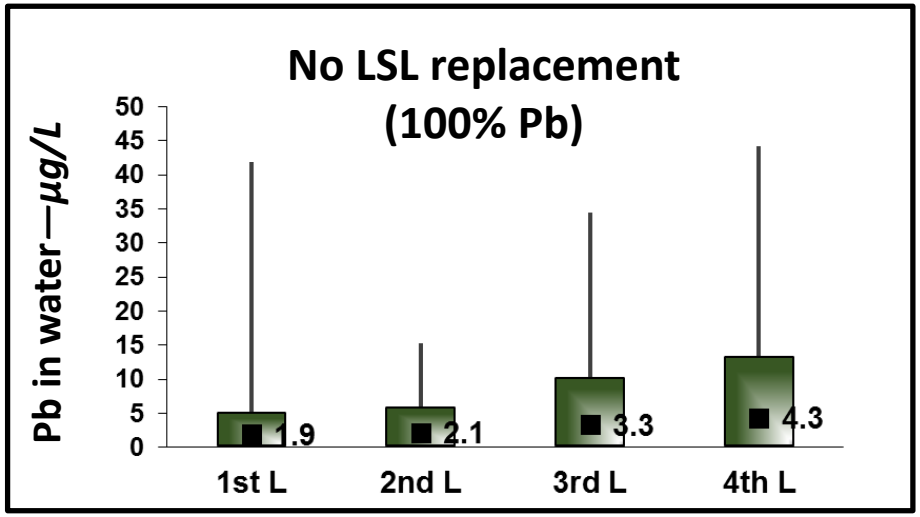


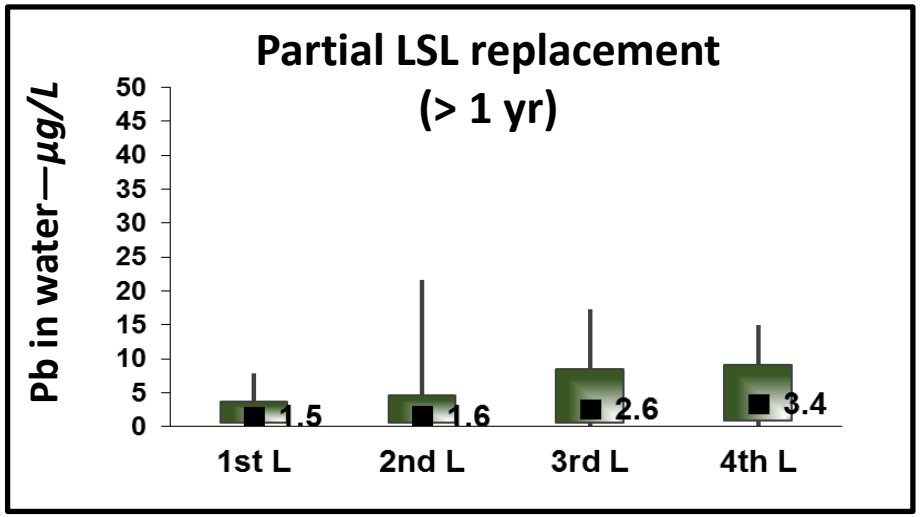
Comparable relationship found for 6 hours profile sampling

Adapted from Deshommes et al. 2016 Jour AWWA

PLSLR MONITORING

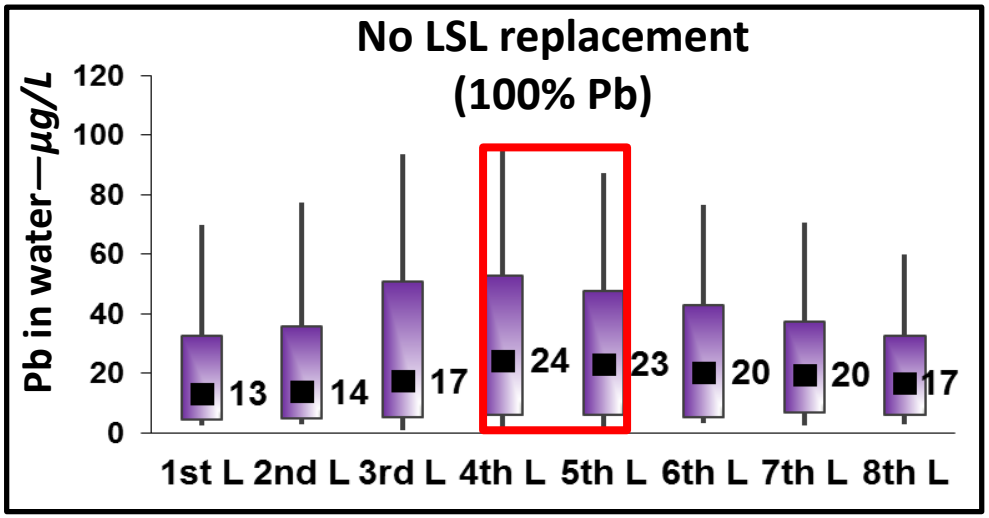
- Full-scale monitoring in Ottawa
- pH adjustment at 9.2, alkalinity at 35 mg$CaCO_3$/L
- 392 households
- Profile sampling after 30 min stagnation (4 L)

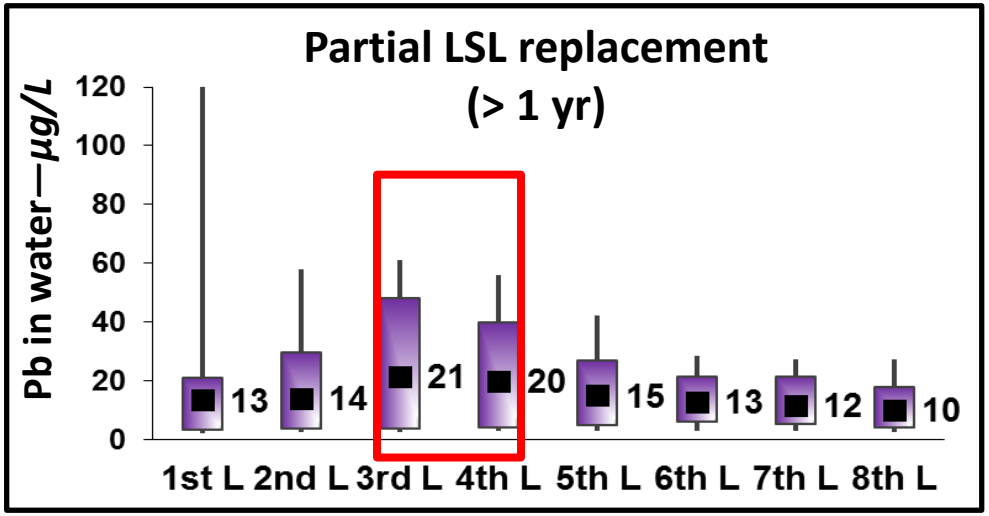




PLSLR MONITORING

- Full-scale repeated sampling in 14 sentinel worst case households in London (2007-2013)
- pH adjustment at 7.9, alkalinity at 80 mg$CaCO_3$/L
- Profile sampling after 30 min stagnation (8 L)





London CANADA

FLUSHING RESULTS

POE monitoring at the time of LSL replacement

Up to 800 mg Pb collected over the PLSLR period

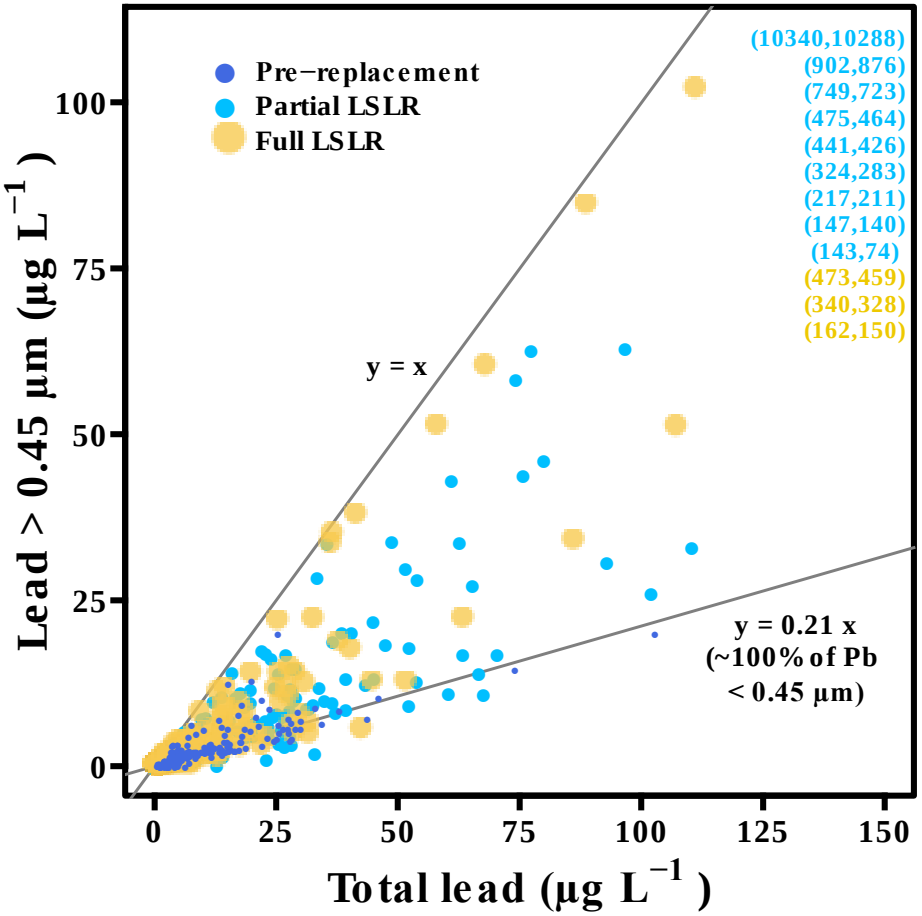
Sampling on the day of LSL replacement

3,666 ± 8,356 µg Pb/L

15 to >30 min of flushing necessary to restore Pb levels

FLUSHING RESULTS

- Significant particulate lead released 3 days and 1 month after partial LSL replacement
- Available data suggest that lead below 0.45 µm dominated by particles as well (Trueman and Gagnon 2016, *J. Hazard. Mater.*)



Trueman et al. 2016, Env. Sci. Tech.

REGULATIONS

Current Lead and Copper Rule	NDWAC recommendations

○ Regulatory tap sampling in high risk single-family homes (1st draw)
○ AL of 15 µg/L (90th percentile)
○ Compliance? Reduce sampling
○ Non compliance?
  ○ Corrosion control
  ○ Public education
  ○ Replace 7% of LSLs (public side) every year the system exceeds the AL
	○ Customer requested tap sampling
	○ Water quality monitoring (pH, alkalinity, etc.)
	○ LSL replacement program
	○ Increase public education on lead at the tap
	○ Definition of a Household Action Level based on customer requested tap sampling results

CONCLUSIONS

- **Overall no increase of total Pb in tap water over long-term after PLSLR in the systems studied <u>however</u>:**
  - **Modest reduction of water lead levels**
  - **Water lead levels still over regulated levels**
  - **Higher lead release for cast iron distribution mains**
  - **Especially observed for households with long remaining LSLs**

- **Particulate Pb release over short-term after PLSLR:**
  - **Acute lead concentrations on the day of PLSLR**
  - **Particulate lead is the dominant form 1 month after PLSLR for one system**

RECOMMENDATIONS

- Record PLSLRs and increase communication with homeowners and contractors
- Increase homeowners awareness on Pb at the tap:
  - Health effects
  - Lead sampling results
  - Obligations linked to LSL replacement (private side)
- Implement incentives for full LSLR (worst case households):
  - Funding and assistance to find a contractor (utility survey)
  - Mandatory replacement at the resale of the house
- Implement flushing procedures
  - After full and partial LSL replacements
  - Increase contractor homeowner awareness on flushing procedures

Bench and pilot scale studies on PLSLR (summary)

PILOT-SCALE STUDIES

- **Studies of specific water quality parameters that impact lead release from copper-lead pipes**
- **Summary of the pilot-scale studies completed:**
  - **University of Dalhousie (Halifax water):**
    - Factors tested: cast iron pipes, orthoP ↑
    - Water dosed with orthoP and zinc orthoP
  - **University of Toronto (Toronto water):**
    - Factors tested: CSMR, alkalinity, NOM, disinfectant, conductivity, stagnation
    - Water dosed with silicates, orthoP, zinc orthoP
  - **Polytechnique Montreal (Montreal water):**
    - Factors tested: chlorine dosing, stagnation time, orthoP
    - Water dosed with orthoP, CSMR adjustment, pH adjustment ↑
    - Long-term effects

PILOT-SCALE STUDIES

Polytechnique Montreal

5 L/min
5 days/week
4 years

Conditions	Full LSLs	PLSLRs
No treatment (pH= 8, CSMR=0.9, Cl_2=0)	Control	Particulate Pb ↑
1.0 mg oPO_4/L	Total Pb ↓	Particulate Pb ↑↑
1.5 mg oPO_4/L	Dissolved Pb ↓	Total Pb ↓
pH adjustment at 8.3	No change	No change
Lower CSMR (0.3)	No change	Lowest % of particulate Pb

- Higher release of Pb per meter of Pb pipe in PLSLRs than in full LSLs
- OrthoP dosing efficient to reduce Pb release except in PLSLRs
- Adjusting CSMR reduced galvanic corrosion
- Dosing of 1.0 mgCl_2/L temporarily destabilized scale deposits

PILOT-SCALE STUDIES

University of Toronto

Pipe recirculation loops, sampling after 30 min, 6 h, 65 h stagnation

	Treatment
Cu-Pb pipes VS PVC-Pb pipes	No inhibitor
	Zinc orthoP 1 mg/L as P
	orthoP 1 mg/L as P
	Sodium silicate 10 and 24 mg/L

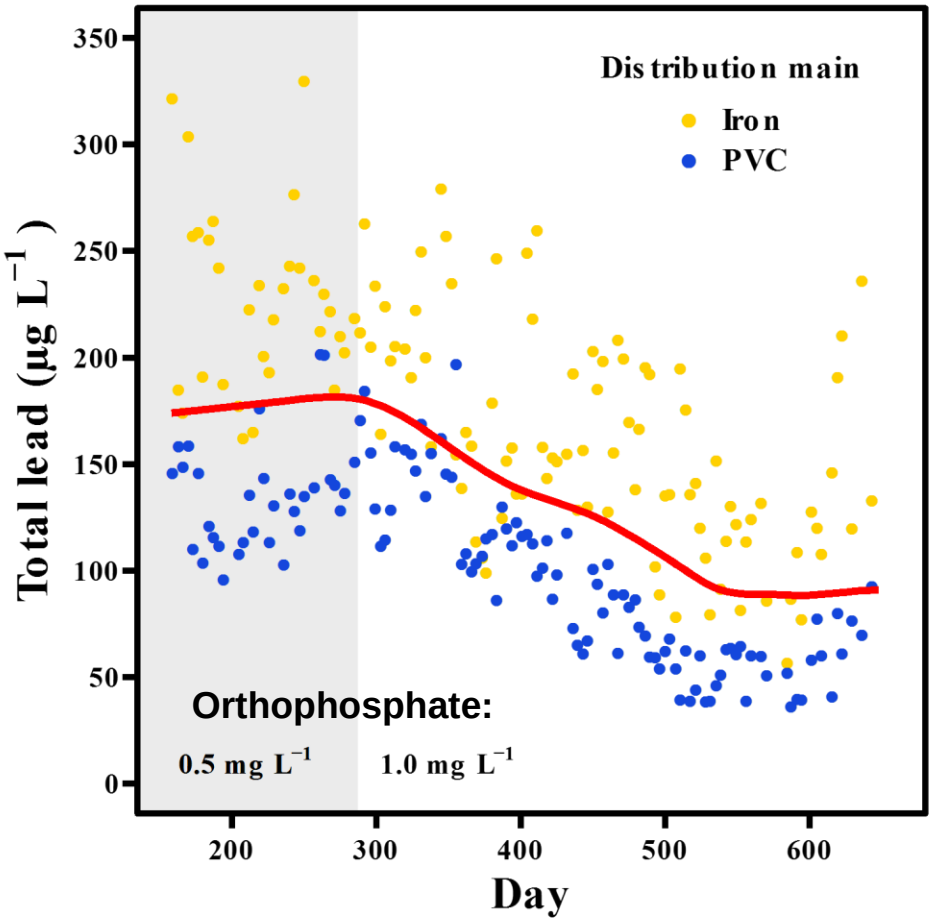
Water quality factors tested
NOM: 1 vs 7 mg/L
Disinfectant: chlorine vs chloramine
Alkalinity: 15 vs 250 mg$CaCO_3$/L
CSMR: 0.2 vs 1.0
Conductivity: 330 vs 560 mS/cm

- NOM and monochloramine increased lead release from galvanic corrosion in silicate-treated PLSLR
- Changes in CSMR and conductivity did not impact significantly Pb release
- Zn-orthoP and orthoP provided better corrosion control for Pb and Cu than silicates
- Pb released through galvanic current stored as corrosion scale:
  - ≈90% (no inhibitor)
  - 96-99% (orthoP)
  - 89-91% (sodium silicate)

PILOT-SCALE STUDIES

University of Dalhousie

- **Presence of an upstream iron main increased lead release from recovered LSLs**
- **Effect not diminished by increasing orthoP (0.5 to 1.0 mg L^{-1} as PO_4)**

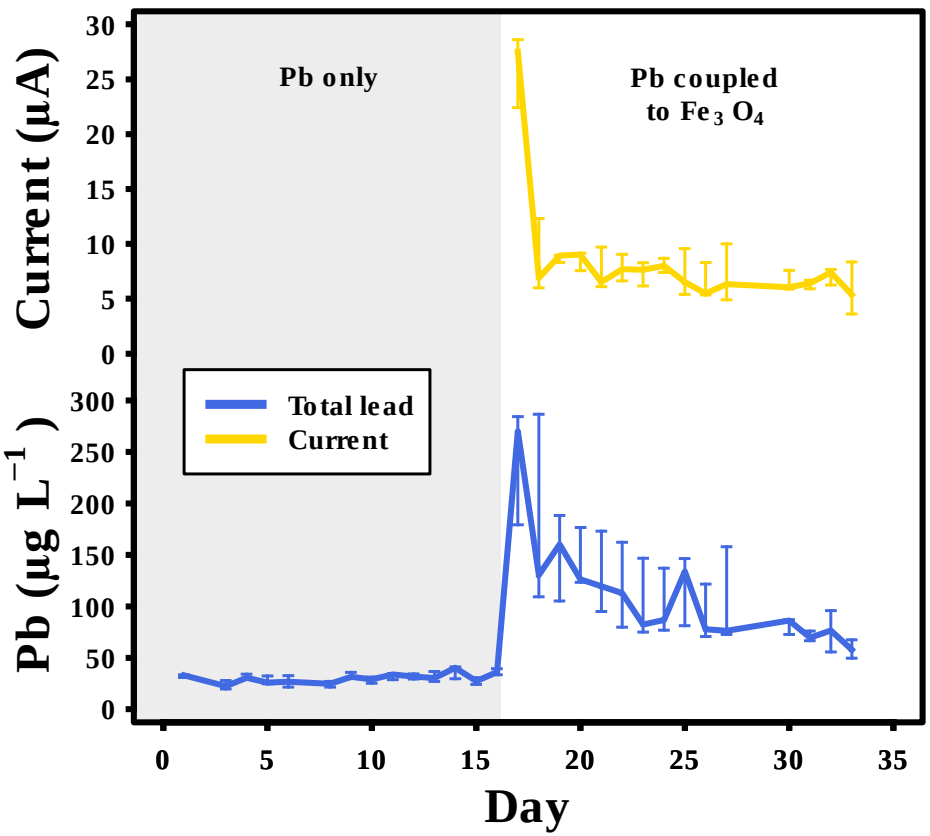


Trueman and Gagnon 2016, Env. Sci. Tech.

PILOT-SCALE STUDIES

University of Dalhousie

- **Effect of an upstream iron main could be explained in part by deposition corrosion of lead pipe by semiconducting iron oxide particles (such as magnetite, Fe_3O_4)**

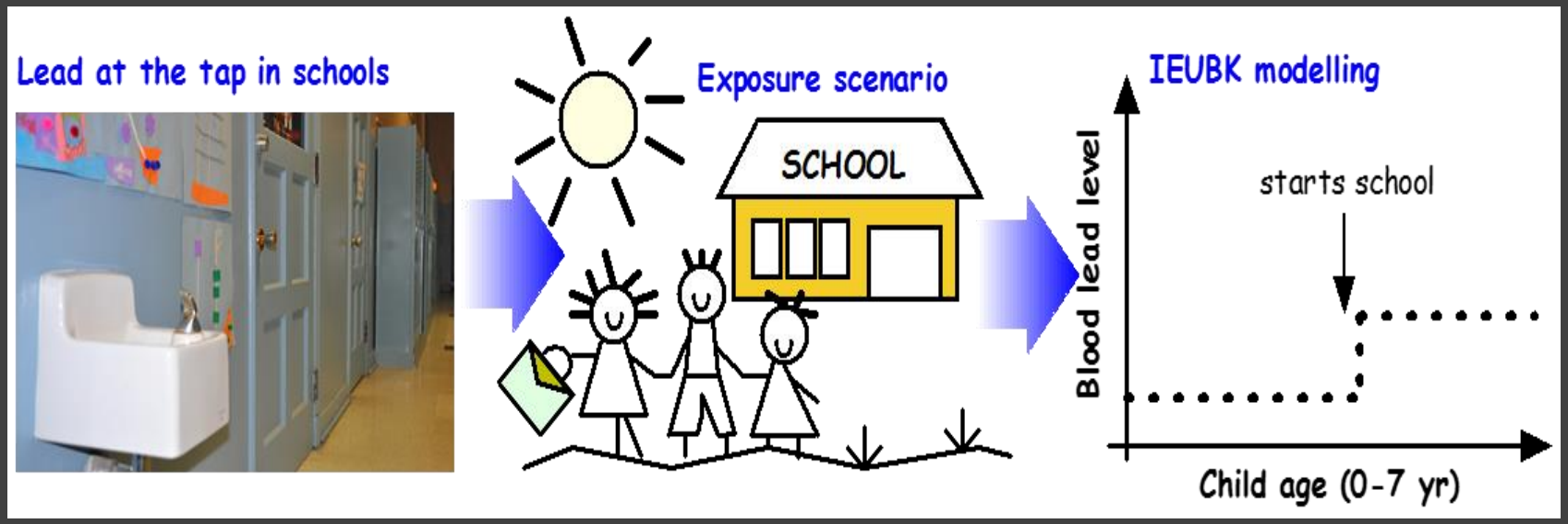


Trueman and Gagnon 2016, Env. Sci. Tech.

PILOT-SCALE STUDIES

- **Corrosion control efficiency reduces lead release from LSLs:**
  - Varies depending on water quality
  - Varies depending on the type of LSL (full vs partial)
  - Varies depending on the distribution main material (cast iron vs PVC)
  - Differs according to the form of Pb in water (dissolved vs particulate)
- **Changes in water quality are associated with scale destabilization**

PERIOD OF QUESTIONS



Deshommes et al. 2016, Wat. Res.

Schools, daycares and large buildings

LEAD IN SCHOOLS

- Not served by a lead service line
- Pb release from galvanic corrosion in the premise plumbing and the combination of 3 factors:
  - Presence of lead-bearing elements (solders, brass fixtures and fittings, fountains)
  - Long stagnation typical of large buildings
  - Corrosive water
- No specific regulations in Canada except Ontario 243/07 regulation

LEAD IN SCHOOLS

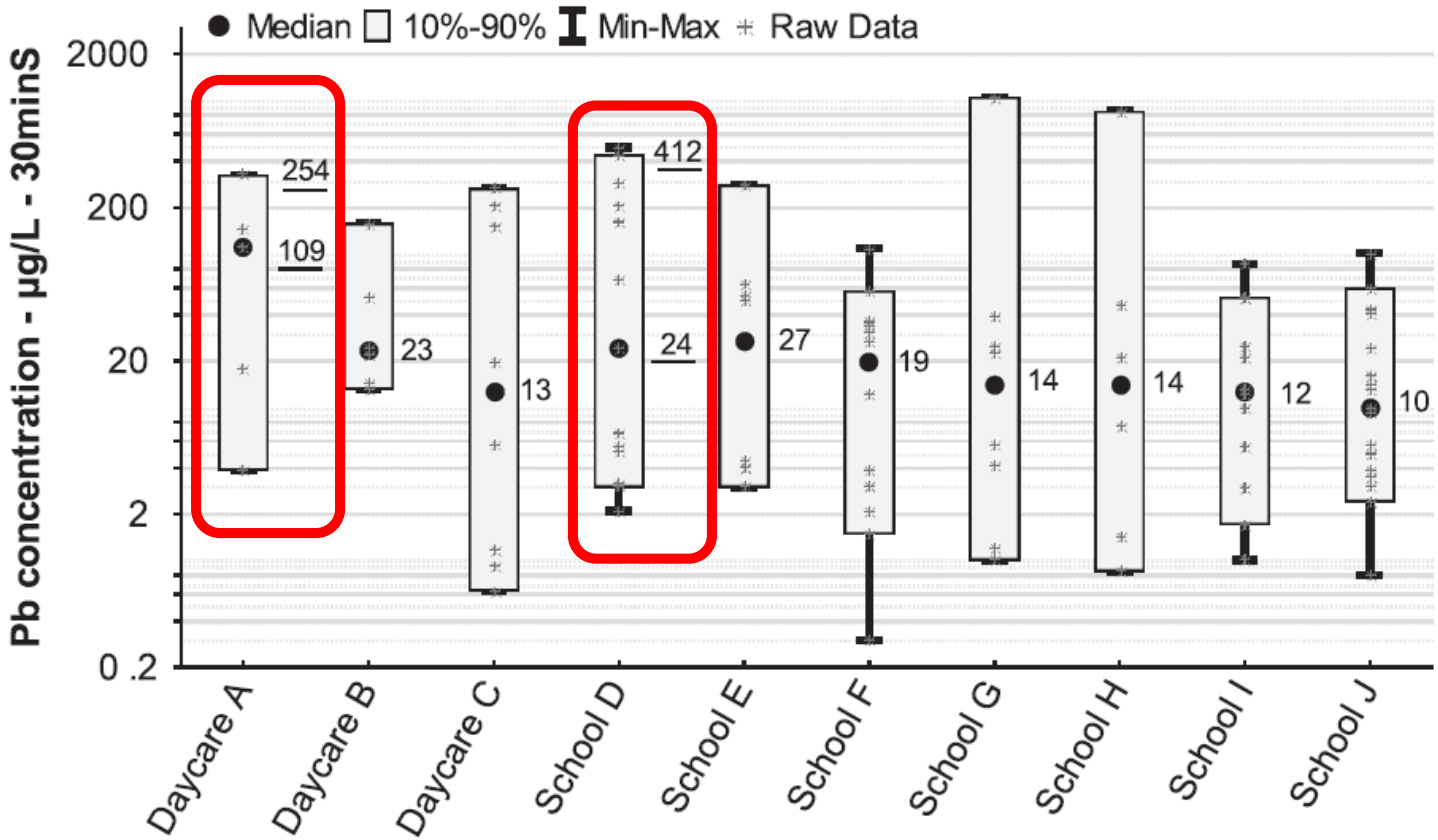
- **Pb concentrations in large buildings in Canada**
  - **78,971 samples, ≈ 8,000 large buildings, 4 provinces**
- **Sampling after 6 h or 30 min of stagnation (6hS, 30minS), 30 sec or 5 min of flushing (30sF, 5minF)**
- **40 taps linked to acute concentrations (> 175 µg Pb in one glass, USCPSC level for toys)**
- **Pb concentrations in elementary schools and daycares:**

	N	Median	90th percentile	Max	% >10 µg/L
6hS-1	31,679	1.8	11	13,200	11%
6hS-2	57	2.6	20	133	16%
30sF	1,260	1.3	9.2	710	10%
5minF	57	0.7	3.0	7.3	0%
30minS	31,061	1.0	4.7	3,890	4%

Deshommes et al. 2016, Wat. Res.

LEAD IN SCHOOLS

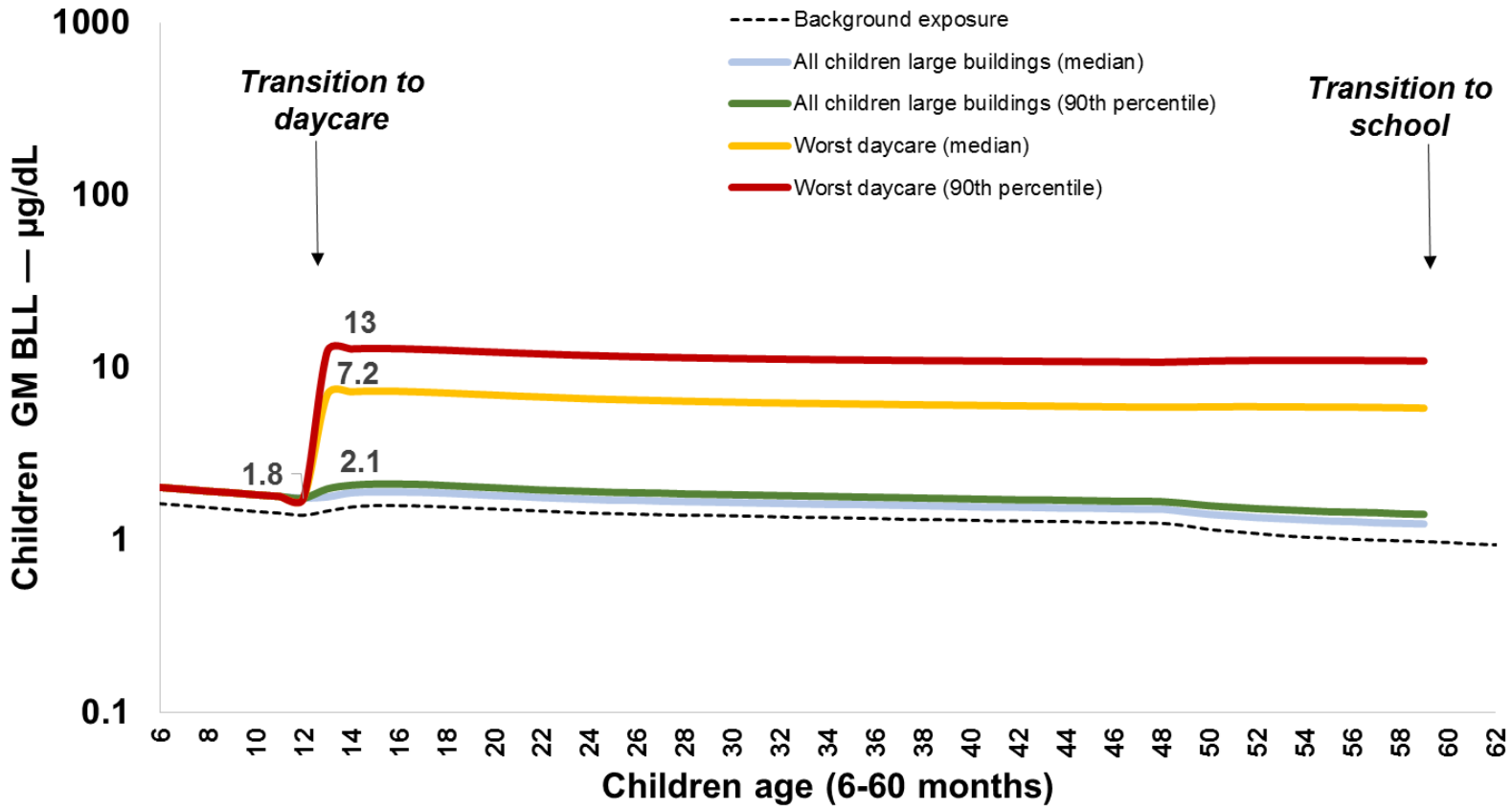
Pb levels after 30min of stagnation in worst-case schools



Deshommes et al. 2016, Wat. Res.

IMPACT ON BLLs

IEUBK simulations for daycares



Deshommes et al. 2016, Wat. Res.

CONCLUSIONS

- Extreme lead concentrations were measured in schools and daycares
- These concentrations can lead to the risk of:
  - Increased BLLs of the children attending these schools
  - Acute exposure (for a few taps)
- Recommendation: sample all consumption taps to identify problematic taps

KEY MESSAGES

SAMPLING

- **Interpretation of lead sampling results depends on protocol used to meet the objective of sampling**
  - **LSL detection, compliance, corrosion control efficacy, consumers' exposure**
- **Particulate can be the dominant form present**
  - **Use adequate total lead analytical methods and sampling protocol**

SYSTEM ASSESSMENT

- **Characterize your system: identify LSL location and high-risk households**
- **Site-specific and simple tools can be developed to detect LSLs**
- **Control red water as it is associated with elevated lead**

KEY MESSAGES

PARTIAL LEAD SERVICE LINE REPLACEMENT

- No proactive PLSLR because limited reduction of Pb levels and short term release issues
- Tolerate partial replacements when replacing mains
- Deploy all actions/incentives possible to facilitate full LSL replacements
- Develop MANDATORY standard flushing procedures after LSL replacement
- Increase homeowners and contractors awareness on the risks linked to LSLs, especially on the importance of flushing after LSL replacement

SCHOOLS AND LARGE BUILDINGS

- For most schools, the problem is unit specific: bad taps and fountains
- Preventive flushing benefits are short lived (less than one hour)
- Sample each drinking water taps (fountain, kitchen sink) in elementary schools and daycares to protect most vulnerable population

ACKNOWLEDGEMENTS

- City of Halifax
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- New Brunswick Department of Education and Early Childhood Development
- Utilities participating to the survey
- Homeowners participating to the study
- Lab and technical staff
- Canadian Water Network

PERIOD OF QUESTIONS

Contributors to this presentation

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- Graham Gagnon
- Shokoufeh Nour
- Michèle Prévost
- Sarah Jane Payne
- Robert C. Andrews

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2. Trueman, B.F., Camara, E. and Gagnon, G.A., 2016. Evaluating the effects of full and partial lead service line replacement on lead levels in drinking water. Environmental Science & Technology 50(14), 7389-7396.
3. Trueman, B.F. and Gagnon, G.A., 2016. A new analytical approach to understanding nanoscale lead-iron interactions in drinking water distribution systems. Journal of Hazardous Materials 311, 151-157.
4. Deshommes, E., Bannier, A., Laroche, L., Nour, S. and Prévost, M., Monitoring-1 based framework to detect and manage lead water service lines (in press).
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13. Deshommes, E., Prévost, M., Levallois, P., Lemieux, F. and Nour, S., 2013. Application of lead monitoring results to predict 0-7 year old children's exposure at the tap. Water Research 7(1), 2409–2420.
14. Cartier, C., Doré, E., Laroche, L., Nour, S., Edwards, M. and Prévost, M., 2013. Impact of treatment on Pb release from full and partially replaced harvested lead service lines (LSLs) Water Research 47(2), 661–671.
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