Lead and Copper Rule and Treatment Overview

for the

Wisconsin Wastewater Operator’s Association
2018 Annual Conference

Cathrine Wunderlich, Chief
Public Water Engineering Section

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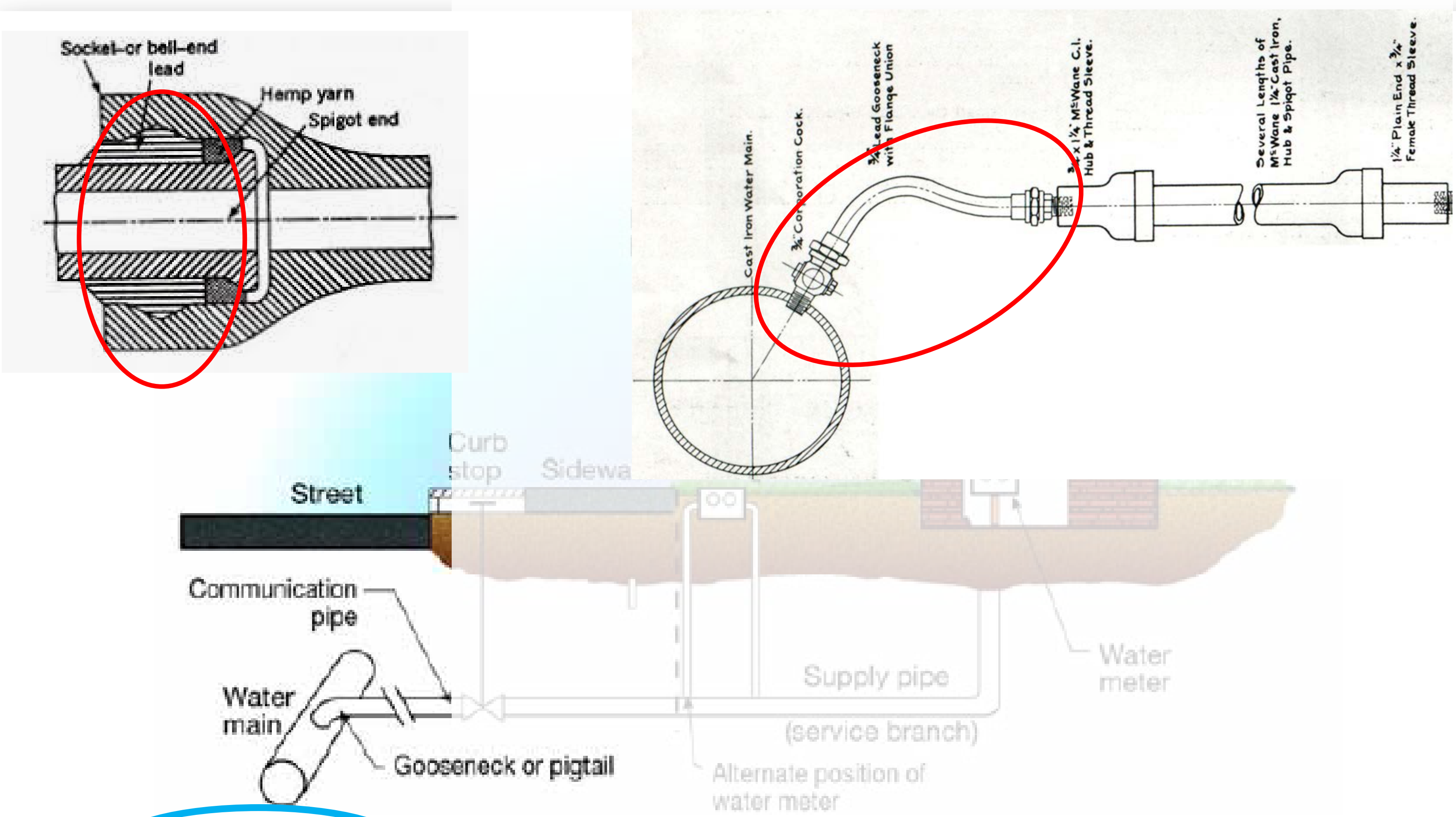
Lead and Copper Overview

- Sources of lead and contribution to DW
- LCR monitoring
- Assessing efficacy of treatment
- Treatment options
- Conclusions

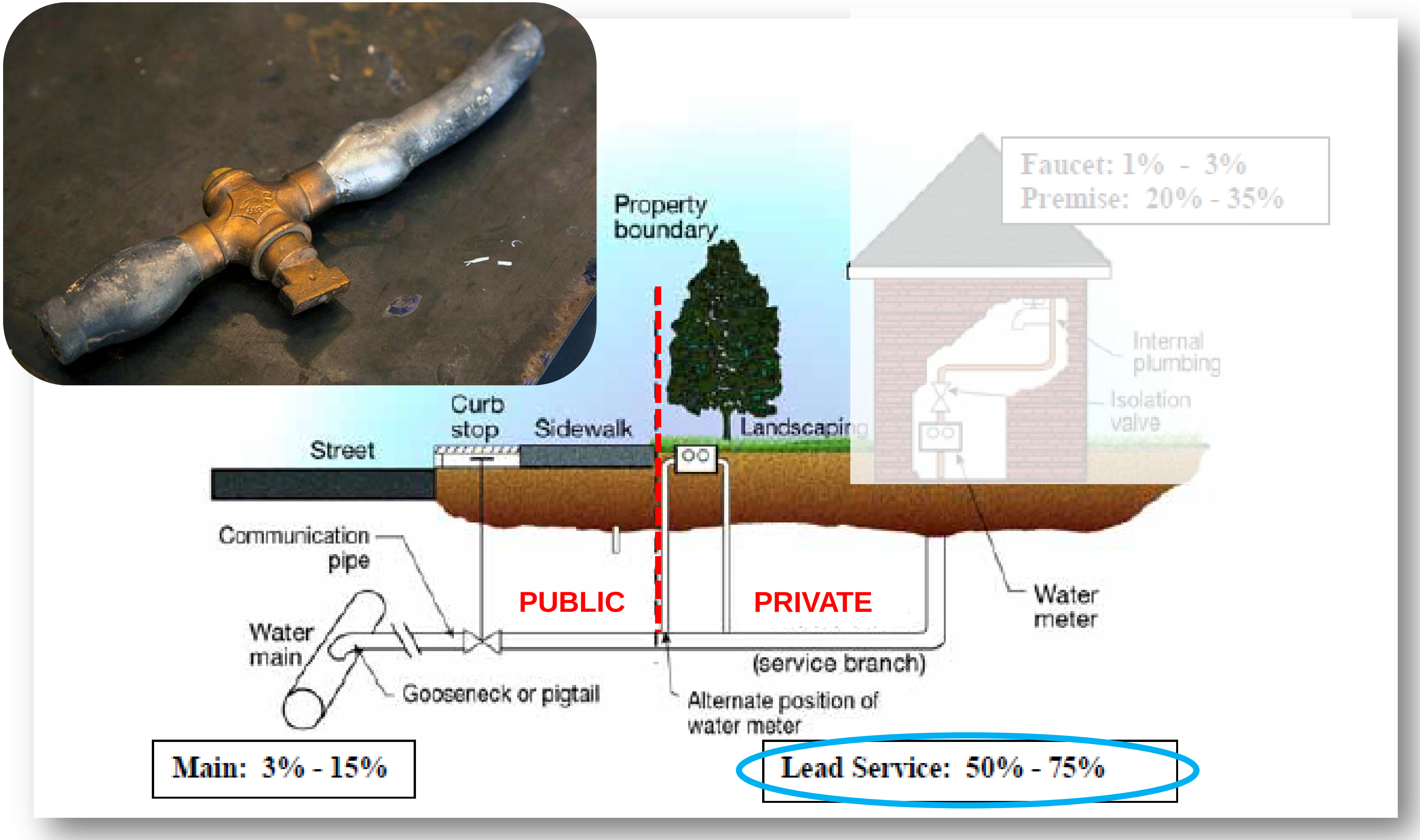
Sources of Lead and Contribution to DW



Main: 3% - 15%

Lead Service: 50% - 75%

Sources of Lead and Contribution to DW



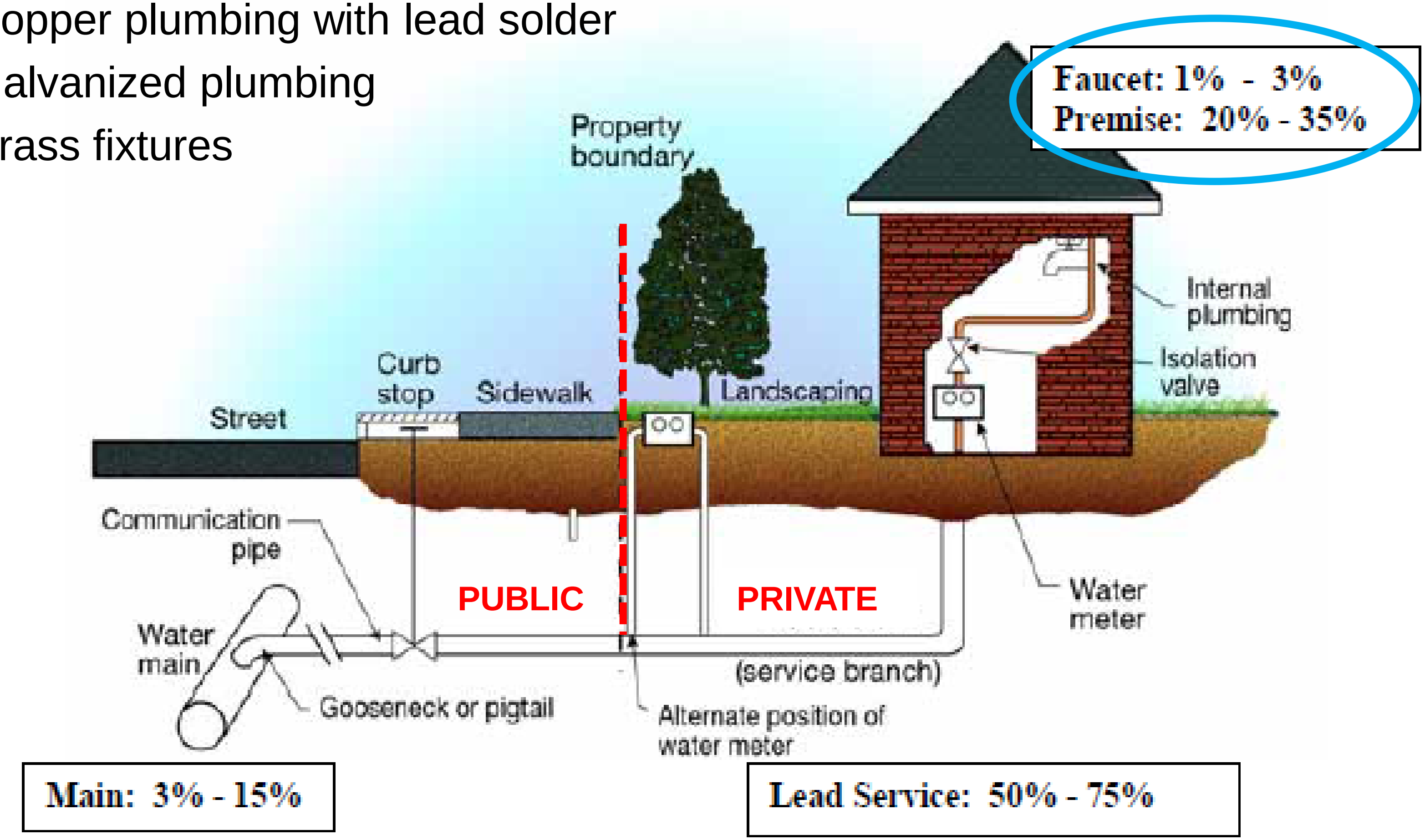
Faucet: 1% - 3%
Premise: 20% - 35%

Main: 3% - 15%

Lead Service: 50% - 75%

Sources of Lead and Contribution to DW

- Lead plumbing
- Copper plumbing with lead solder
- Galvanized plumbing
- Brass fixtures



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Sources of Lead- Galvanized Pipe

1. Lead bears a strong adsorptive affinity for both ferric and ferrous iron compounds, and scale formation by co-precipitation and deposition of lead-iron precipitates can potentially result in accumulation over decades of a crystalline iron corrosion scale rich in lead.

2. Lead adsorbs to galvanized iron corrosion scale; lead can persist and be mobilized to consumer taps after full replacement of lead service lines, potentially for the remaining service life of the galvanized plumbing.

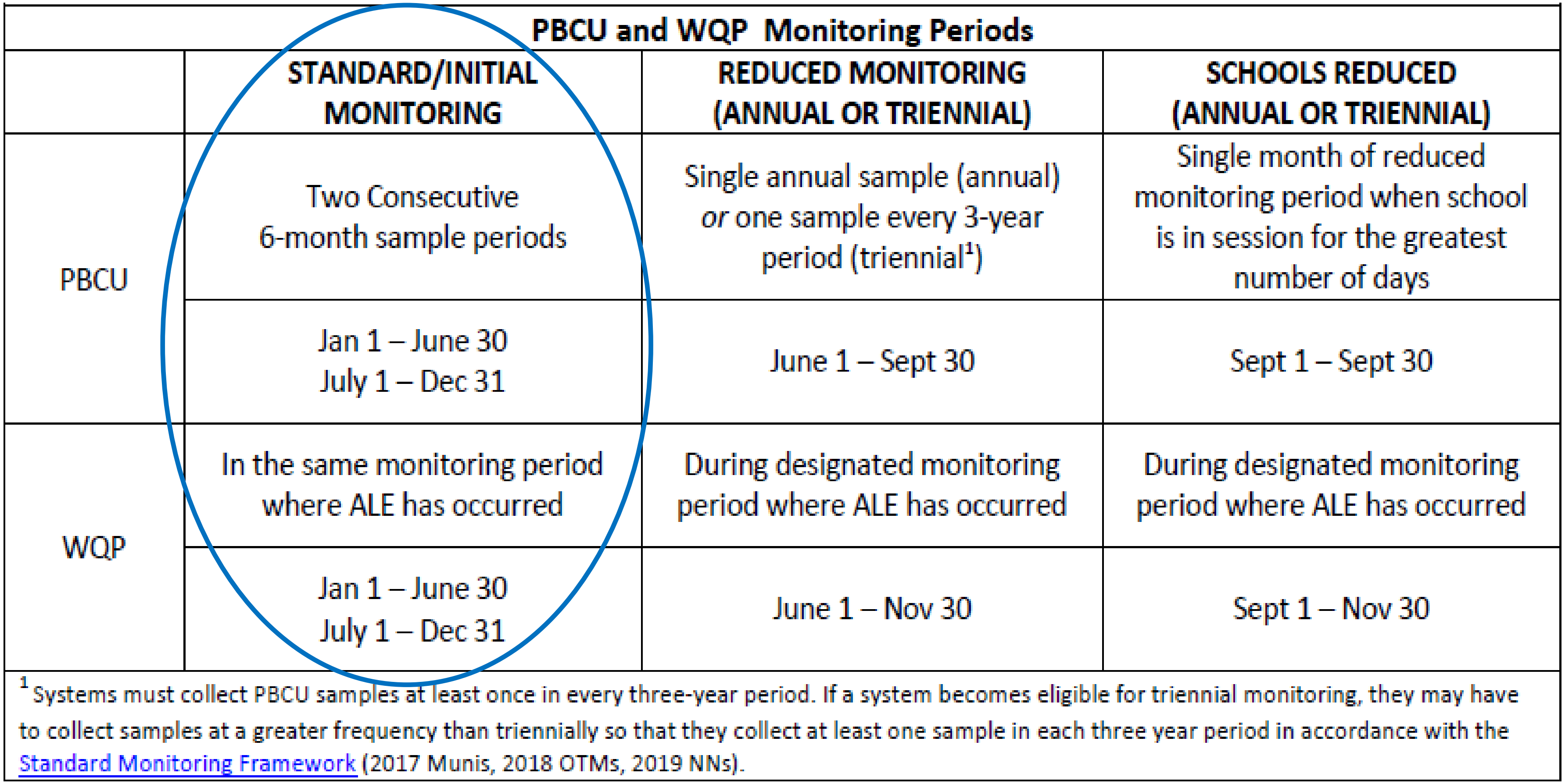
3. More particulate lead was released per unit surface area of galvanized plumbing than was released from lead service lines.

4. Lead content can vary substantially in galvanized iron pipe corrosion scales depending on the history of the premise piping. A range from a few hundredths of a percent to as high as eight percent lead by weight was observed in galvanized plumbing from different homes where lead service lines have been in place.

Sources of Lead- Galvanized Pipe, cont’d

5. Lead can reside in the deepest layers of galvanized iron corrosion scales indicating the potential for continued lead release for the remaining service life of the pipes.
6. Non-iron lead minerals such as apatites, carbonates and oxides of lead can exist in isolated deposits embedded in iron corrosion scales, indicating the potential for multiple adsorptive mechanisms including physical capture that will influence scale characteristics and lead release.
7. Lead release from galvanized plumbing will likely be exacerbated substantially by physical disturbance, especially immediately following a service line replacement.
8. Lead release from galvanized plumbing can be exacerbated by hydraulic disturbances such as water hammer or increased flow velocity.
9. Lead release from galvanized plumbing that appears to have subsided to some stable level over time following physical disturbance may increase again due to subsequent disturbances.

LCR Monitoring- Frequency



PBCU and WQP Monitoring Periods			
	STANDARD/INITIAL MONITORING	**REDUCED MONITORING (ANNUAL OR TRIENNIAL)**	**SCHOOLS REDUCED (ANNUAL OR TRIENNIAL)**
PBCU	Two Consecutive 6-month sample periods	Single annual sample (annual) *or* one sample every 3-year period (triennial[1])	Single month of reduced monitoring period when school is in session for the greatest number of days
	Jan 1 – June 30 July 1 – Dec 31	June 1 – Sept 30	Sept 1 – Sept 30
WQP	In the same monitoring period where ALE has occurred	During designated monitoring period where ALE has occurred	During designated monitoring period where ALE has occurred
	Jan 1 – June 30 July 1 – Dec 31	June 1 – Nov 30	Sept 1 – Nov 30

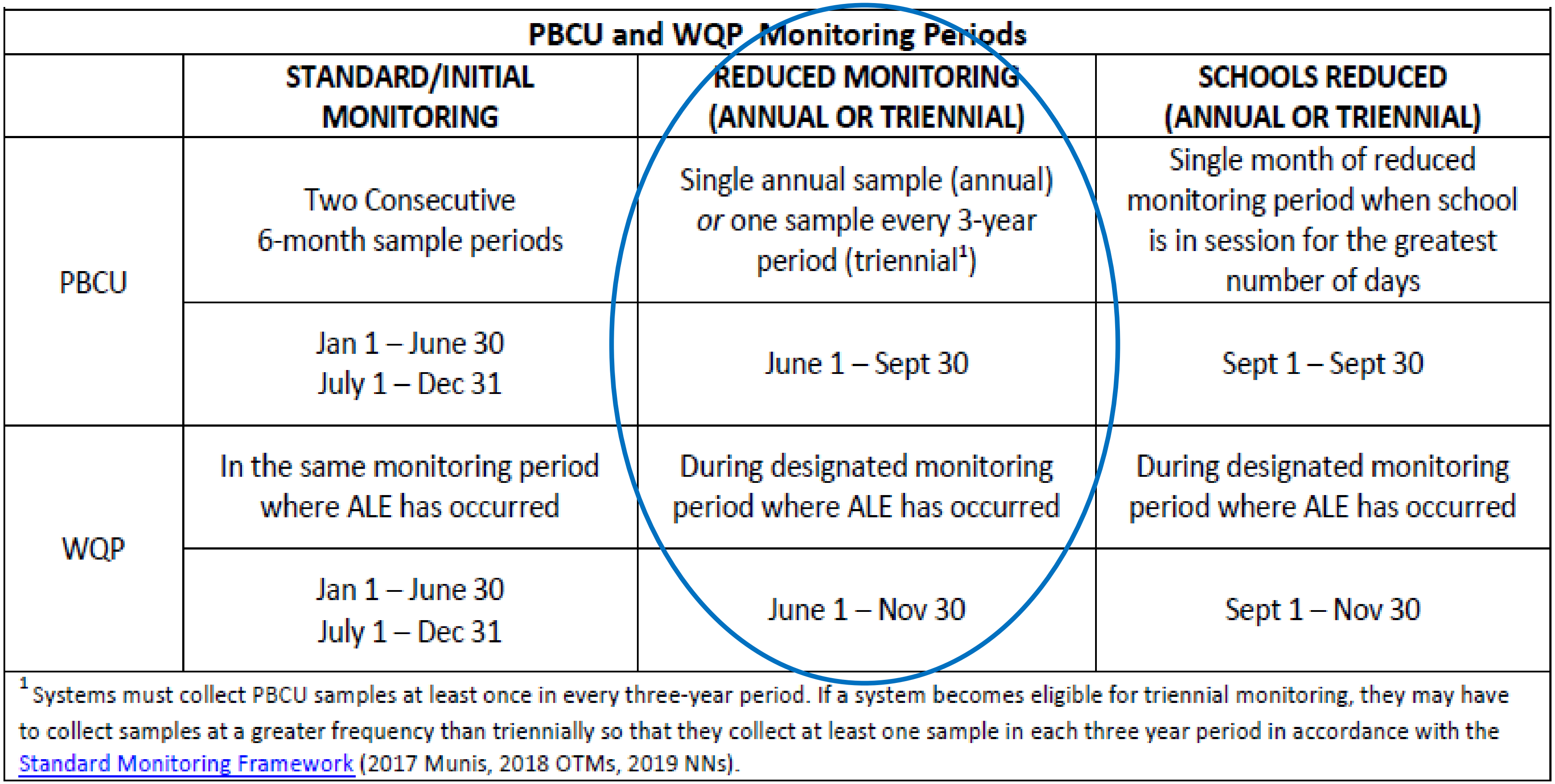
[1] Systems must collect PBCU samples at least once in every three-year period. If a system becomes eligible for triennial monitoring, they may have to collect samples at a greater frequency than triennially so that they collect at least one sample in each three year period in accordance with the Standard Monitoring Framework (2017 Munis, 2018 OTMs, 2019 NNs).

NR 809.547 Monitoring requirements for lead and copper in tap water.

(4) TIMING OF MONITORING

(d) *Reduced monitoring…* A water supplier shall also conduct water quality parameter monitoring in accordance with s. NR 809.548 (2), (3) or (4) during the monitoring period in which the action level was exceeded.

LCR Monitoring- Frequency



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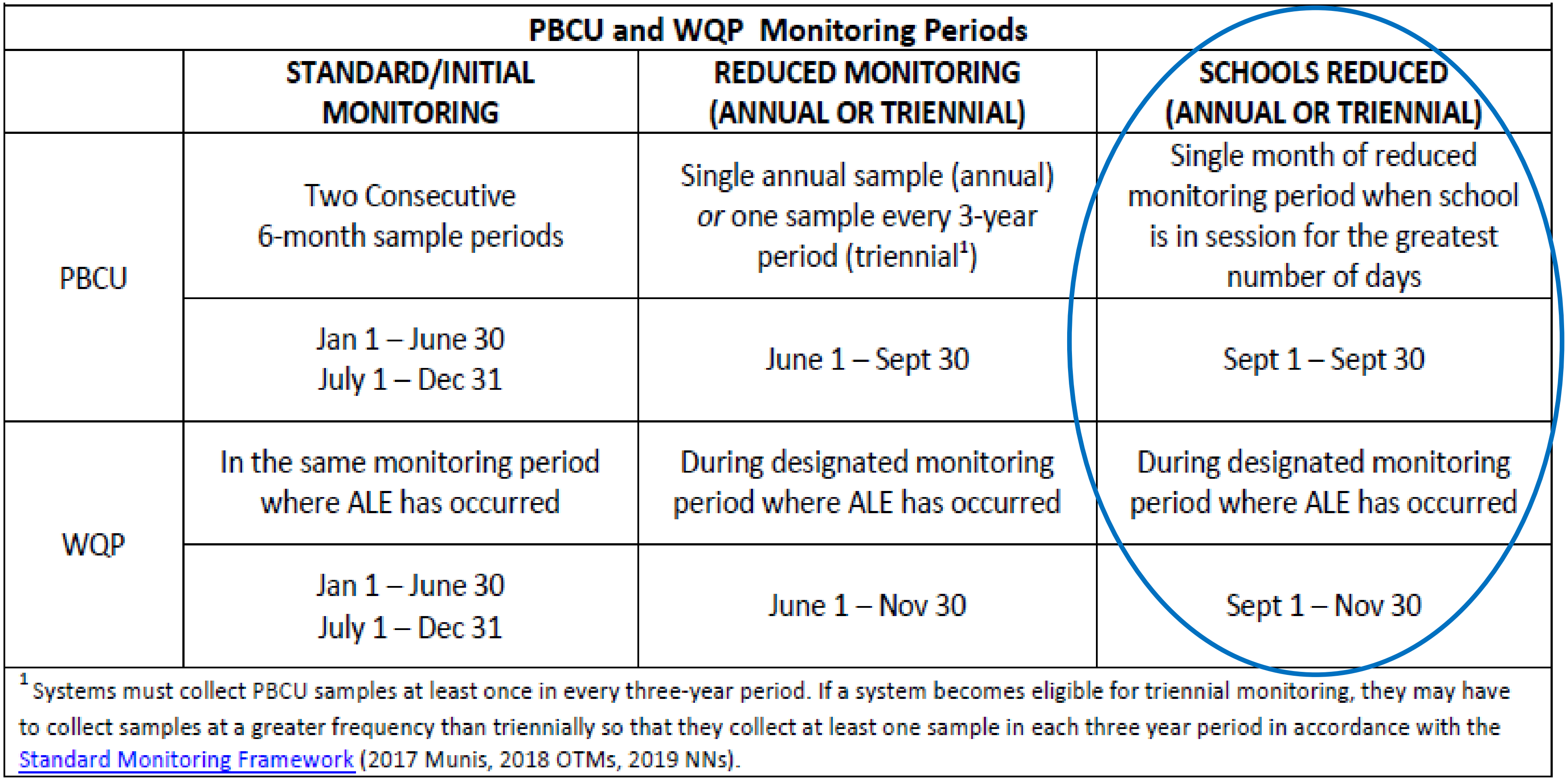

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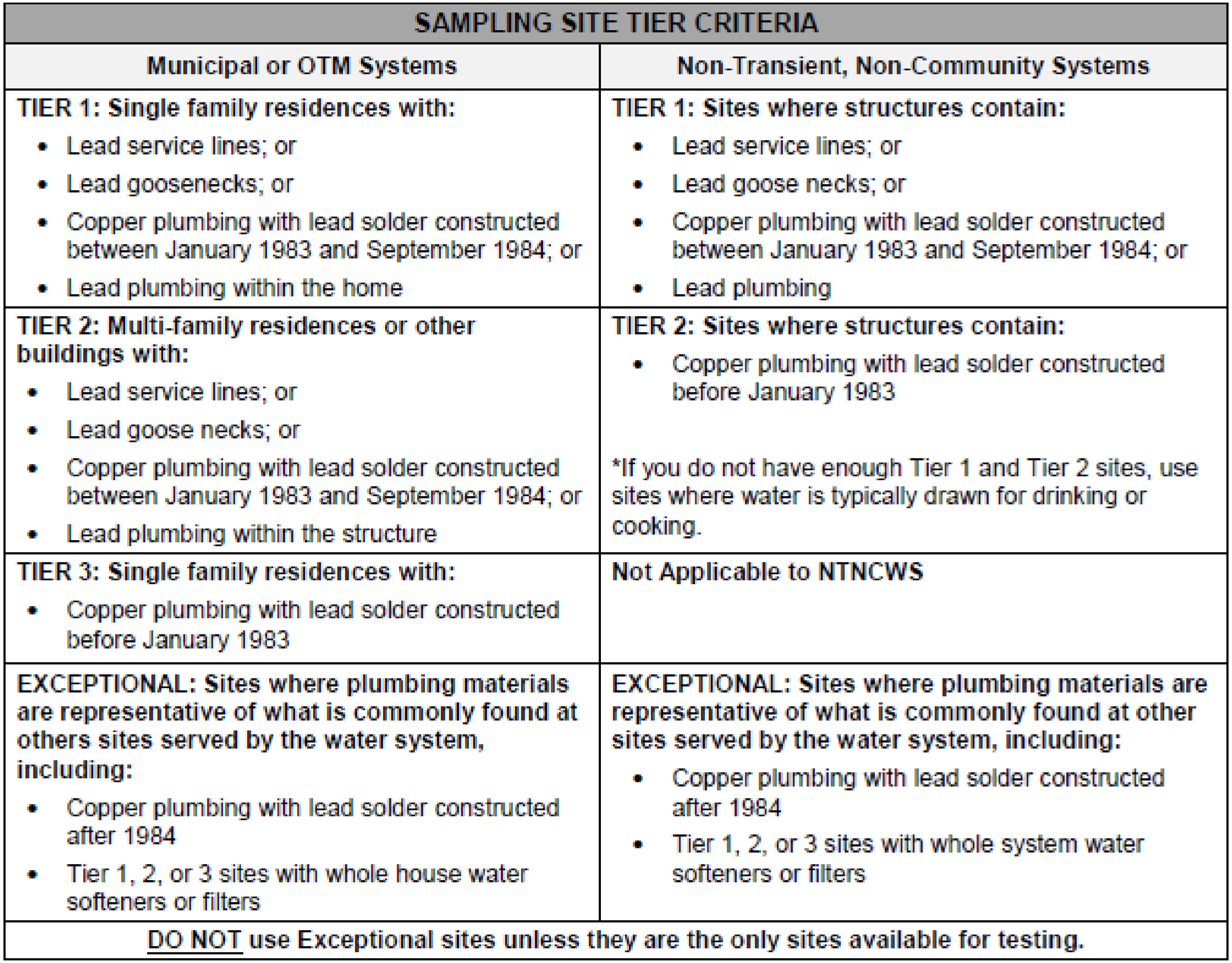
LCR Monitoring- Site Selection



SAMPLING SITE TIER CRITERIA	
Municipal or OTM Systems	**Non-Transient, Non-Community Systems**
TIER 1: Single family residences with: • Lead service lines; or • Lead goosenecks; or • Copper plumbing with lead solder constructed between January 1983 and September 1984; or • Lead plumbing within the home	**TIER 1: Sites where structures contain:** • Lead service lines; or • Lead goose necks; or • Copper plumbing with lead solder constructed between January 1983 and September 1984; or • Lead plumbing
TIER 2: Multi-family residences or other buildings with: • Lead service lines; or • Lead goose necks; or • Copper plumbing with lead solder constructed between January 1983 and September 1984; or • Lead plumbing within the structure	**TIER 2: Sites where structures contain:** • Copper plumbing with lead solder constructed before January 1983 *If you do not have enough Tier 1 and Tier 2 sites, use sites where water is typically drawn for drinking or cooking.
TIER 3: Single family residences with: • Copper plumbing with lead solder constructed before January 1983	**Not Applicable to NTNCWS**
EXCEPTIONAL: Sites where plumbing materials are representative of what is commonly found at others sites served by the water system, including: • Copper plumbing with lead solder constructed after 1984 • Tier 1, 2, or 3 sites with whole house water softeners or filters	**EXCEPTIONAL: Sites where plumbing materials are representative of what is commonly found at other sites served by the water system, including:** • Copper plumbing with lead solder constructed after 1984 • Tier 1, 2, or 3 sites with whole system water softeners or filters
DO NOT use Exceptional sites unless they are the only sites available for testing.	

SAMPLE TAP CRITERIA

- Cold water taps
- Taps within the interior of a residence of other building
- Taps where water is used for human consumption
- Taps where water is untreated by softening or filters
- Taps where water is used on a regular basis

Examples of VALID Taps	Examples of INVALID Taps
Kitchen Sink Cold Water Taps	Hot Water Taps
Bathroom Sink Cold Water Taps	Exterior Taps or Hose Bibs
Break Room Sink Cold Water Taps	Pressure Tank Taps
Drinking Water Fountains/Bubblers	Laundry Sinks or Eye Wash Stations
Kitchenette Taps (or other food preparation areas)	Vacant Apartment/Condo/Hospital Room Taps

SAMPLING DO'S AND DON'Ts

SAMPLING DO'S

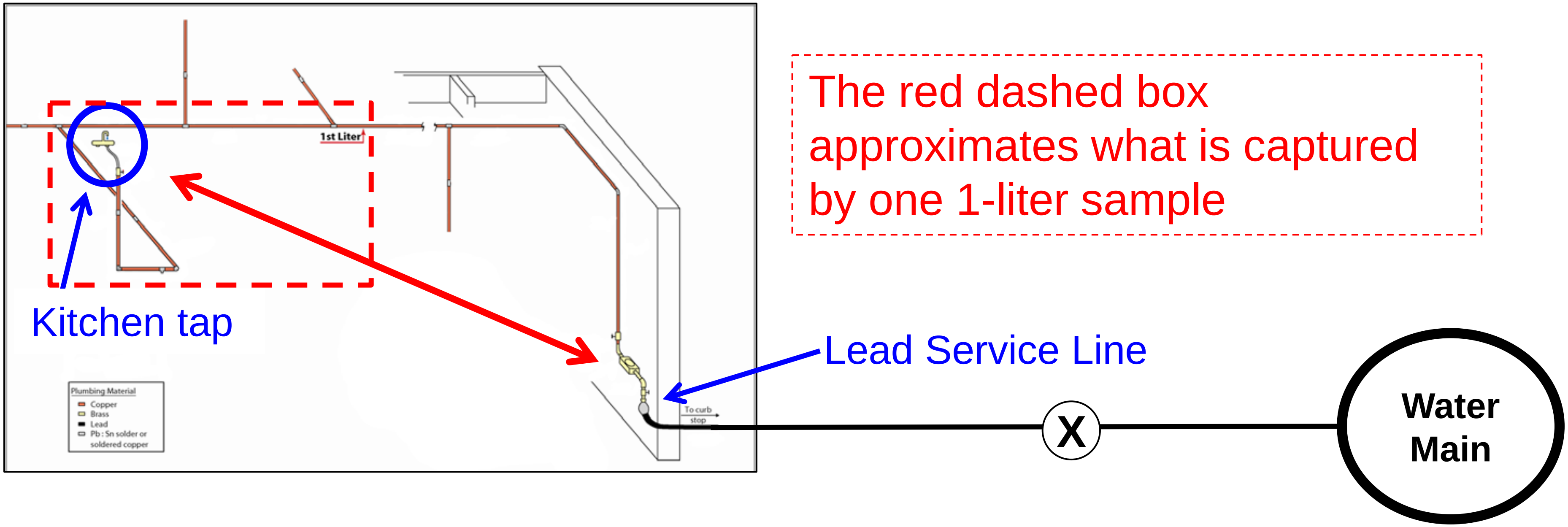
- Sample during the appropriate monitoring period
    - Standard Monitoring: Jan 1 – June 30 and July 1 – Dec 31
    - Reduced (Annual or Triennial Monitoring): June 1 – September 30
    - Schools (Annual or Triennial Monitoring): September 1 – September 30
- **SAMPLE EARLY!** Give yourself time to re-sample if you have issues with shipping or lab procedures or need to take corrective actions (systems with lead and copper Action Level exceedances will be required to collect water quality parameter samples in the same monitoring period).
- Collect samples at the same location as all previous sampling events in accordance with your SITE MONITORING PLAN (contact your DNR Rep if you need to adjust your system's monitoring sites).
- Collect first-draw samples (water is to have stood motionless for at least six hours).
- Collect samples in 1-liter wide-mouth sample containers.
- When samples are sent to the laboratory for analysis, make sure that all sections of the lead and copper sample form are completed and the form is included with your lab sample. This includes clearly noting the date and time the sample was collected, sample ID, the address, and the location (second floor) and tap description (bathroom cold water tap) where the sample was collected.

SAMPLING DON'Ts

- DO NOT pre-flush the tap prior to the stagnation period (six hours) or prior to collecting the sample.
- DO NOT remove the aerator prior to sampling.
- DO NOT collect samples from taps where water has remained motionless for significantly longer than 6-hours (i.e. vacant properties, schools over break periods).
- DO NOT use a tap that is downstream of a filter or softener.

Assessing Efficacy of Treatment

- First draw 1 L sampling inadequate in assessing true lead exposure
- Improper site selection for LCR sampling
  - ✓ Tier 2 and Tier 3 sites chosen over Tier 1 sites
  - ✓ Inadequate records of LSL infrastructure



The red dashed box approximates what is captured by one 1-liter sample

Assessing Efficacy of Treatment

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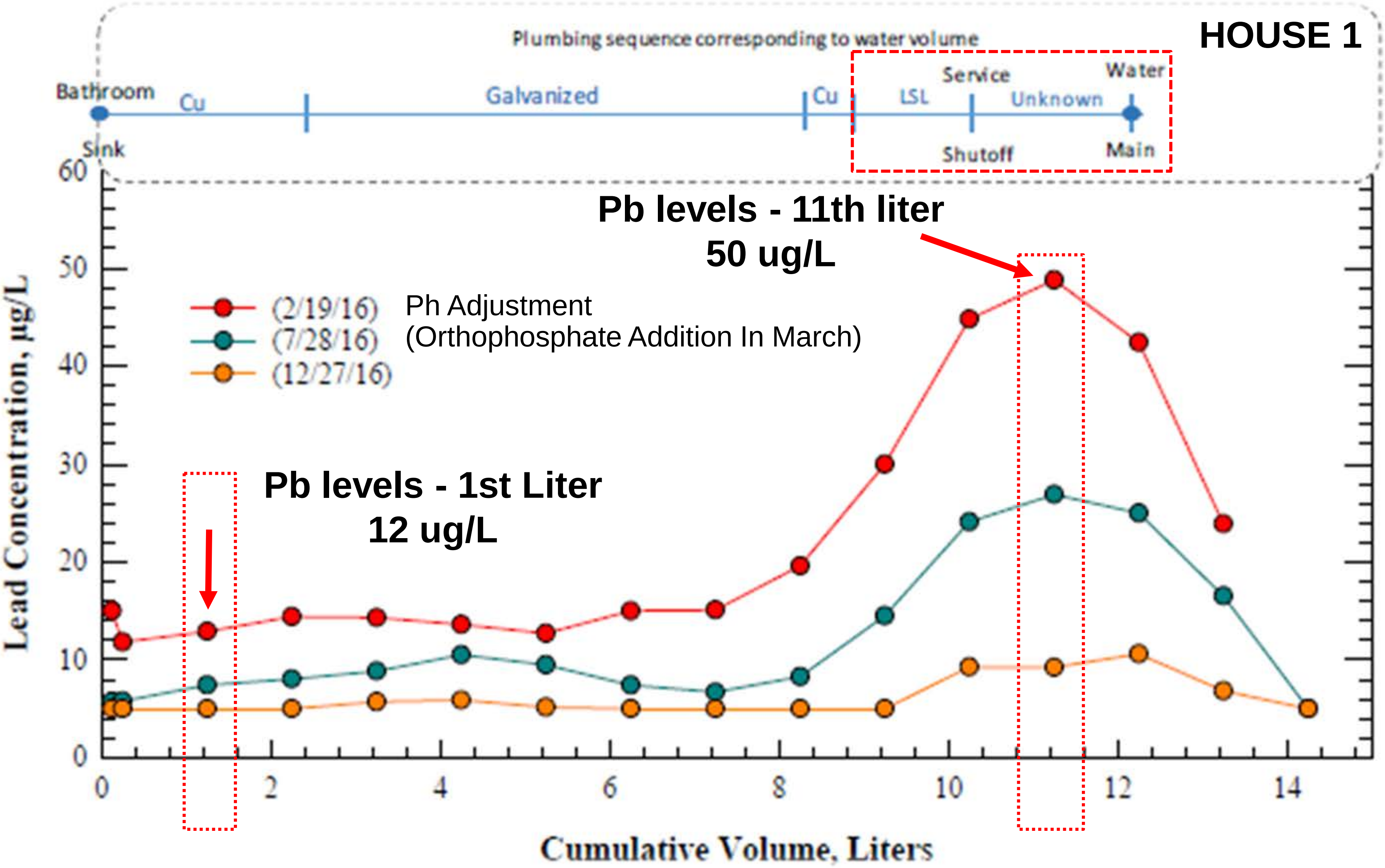
Distance Between Water Main and Homes Varies Significantly

Assessing Efficacy of Treatment



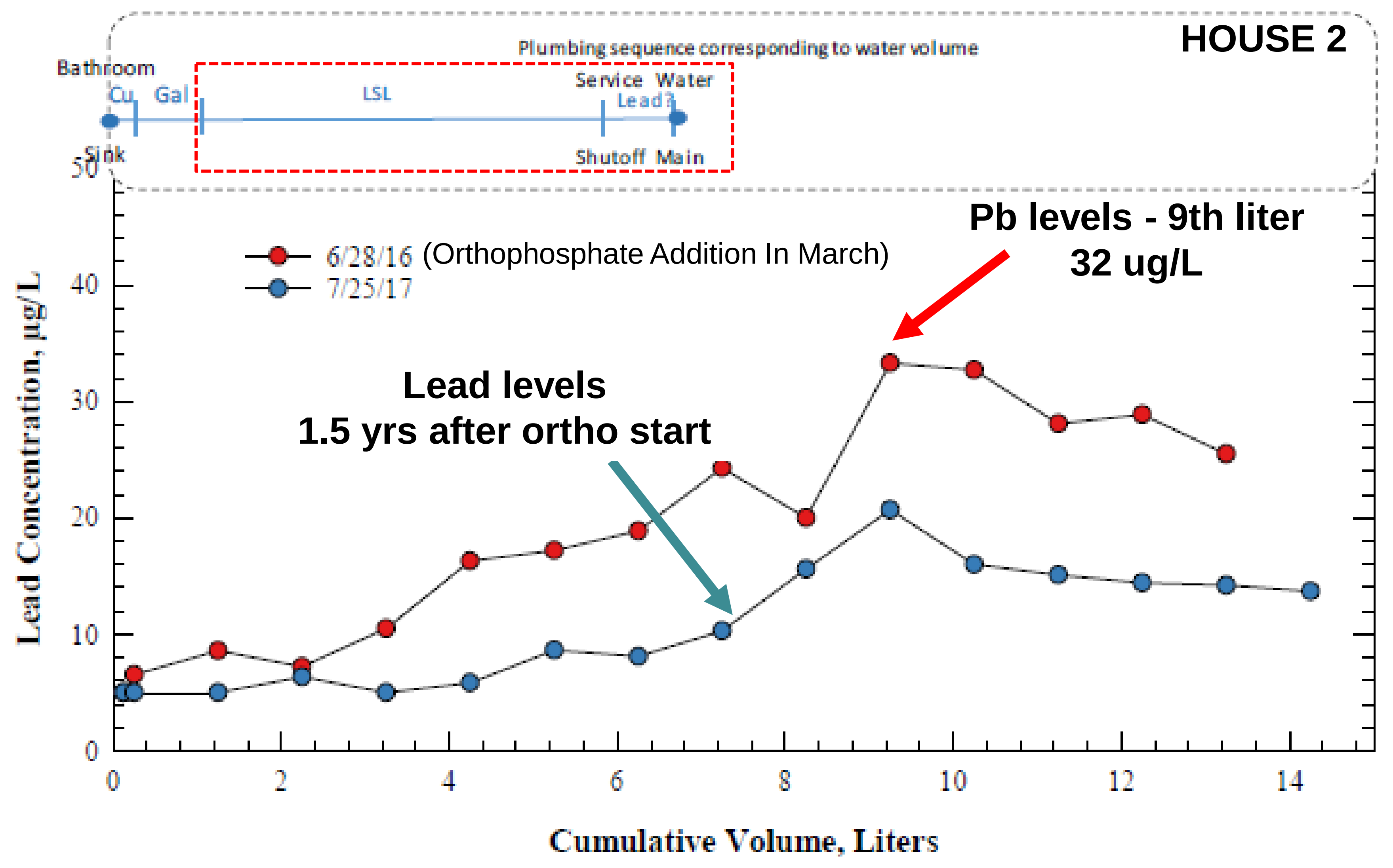
HOUSE 1

Ph Adjustment
(Orthophosphate Addition In March)

Pb levels - 11th liter
50 ug/L

Pb levels - 1st Liter
12 ug/L

Assessing Efficacy of Treatment

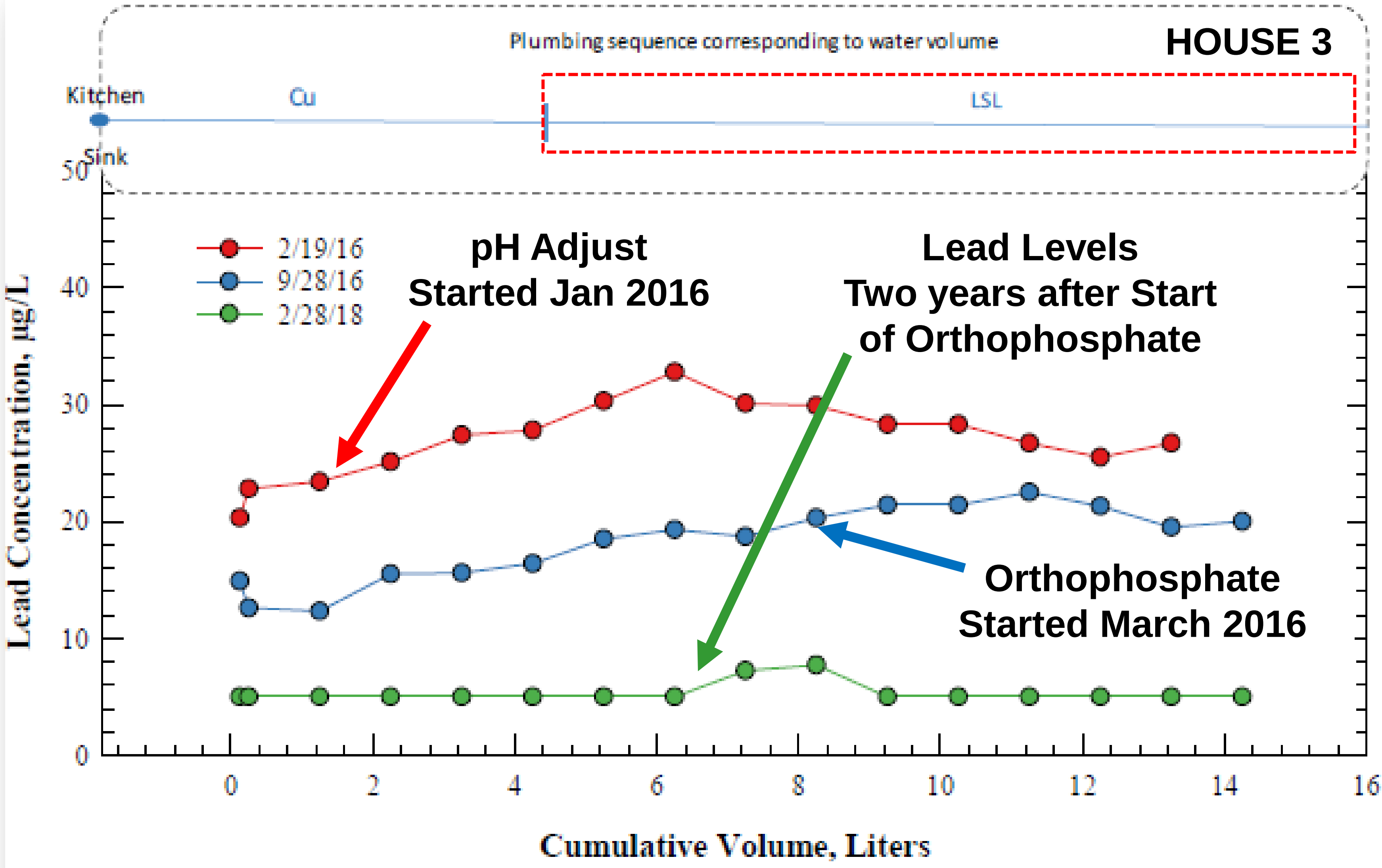


HOUSE 2

Pb levels - 9th liter
32 ug/L

Lead levels
1.5 yrs after ortho start

Assessing Efficacy of Treatment



pH Adjust Started Jan 2016

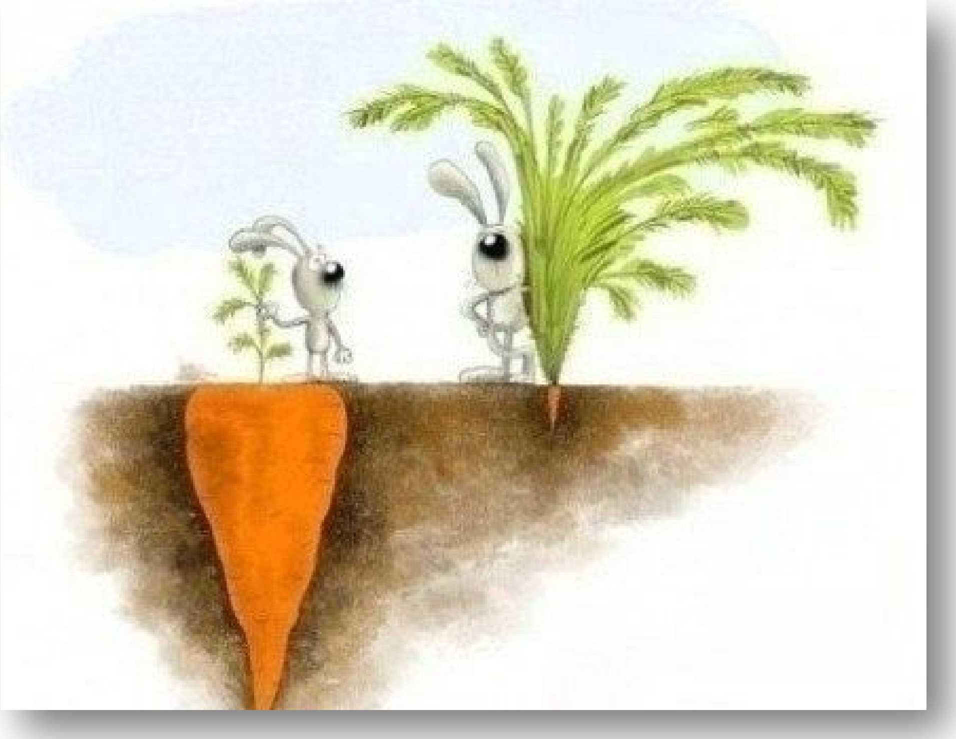
Lead Levels Two years after Start of Orthophosphate

Orthophosphate Started March 2016

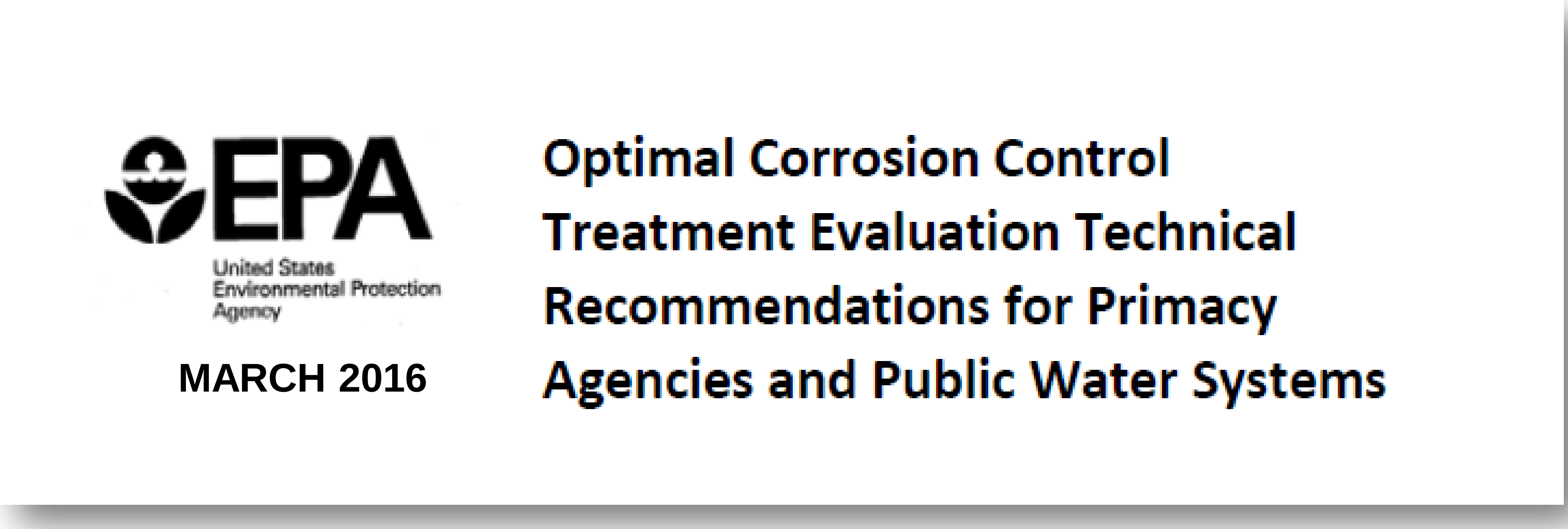
Assessing Efficacy of Treatment

We Know...

Lead and copper in drinking water can be 4-8 times higher than what first-draw sample values demonstrate.



Assessing Efficacy of Treatment



EPA
United States
Environmental Protection
Agency

MARCH 2016

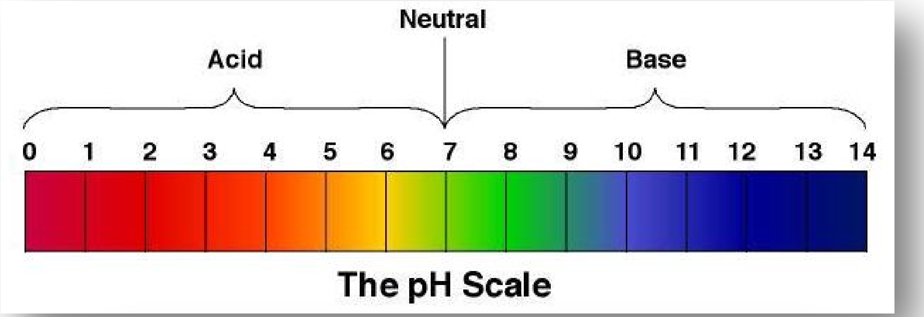
Optimal Corrosion Control Treatment Evaluation Technical Recommendations for Primacy Agencies and Public Water Systems

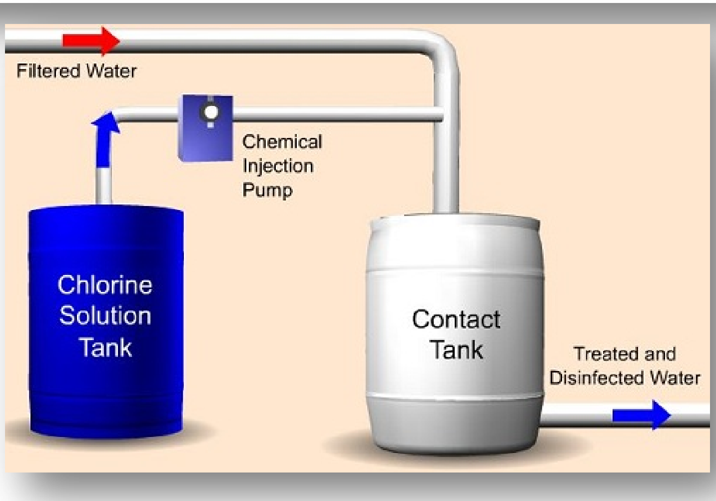
Assessing Efficacy of Treatment

Many different water quality (WQ) conditions can impact Pb and Cu release and need to be considered

CHLORIDE SULFATE MASS RATIO

DISSOLVED INORGANIC CARBON





Assessing Efficacy of Treatment

- pH
- Alkalinity
- Dissolved inorganic carbon (DIC)
- Temperature
- Hardness, calcium and magnesium
- Conductivity
- Ammonia, chloride, and sulfate
- Iron, aluminum, and manganese
- Corrosion Control Inhibitors
- Chlorine, chloramines
- Oxidation reduction potential (ORP)
- Buffer intensity
- Dissolved oxygen
- Natural organic matter
- Others (fluoride, sequestration)

Alkalinity, pH, DIC, corrosion inhibitors, and ORP (in certain types of waters) remain critical parameters that directly impact lead release.

Treatment Options

CCT SCIENCE

- Was CCT selected to reduce lead and/or copper levels?
- Is CCT dosed at a rate that will effectively reduce lead and/or copper levels to the greatest extent practical?
- Was CCT selected to work in combination with another treatment goal (i.e. sequestration)? Are the technologies competing with each other? With other water quality factors?
- If using blended phosphates, is the addition of excess polyphosphate sequestering lead and copper?

Treatment Options

ORTHOPHOSPHATE

- Systems should target distribution system orthophosphate residuals of 1-3 mg/L or as high as 3-6 mg/L where systems have LSLs
- Lead levels may continue to decline for years after optimal ortho doses have been applied due to slow rate of scale formation (passivation dose vs. maintenance dose)
- Blended phosphates can add excess polyphosphate to systems and sequester lead and copper

EPA OCCT Guidance – March 2016

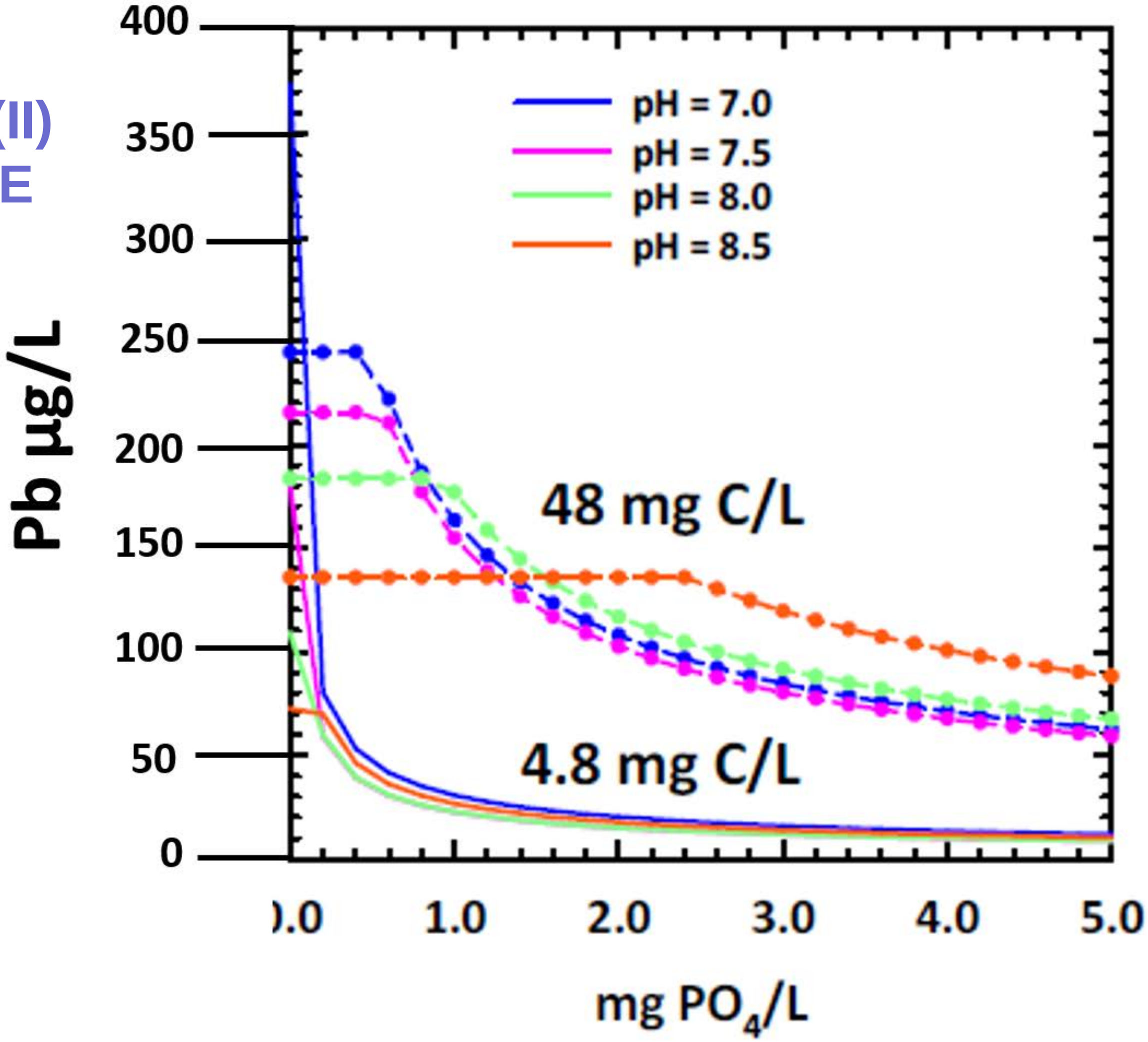
2017 EMOR Data - DS **Orthophosphate Residuals**

Status	DS Ortho (mg/L)	# Systems	Totals	Percent Total
Not Likely Optimized	0.0-0.30	19	163	**65.5**
	0.31-0.60	45		
	0.61-0.9	53		
	0.91-1.2	46		
Maybe Optimized	1.21-1.5	27	60	**24.1**
	1.51-2.0	33		
Likely Optimized	2.01-2.5	20	26	**10.4**
	2.51-3.0	6		
	Total Systems	**249**		

***For systems with LSLs**

Treatment Options

THEORETICAL FORMATION OF PB(II) ORTHOPHOSPHATE SOLIDS



Schock, M.R. & Lytle, D.A., 2011 (Sixth ed.). Internal Corrosion and Deposition Control. Ch. 20 in: *Water Quality and Treatment: A Handbook of Community Water Supplies*, J.K. Edzwald ed. McGraw-Hill, Inc., New York.

Treatment Options

SILICATES

- High doses in excess of 20 mg/L may be required to control lead release
- Start-up dose of 24 mg/L is recommended; *eventual maintenance does of 8-12 mg/L (maybe???)*
- Silicates can raise pH
- Silicates can also sequester where Fe and Mn are <1 mg/L
- Chloride, calcium, and Mn can affect optimum dose
- Lack of research an field information proving its effectiveness

EPA OCCT Guidance – March 2016

2017 EMOR DATA – EP SILICA Residuals

Status	EP Silicate (mg/L)	No of Systems	Totals	Percent Total
Not Likely Optimized	0-2.49	1	7	63.6
	2.5-7.49	1		
	7.5-14.99	5		
Maybe Optimized	15.0-19.99	1	2	18.2
	20-24.99	1		
Likely Optimized	25.0-29.99	1	2	18.2
	>30.0	1		
	Total	**11**		

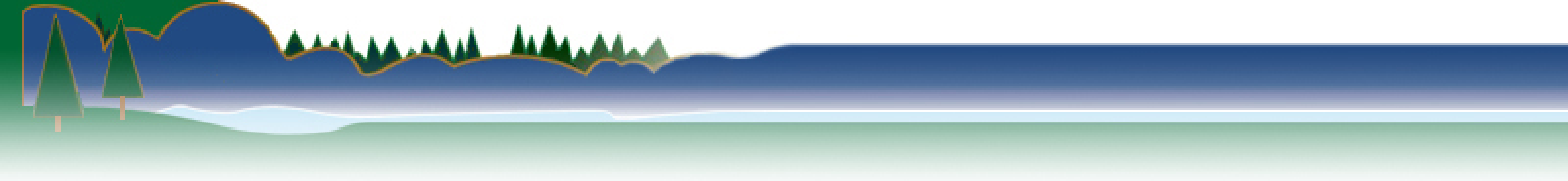
***For systems with LSLs**

Treatment Options

pH Adjustment

- Target pH should be **8.8 to 10**.
- Systems with lead service lines that are not using a corrosion inhibitor should consider increasing the pH to **9.0 or greater**.
- Lower pH values, particularly between 8.2 and 8.5, can result in poor buffer intensity of the water (regardless of DIC levels) and wide swings in distribution system pH

EPA OCCT Guidance – March 2016



2017 EMOR Data - DS **pH Values**

Status	pH (SU)	# Systems	Totals	Percent Total
Not Likely Optimized	< 6.99	7	106	**99.1**
	7.00 – 7.50	38		
	7.51 – 7.99	45		
	8.00 – 8.50	16		
	8.51 – 8.79	0		
Likely Optimized	8.80 – 9.00	1	1	**0.9**
	> 9.01	0		
	Total Systems	**107**		

***For systems with LSLs**

Conclusions

1) “Passing” Lead and copper sampling is not an indication that lead and copper exposures have been minimized or that CCT is optimized.

2) First draw samples ≠ peak lead levels. Peak lead levels can be up to 4-8 times higher.

3) Corrosion Control Treatment targets tailored to 90th percentile values are not necessarily optimized.

4) Treatments must be tailored to the source of lead and/or copper present in a given community (i.e. LSLs vs. fixtures)