

Overview of Tools to Assess Corrosion: Sampling Drinking Water for Lead

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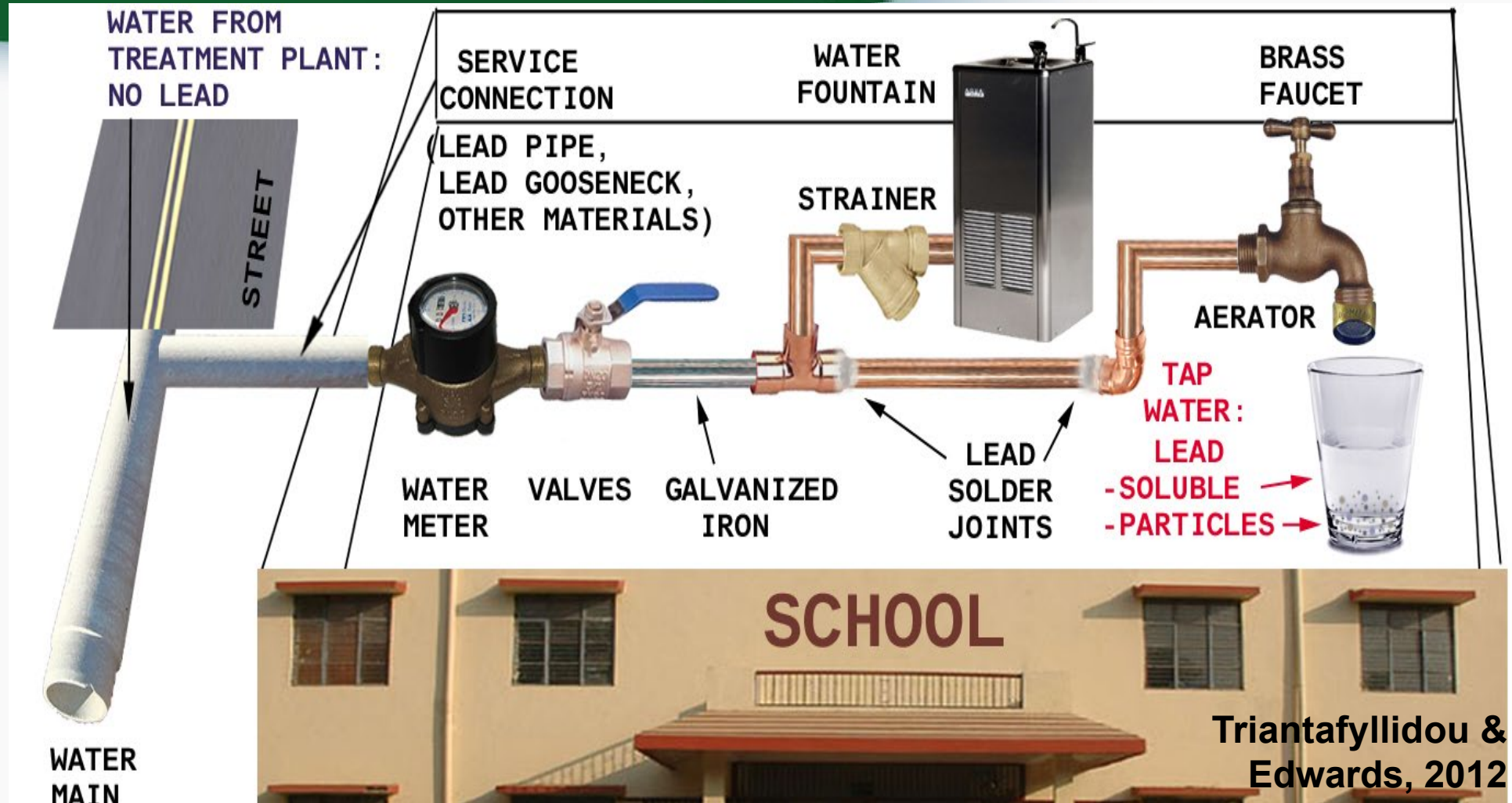
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Lead Plumbing Sources



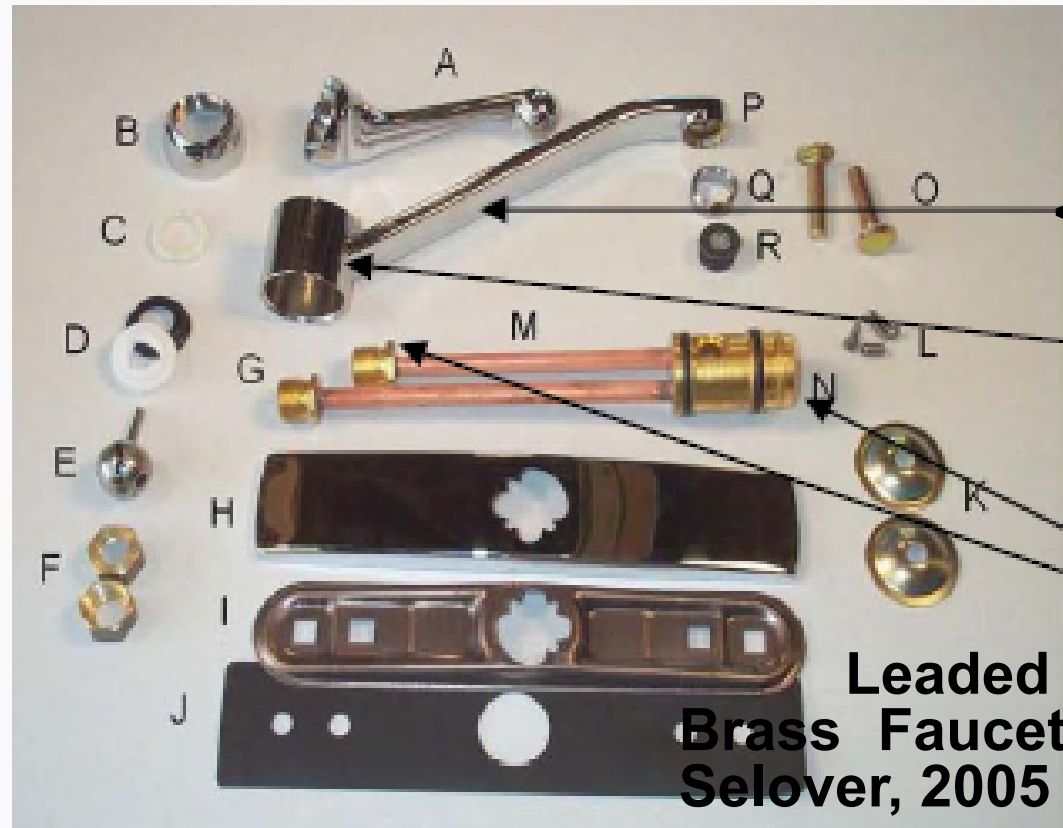
- Lead Service Lines (LSLs)
- Lead Goosenecks
- Leaded Solder

- Leaded Brass (valves, fittings, faucets, water fountains)
- Galvanized Pipe downstream of leaded plumbing

Lead Plumbing Sources



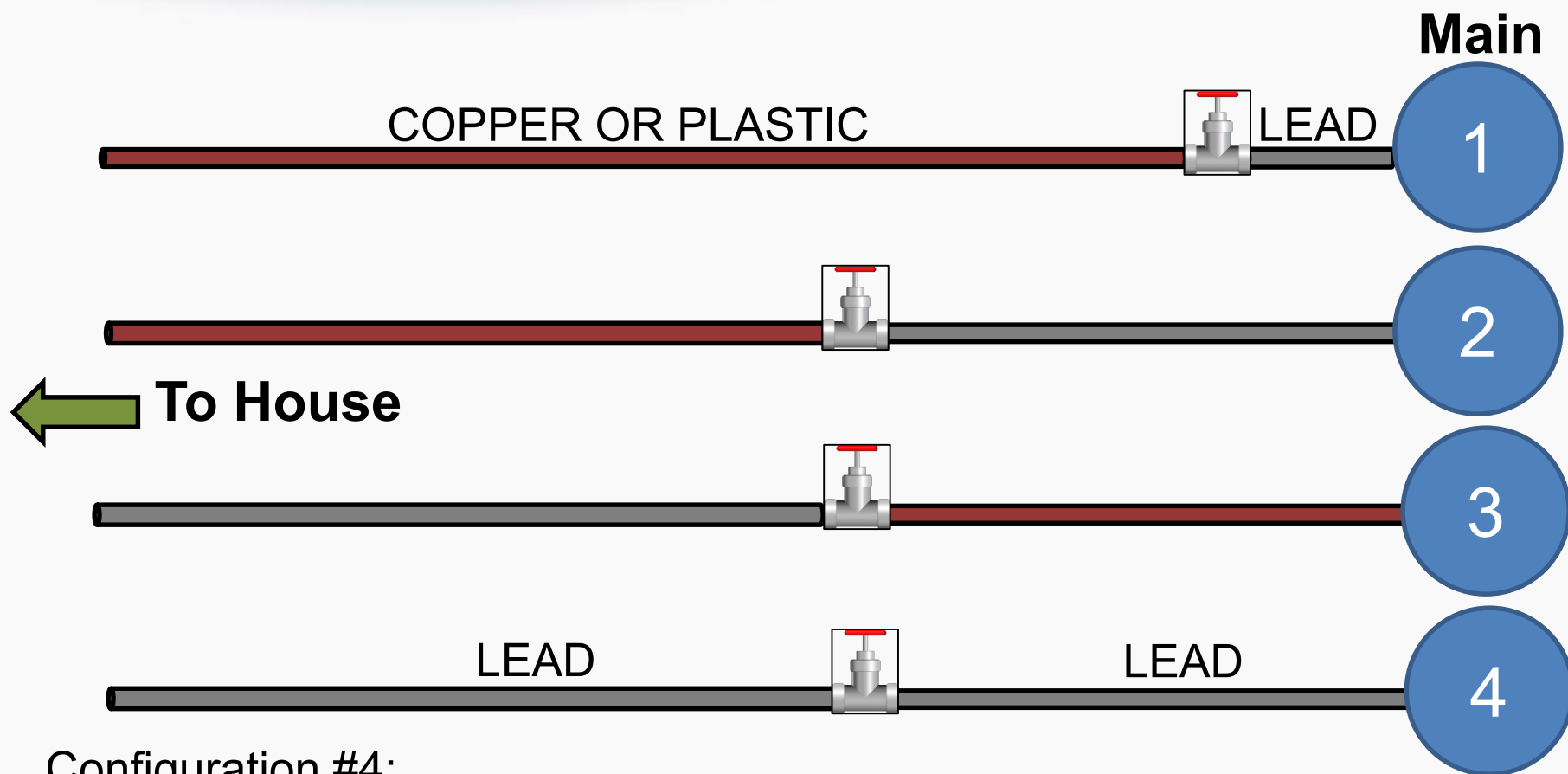
Lead Plumbing Sources



Not just faucets: Shut-off valves



Lead sources are not uniformly distributed



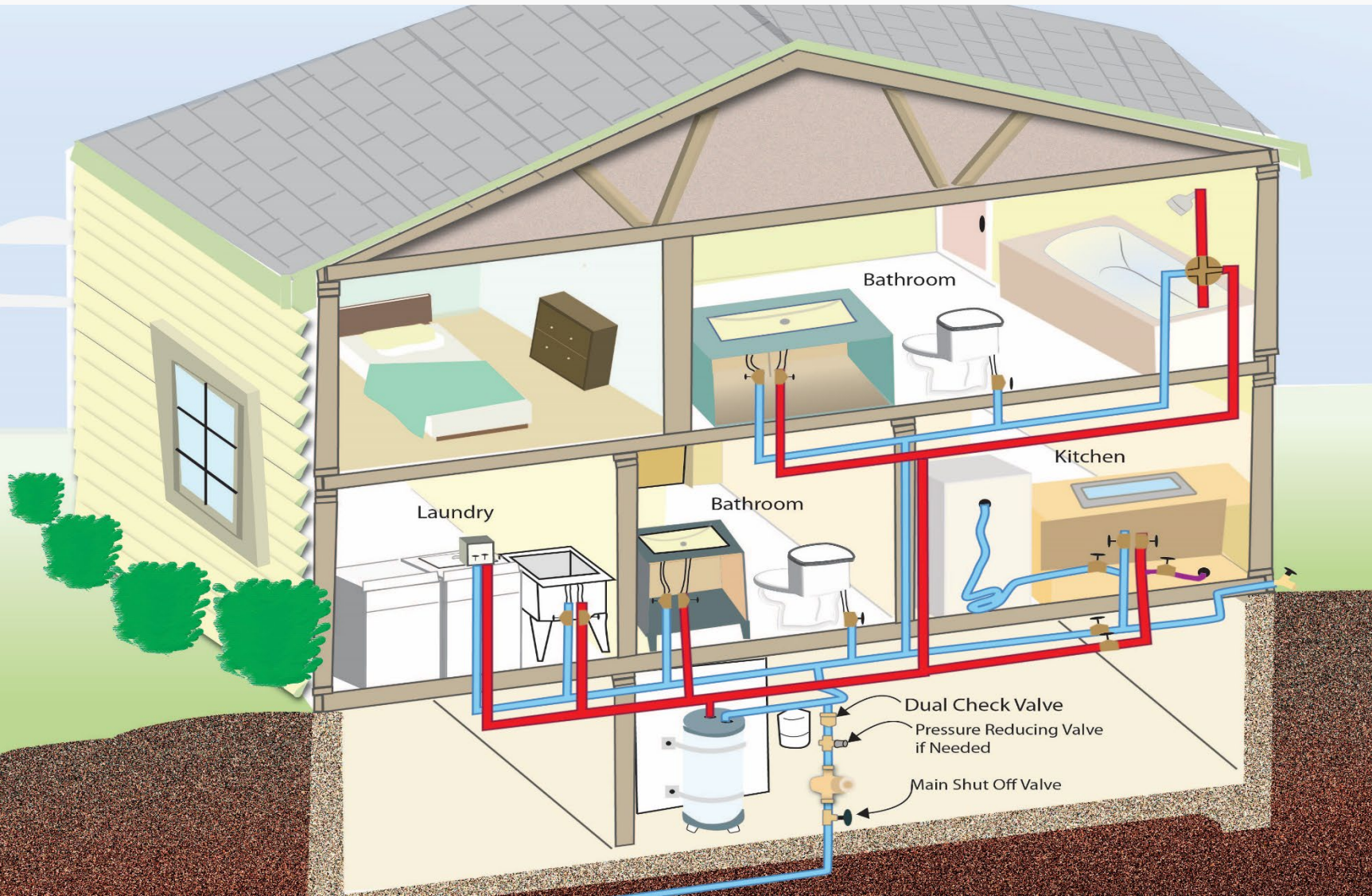
Configuration #4:

- long run of LEAD, potentially highest exposure risk

Even worse would be:

- GALVANIZED IRON downstream of LEAD

Household Water use matters



Household water use is complex

- When do you use your water each day?
- How many people, and of what ages, use the water?
- Which faucet or outlet is used EACH time, and by whom?
- Which activities are done, and in what order?
- What is the water pathway through the plumbing, each time a faucet or appliance is turned on?
- What kind of pipes are there, in what order are they arranged, how old and how long are they?
- How long did the water stand in *which part(s) of the* piping?
- How much does the pattern of use vary from day to day, week to week?
- Does the background water chemistry change during the day?
- Are school or work-related activities the same or different from the prior day/week/month?
- Are there visitors that change the water use pattern?
- Is work being done to the plumbing, to the water mains in the street, hydrant repairs, or other construction work that can physically disturb pipe scales?

What is a “representative” water sample?



Factors affecting Pb release...

Pb plumbing materials, dimensions, configurations & age

Water chemistry (corrosivity) and chemical changes

Hydraulics and hydraulic changes

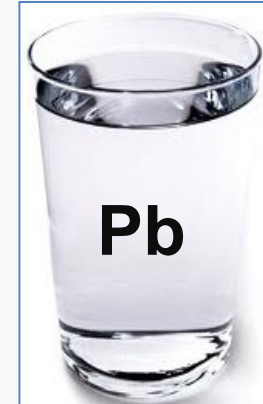
Individual water use patterns

...Contribute to Pb variability

Pb Spatial variability

Pb Temporal variability

Particulate vs dissolved Pb



water consumed



water sampled

How we quantify lead in water



1. Sample Collection

- Sampling site?
- Number of sites?
- Number of samples per site?
- Sampling frequency?
- Sample volume?
- Stagnation time?
- First draw or flush?
- Pre-flushing, aerator removal?
- Sampling flow rate?
- Sample hot or cold water?

2. Sample preparation

- Standard preservation or rigorous digestion?
- Amount of acid preservative?
- Mixing and holding time?
- Presence/absence of particulates?
- Triantafyllidou et al., 2011

3. Analytical Quantification

- Is the lead in a form that the analytical detector can quantify?
- Laboratory instruments versus on-site analyzers?

Sampling: What question(s) are you trying to answer?



- No single universally applicable sampling approach for lead in drinking water exists
- There are many protocols, but each has a specific use answering a specific question
- What question(s) are you trying to answer?



Evaluation of Lead Sampling Strategies

Web Report #4569

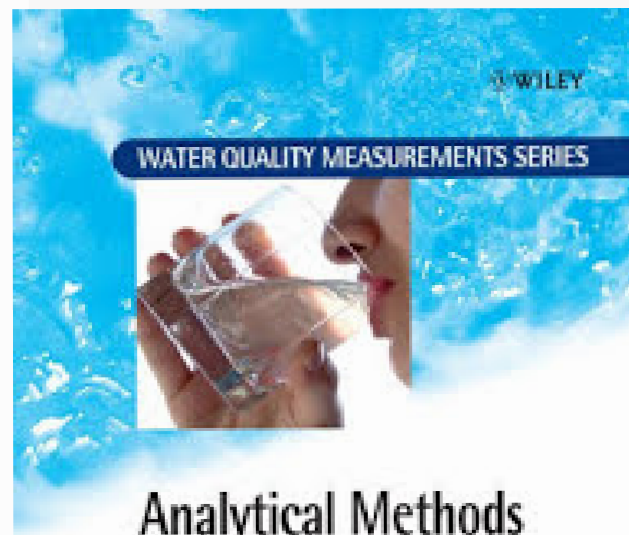
Subject Area: Water Quality



Metals and Related Substances in Drinking Water Series

Best Practice Guide on Sampling and Monitoring of Metals in Drinking Water

Edited by Dr. Adam Postawa



Analytical Methods for Drinking Water Advances in Sampling and Analysis

Edited by
Philippe Quevauviller | K. Clive Thompson

Sampling: What question(s) are you trying to answer?



QUESTION(S):

- Does the water meet regulatory standards for Pb?
 - How effective is the current corrosion control treatment for interior plumbing?
-
- Where is the Pb coming from?
 - What type of Pb is present (dissolved/ particulate)?
-
- What is the general public's exposure to Pb in water in this residence/ neighborhood/ town/distribution system?

SAMPLE FOR:

1. Lead regulatory compliance

2. Lead plumbing sources determination or Lead type identification

3. Lead exposure assessment

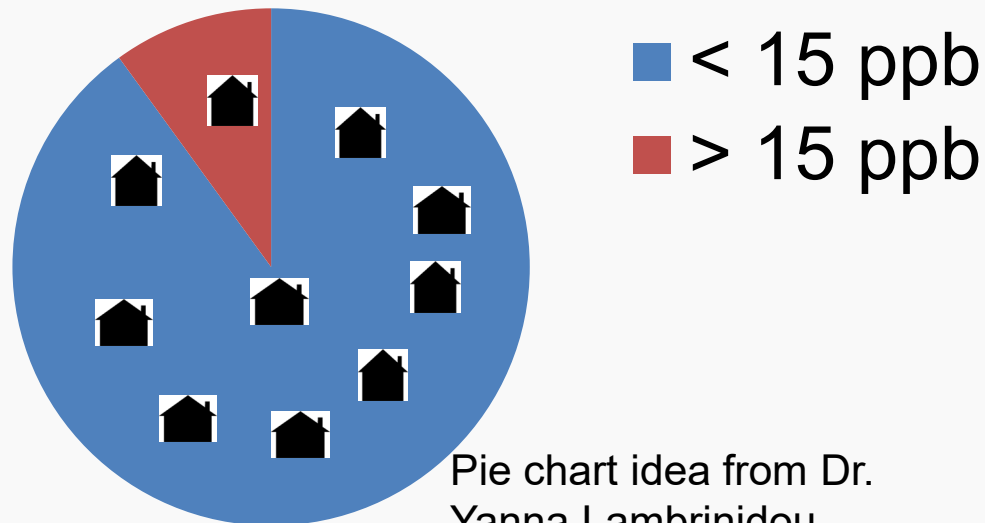
OBJECTIVE & QUESTION(S) ANSWERED	SAMPLE TYPE	SAMPLE PROTOCOL SUMMARY
Lead regulatory compliance in a certain jurisdiction: <ul style="list-style-type: none"> • Does the water meet the regulatory standard for Pb? • How effective is the current corrosion control treatment for interior plumbing? 	First Draw, US - 90 th percentile Pb<15 µg/L	- Collect after overnight water stagnation (6+ hr) - Collect first 1 L
	Random Daytime (RDT), UK - 95 th percentile Pb<10 µg/L	- Collect during random work hours (i.e., variable stagnation) - Collect first 1 L
	30 Min. Stagnation (30MS), Ontario Canada - 90 th percentile Pb <10 µg/L - Stricter criterion of <5 µg/L considered	- Flush ≥ 5 min. - 30 min. stagnation - Collect first two liters

1. Corrosion Control Assessment



LCR Sampling, US

- Lead Action Level is not an MCL
- Aimed at identifying system-wide problems rather than problems at outlets in individual buildings
- 90th percentile 15 $\mu\text{g}/\text{L}$ action level is a trigger for corrosion control treatment rather than an exposure level

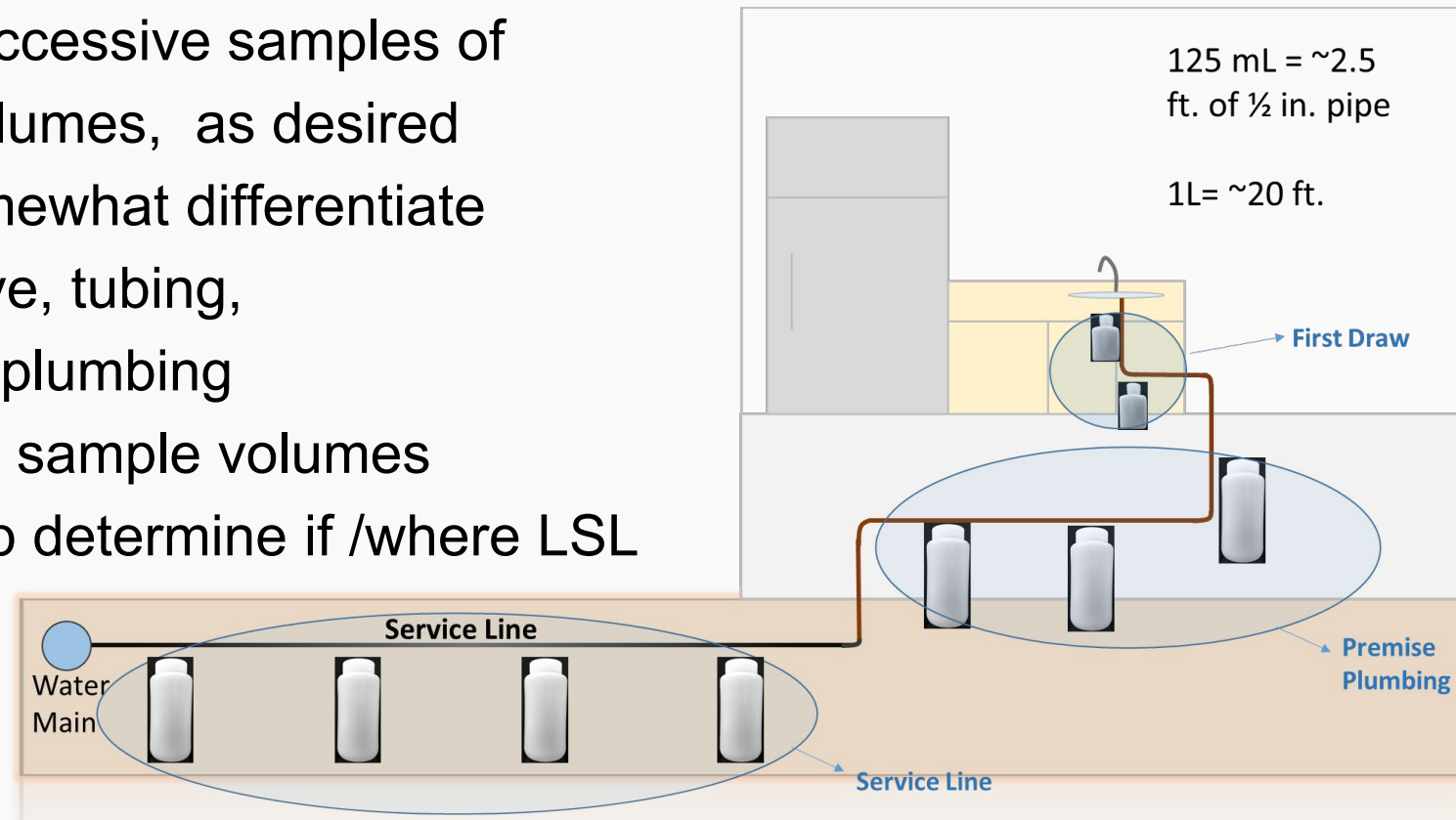


OBJECTIVE & QUESTION(S) ANSWERED	SAMPLE TYPE	SAMPLE PROTOCOL SUMMARY
Lead plumbing sources determination and/or lead type identification: <ul style="list-style-type: none"> Where is the Pb coming from? What type of Pb is present (dissolved/particulate)? 	Profile (or else sequential)	<ul style="list-style-type: none"> Defined stagnation time Collect 10 to 20 sequential samples of defined volume (125 mL, 250 mL, 1 L, etc.)
	Fully flushed	<ul style="list-style-type: none"> No stagnation Flush out several piping volumes Collect 1 L
	School guidance, US	<ul style="list-style-type: none"> Overnight stagnation Collect first 250 mL from all taps and fountains If any sample > 20 µg/L, take follow-up samples
	Particle stimulation	Profile sampling repeated at increasingly higher water flow rate: low, medium, and high flow rate <ul style="list-style-type: none"> 5 min stagnation Collect first liter and maximum flow rate, open and close tap five times, fill rest of bottle at normal flow rate. Collect second liter at a normal flow rate <ul style="list-style-type: none"> Collect third liter the same way as the first

2. Lead plumbing sources determination

Sequential Sampling (Profile Sampling)

- Map interior plumbing and approximate exterior route to main in terms of lengths, ID and visible materials
- Allow water to sit motionless for 30 minutes to overnight
- Take successive samples of variable volumes, as desired
- Can somewhat differentiate faucet, valve, tubing, inside-wall plumbing by different sample volumes
- Can help determine if /where LSL is present

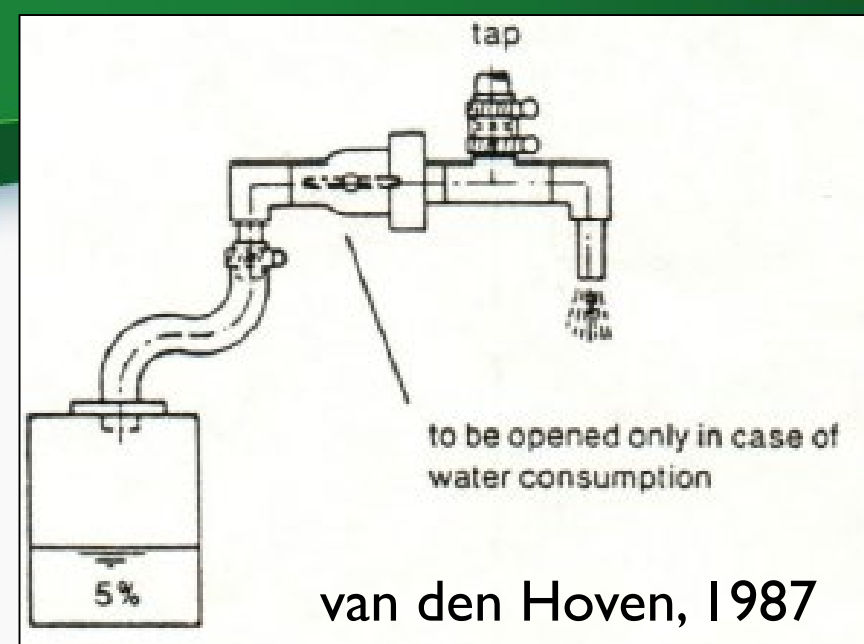


OBJECTIVE & QUESTION(S) ANSWERED	SAMPLE TYPE	SAMPLE PROTOCOL SUMMARY
Exposure Assessment • What is the public's exposure to Pb in water in this town, neighborhood, or home?	Composite proportional (automatic or manual)	<ul style="list-style-type: none"> - Device splits fixed proportion (e.g., 5%) of water from every draw intended for consumption - Can also be done manually - Collect cumulative water sample (typically no more than 3 L) over extended period of time (e.g., 1 week)
	Environmental assessment in home of child with elevated blood lead, US	<ul style="list-style-type: none"> - "Ad hoc", if water is tested at all - At the discretion of health department, since relevant guidance does not exist

3. Exposure assessment

Side Stream (Proportional) Composite Sampler

- Exposure reference method
- Device affixed to tap & consumer-operated
- Proportion of every draw meant for consumption routed into holding tank
- Collects lead under normal use conditions
- Capturing a range of flow rates, stagnation times, flow durations, and temperatures
- After one week the composite sample analyzed for lead to obtain the average lead concentration



Deshommes et al, 2017

3. Exposure Assessment

- Environmental assessments of lead-exposed children by Health Departments:
- “Ad hoc” sampling protocol
- At the discretion of Health Department, since guidance does not exist
- Can single-sample protocols capture variability in exposure?




Summary

- Lead in water can be highly variable (spatially and temporally)
- Different sampling protocols may yield different lead concentrations and sample different sources/forms of lead
- The efficacy of a given protocol in capturing water lead risks varies from building to building due to plumbing differences and other site variabilities
- Choosing the appropriate protocol for the sampling intent is crucial to producing meaningful data
- Understanding differences in sampling protocols is important when attempting to compare lead results from different studies



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