Water Quality Sampling for Lead Service Line Identification

VDH ODW Guidance

May 2023

Water Quality Sampling - Sampling protocol, protocol for addressing premise plumbing and service line volume, sample volume, analytical methods, laboratory certification, data analysis protocol, service line material classification criteria, criteria for triggering water quality sampling.

BACKGROUND INFORMATION

Diagnostic water sampling provides a picture of potential lead release in a service line and premise plumbing. Sampling protocols include a **defined stagnation time and defined volumes**. It is based on the principle that water samples of a particular volume represent the distance that water travels through the premise plumbing system. It is important to **collect samples of varying volumes, while accurately mapping the volumes, to properly identify the potential sources of lead within a system.** The accuracy of the identification method may vary, and it is the waterworks' responsibility to understand, manage and mitigate the factors that impact the accuracy of the method employed.

The Virginia Department of Health, Office of Drinking Water will approve the following identification protocols on a case-by-case basis. Proposals could include, but are not limited to:

1. **Sequential sampling –** Consists of the collection of a series of consecutive samples (typically two 125 mL samples followed by a series of 1000 mL samples) from the tap following flushing and a standardized stagnation period (> 6 hours). Water volumes correlate to pipe and plumbing component lengths provided associated diameters are known. See Figure 1. The number of sequential samples needed depends upon the length and inside diameter of piping. See Figure 2. Sequential sampling is relatively invasive to the resident, and complex to accomplish, but may be most informative when used to identify lead plumbing sources. See Appendix A for an example procedure.
2. **Flush Sampling –** Consists of the collection of a few samples without a stagnation requirement. Typically, the sample tap is fully opened for the collection of flushed samples. After flushing for 5 minutes, a 1L sample at a high flow (approximately 6L/minute) is taken. This represents a high flush sample. The flow rate is then reduced to a medium flow (4L/minute) and flushed for 5 minutes. Following the flushing, another 1L sample is collected and represents a medium flow sample. Lastly, the flow rate is reduced to a low flow (3L/minute) and flushed for an additional 5 minutes, after which a final 1L sample is collected. This represents a low flow sample. Flush samples are conducive to collection by either utility sampling personnel or residents of a home.

Submit samples to a certified laboratory under chain-of-custody for analysis. The Division of Consolidated Laboratory Services (DCLS) maintains an updated list of accredited and certified laboratories who can support these sampling efforts. All samples shall be field preserved by using 0.15% v/v nitric acid and analyzed using inductively coupled plasma mass spectrometry for total recoverable lead per EPA Method 200.8.

Protocols for sample collection have been published by others. For example, see *Utility guidelines on how to collect and analyze sequential profile samples,* in the references.

DATA ANALYSIS

An appropriate community threshold lead concentration must be established to reflect local conditions. Sampling results may be used as a method for identifying lead service lines, but low lead and sampling results with undetectable levels of lead do not ensure the absence of a lead service line. Locations with water samples above the community threshold lead concentration indicates the likely presence of a lead service line. Waterworks will need to determine a waterworks-specific threshold for the presence of a lead service line based on experience, including sampling from known lead service lines.

In developing the sampling program, the waterworks will need to consider that the laboratory detection limit makes a difference, since the lead level from an LSL in a flushed sample may be in the range of 1 to 2 ppb. Laboratory detection limits for lead in drinking water samples vary from laboratory to laboratory and are typically in the range of 0.5 ppb to 2 ppb.

If the results indicate an undetectable lead level, there is still a chance that the service line is lead, perhaps if corrosion control treatment is highly effective. Undetectable levels of lead could also be caused by unintended water use during the 6-hour stagnation period. If lead is not detected, a waterworks should consider the age of the home, history of renovations at the home, and information on other service lines in the area to weigh whether the service line might still be made of lead and if additional investigation is warranted.

The lead results from sequential samples may reveal a curve characteristic of a lead service line where lead levels are elevated in the water that has been sitting in the lead pipe. See Figure 3. If the lead results show a characteristic curve like the one in Figure 3 below, the service line should be assumed to be made of lead. If the results do not show a steady increasing and decreasing curve, persistent lead—even at low levels—should be interpreted as a potential lead service line and confirmed through physical inspection, such as by excavation. If the home has a partial lead service line, the lead levels may not increase as much as they would in a home with a full lead service line, and the elevated lead might be found in fewer sample bottles. An increase in lead of any magnitude indicates the potential for a lead service line.

ADDITIONAL ACTIONS

Submitted proposals shall also consider and include the following information in addition to the sampling protocol:

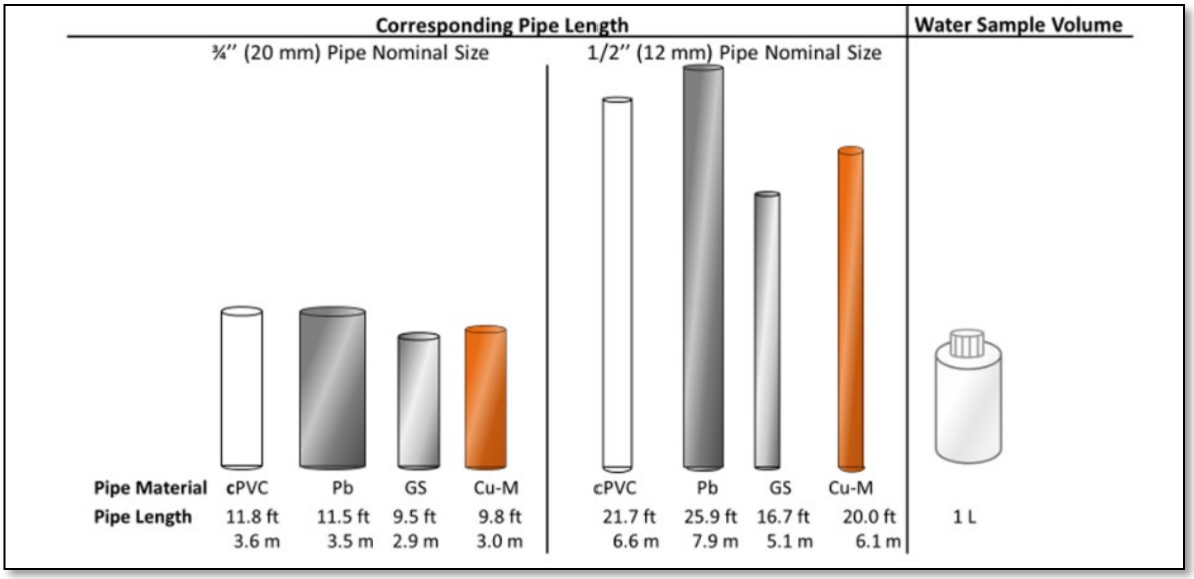
1. **Total plumbing volume** – Calculate from water main to tap. It is important to keep in mind that if the lead service lines are in the range of 0.63–0.75 inches in diameter (16–19 mm), the length of pipe per liter of sample would range from about 12-17 feet (3.5-5.1 m). Thus, it may be necessary to use sample volumes less than 1 liter to obtain enough resolution to accurately estimate the presence of a lead service line. For sequential sampling, waterworks may reduce the number of samples to analyze by estimating the premise plumbing volume and selecting at least the first draw sample plus two samples representing the water in the service line.

2. **Flow rate** – This is important for two reasons. First, if the interior pipe scales are physically stable and the lead release is radial diffusion controlled, lower lead concentrations would be generated by increasing flow rates because of the decreased contact time between the water and the scale. However, if the scale material has the tendency to release colloidal or particulate material during water flow, an inverse pattern of higher total lead with an increasing flow rate would be observed. Frequently, lead release is in the form of particles, which suggests a protocol with a high water flow rate.
3. **Corrosion Control Assessment** – Systems with corrosion control treatment must analyze water quality parameters for each testing site. A site that is on the same size water main in the same pressure zone and located within a half mile of the testing site may be used to determine water quality parameters. Water quality parameters include pH, alkalinity, free chlorine residual (when used), and orthophosphate (when used.) Systems should assess if the sampled water quality parameters are within expected ranges (where treatment is voluntary) or established treatment goals (where treatment is required).
4. **Seasonal Influence** – Lead results can change based on season. Collecting samples in winter months when water is colder and water quality is expected to be less corrosive may result in relatively lower lead levels.
5. **Water Usage** – Review water meter readings, vacancies, recent plumbing work, etc. These may help explain sampling results.

It is the responsibility of the waterworks owner to ensure that the proper number of samples are collected, submitted for analysis, analyzed, and reviewed for assigning the service line material. Additional monitoring, investigations and other actions may be necessary depending upon the sample results.

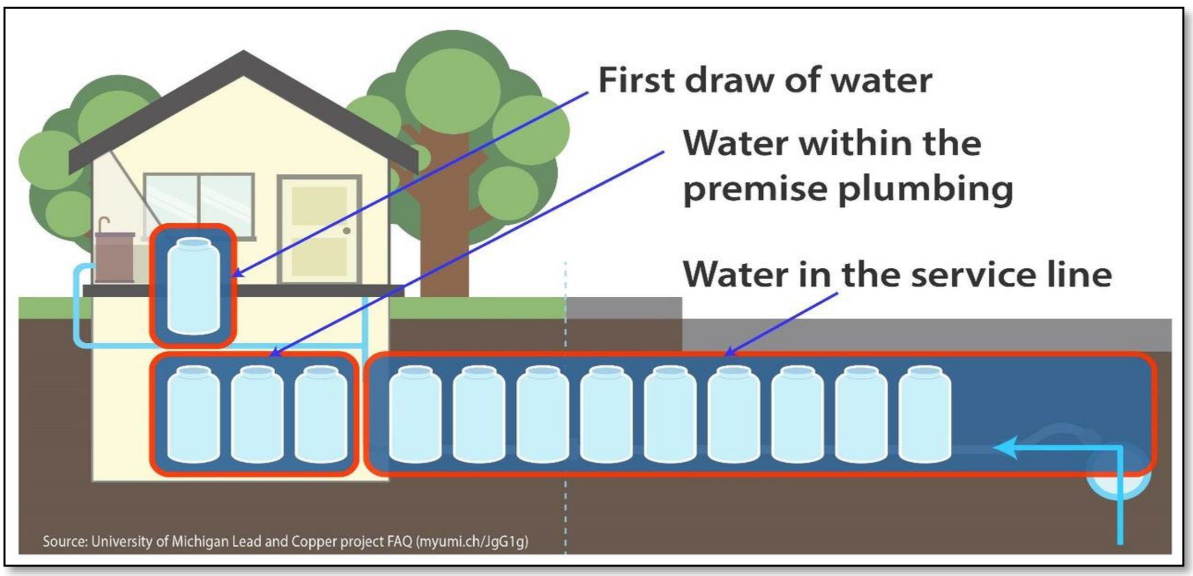
Please contact your regional ODW Field Office if you have any questions about this guidance. In addition, your regional ODW Field Office can connect you to an Environmental Protection Agency representative to assist you in developing a community-based lead threshold for your service area. Contact information for ODW Field Offices is available at: https://www.vdh.virginia.gov/drinking-water/contact-us/.

Figure 1.



Correspondence of one liter of water sample volume to pipe length, for typical pipe materials and nominal sizes. cPVC: Chlorinated Polyvinylchloride, Pb: lead, GS: Galvanized steel, Cu-M: Copper type M. Not to scale. Note: GS pipe may undergo severe corrosion (i.e., tuberculation) that can substantially decrease internal diameter.

Figure 2.

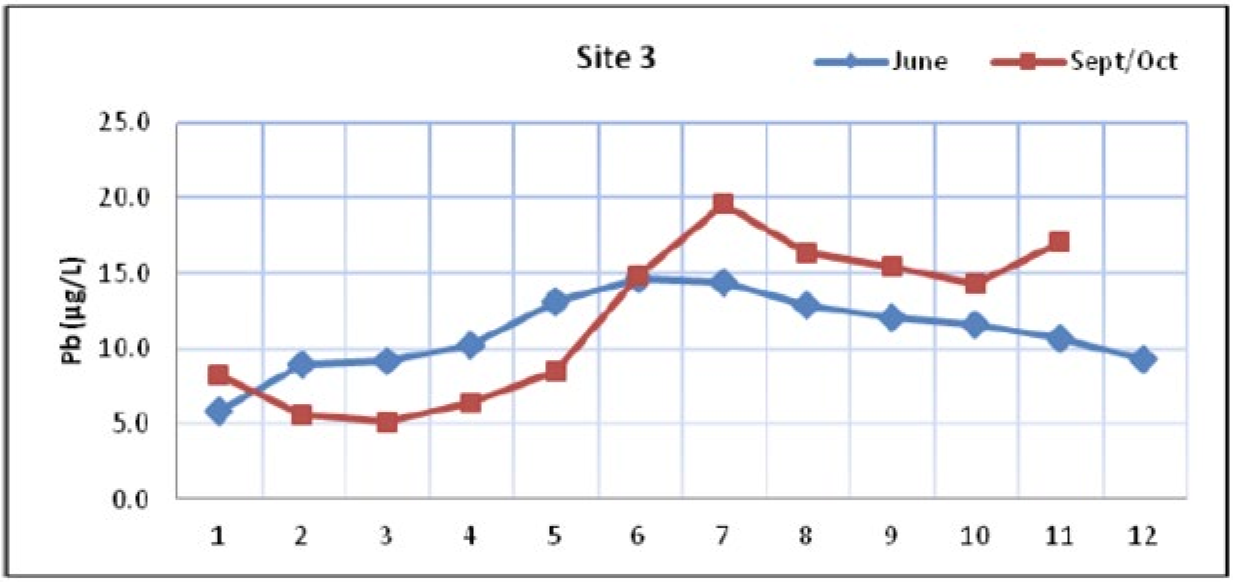


Where was the 5th Liter (L) in the plumbing?

- **20% of Houses – Inside House**
- **23% of Houses – Start of Service Line**
- **39% of Houses – Within Service Line**
- **12% of Houses – End of Service Line**
- **6% of Houses – Beyond Service Line**

The 5th Liter included some part of the service line 74% of the time

Figure 3.



Source: Del Toro, M.A., A. Porter and M. R. Schock (2013). "Detection and evaluation of elevated lead release from service lines: A field study." Environmental Science and Technology 47(16): 9300

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