MEMORANDUM

Legislative Reference Bureau

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To: Ald. James A. Bohl, Jr.

From: Tea Norfolk, Legislative Fiscal Analyst – Lead

Date: October 7, 2016

Subject: The Effect of Water Additives in the Leaching of Lead Service Lines and Interior Plumbing Sources of Lead

This memo is in response to your request to provide information regarding the effect of water additives in the leaching of lead service lines and interior lead plumbing fixtures.

Chlorine and Chloramine

According to a 2011 study by J. Hu, et. al., "Copper-Induced Metal Release from Lead Pipe into Drinking Water," published in Corrosion Engineering: The Journal of Science and Engineering, the addition of chlorine or chloramine affects the rate of lead oxidation and the corrosive and galvanic effects of water on lead pipes. In general, chloramine has been shown to produce greater galvanic corrosion effects on lead pipes than chlorine.

The corrosive effects of chlorine and chloramine are dependent on the type of pipe used. In one experiment involving new lead pipe, free chlorine caused more lead leaching into water than chloramine regardless of the presence of copper. The study was not conducted, however, on old lead pipes, and further research is required to examine old lead pipes with decades of accumulated rust.

Chloraminated water, however, appeared to have more corrosive effects on copper than chlorinated water. In chloraminated water, the presence of copper ions doubled lead leaching from lead pipes into the water. By comparison, chlorinated water required higher copper levels to increase lead leaching. Chloramine caused either the same or more lead leaching into water versus free chlorine when the water was stagnant.

The presence of either chlorine or chloramine increased the galvanic effects of water that had traveled through copper pipe on lead pipe. Water that had neither chlorine nor chloramine had a decreased galvanic effect when subjected to the same conditions.

According to a 2016 study by Jonathan Cuppett for the Water Research Foundation, “Lead and Copper Corrosion: An Overview of WRF Research,” the corrosion rate of and release of lead from solder alloys was higher in water with a high chloride-to-sulfate mass ratio. Lead solder and lead pipe galvanically connected to copper were the primary concern with respect to a high chloride-to-sulfate mass ratio. Both chlorine and chloramines accelerated the corrosion of copper and its alloys at pH6 but caused minimal corrosion at ph 8. Additionally, although free chlorine was slightly more corrosive than chloramines, systems that disinfected with combined chlorine and chloramine experienced higher rates of corrosion.

In a study conducted by the Midwest Technology Assistance Center (MTAC), the researcher concluded that chlorine was of little importance to the galvanic corrosion process in lead pipes. (Cantor, Abigail F., et. al. “The Effect of Chlorine on Corrosion in Drinking Water Systems”. November, 2000.) However, chlorine appeared to increase the corrosivity of water in copper pipes.

Phosphates and Other Additives

In the 2016 study by Cuppett, there does not appear to be a significant difference in performance between zinc orthophosphate and non-zinc orthophosphate for general corrosion of lead and copper. Copper corrosion is almost exclusively chemical, whereas lead release is governed by a combination of chemical, temperature, hydraulic, and other mechanical factors.

Secondary effects of corrosion control additives could lead to decreased performance, such as inoperable valves, pumps, and meters, and significant loss of capacity in water pipes. The most effective way to reduce total mass of lead measured at the tap was to replace the entire lead service line, lead sources in the premise plumbing, the faucet, and the meter. The study showed that elevated lead levels may occur immediately after lead source replacement and may persist for longer periods, depending on the materials and water quality at each site, and the amount of disturbance during replacement.

According to a 2010 study for the Water Research Foundation, “Contribution of Galvanic Corrosion to Lead in Water After Partial Lead Service Line Replacements” by Simoni Triantafyllidou and Marc Edwards, sulfate inhibited corrosion of lead-bearing materials. As the relative concentration of chloride to sulfate increased, so did lead concentration.

In the 2000 MTAC study by Cantor, phosphate further increased the corrosivity by the end of a year of operation. Several researchers oppose adding phosphorus to the water system, as it stimulates microbial counts, which can increase corrosion in a water system.

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