MEMORANDUM

LEGISLATIVE REFERENCE BUREAU

WWW.MILWAUKEE.GOV/LRB

To: Ald. James A. Bohl, Jr.

From: Tea Norfolk, Legislative Fiscal Analyst – Lead

Date: October 7, 2016

Subject: Galvanic Effects on the Leaching of Lead in Pipes

This memo is in response to your request to provide information regarding the galvanic effects on the leaching of lead in pipes.

Galvanic corrosion is an electrochemical process in which the presence of one metal increases the corrosion of another metal when both metals are in electrical contact in the presence of an electrolyte. Water chemistry is a controlling factor in increasing galvanic corrosion and water lead contamination. This memo reviews studies of galvanic corrosion of lead pipes when copper pipes are attached to them.

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, when lead pipe and copper pipe are electrochemically connected for drinking water distribution, galvanic lead corrosion is expected to occur. The presence of copper ions in continuously recirculating water increases the release of lead into water by orders of magnitude. Aside from "normal" lead corrosion, which occurs when lead pipe alone contacts drinking water, plumbing systems having a copper-to-lead pipe connection can introduce additional corrosion, which can exacerbate water lead contamination. Studies have shown abnormally erratic lead concentrations when lead pipe is connected to copper pipe. Because of the electrochemical connection, the corrosion rate of lead pipe can be markedly accelerated relative to that of a pure lead pipe.

When a copper pipe is placed upstream of a lead pipe, dissolved copper ions can collect onto the lead pipe surface and create multiple micro-galvanic cells between lead and plated copper. Each site of copper deposition can act as an individual galvanic cell, increasing the concentration of lead in the water. When lead pipe is placed upstream of copper pipe in the plumbing sequence, the risk of galvanic corrosion is decreased. In a common scenario where a partial lead pipe replacement is connected to a home with copper plumbing, there are two galvanic connections, which may maximize the potential

for lead deposition corrosion. Depending on plumbing materials in the home, partial lead service line replacement with copper has the potential to introduce or enhance galvanic corrosion.

In addition to the type of pipes used, other factors can affect the rate of lead oxidation, including the addition of chlorine or chloramine and the type of joint used to connect pipes together. Chloramine has been shown to produce greater galvanic corrosion effects than chlorine.

A 2010 study published by the Water Research Foundation, “Contribution of Galvanic Corrosion to Lead in Water After Partial Lead Service Line Replacements,” found similar results: connecting copper pipe to lead pipe creates an electrochemical or galvanic cell, which can accelerate corrosion of the lead pipe via galvanic connection to copper. Under stagnant water conditions, galvanic connections between lead pipe (either old or new) and copper pipe increased lead release into the water, compared to a full-length lead pipe alone. Additionally, the quality of water in the pipes (water chemistry, temperature, etc.) affects the extent of galvanic corrosion. In turn, the galvanic process affects the quality of drinking water output. Partial lead service line replacements have been known to increase the concentration of lead in drinking water. Short-term lead increase can occur from disturbing the lead rust that has accumulated on the pipe over decades of use and/or from creating metallic lead particles when the pipe is cut. Longer-term problems arise from creating a new electrochemical or galvanic cell between the old lead pipe and newly installed copper pipe. A rise in lead levels has been reported as lasting anywhere from four to eighteen months after a partial pipe replacement.

A partial lead service line replacement was linked to adverse health effects in Washington, D.C., and a 2010 announcement by the Centers of Disease Control and Prevention (CDC) warned that partial lead service line replacements may have increased the incidence of elevated blood lead levels in children.

A 2013 study by Brandi Clark, et. al., “Effect of connection type on galvanic corrosion between lead and copper pipes,” published in the Journal – American Water Works Association supported findings in the studies cited above. The study focuses on pipe connectors that can significantly influence galvanic corrosion by distancing the lead from the copper pipe.

LRB 166666