IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF NEW JERSEY

NEWARK EDUCATION WORKERS CAUCUS et al., Plaintiffs, v. CITY OF NEWARK et al., Defendants.	Case No. 2:18-cv-11025 **Judge Esther Salas** **Magistrate Judge Cathy L. Waldor**

Second Declaration of Daniel E. Giammar, Ph.D., P.E.

I, Daniel E. Giammar, do hereby affirm and state:

Introduction

1. I am an environmental engineer. My expertise, educational background, certification as a Professional Engineer, employment, and consulting experience are described in the Declaration of Daniel E. Giammar, Ph.D., P.E. dated August 23, 2018.

2. I submit this Supplemental Declaration to provide information regarding the optimization of corrosion control treatment, the relationship between lead concentrations in first-draw samples and lead concentrations in other parcels of water, the response of lead concentrations to flushing and stagnation periods, and the distinctions between an action level and health-based guidelines for lead in drinking water.

3. All of the information set forth in this Supplemental Declaration is based upon my education, personal knowledge, and experience, as well as my personal review of the documents cited in this Declaration.

Optimization of Corrosion Control Treatment

4. Newark's water system has exceeded the U.S. Environmental Protection Agency's lead action level of 15 parts per billion for the last three completed six-month monitoring periods.

5. According to the New Jersey Drinking Water Watch website, the 90th percentile lead concentrations during those three reporting periods are 27, 26.7, and 17.8 parts per billion. For the current six-month period, available data already posted to the New Jersey Drinking Water Watch website have a 90th percentile lead concentration of 42.9 parts per billion (out of 44 total samples analyzed and posted as of October 4, 2018). These concentrations substantially exceed concentrations that would be expected for a system that has optimized lead corrosion control.

6. Estimates of achievable lead concentrations in drinking water can be made based on the predicted solubility of the lead-containing solids present as scales on the inner surfaces of lead pipes. Lead solubility is the dissolved lead concentration in water that would be reached after a particular lead-containing solid and the water had been in contact for sufficient time to reach equilibrium. This time to reach equilibrium will depend on the particular lead-containing solid and the water chemistry, but it is usually closely approached within 8 hours. The lead-containing solids with which the water is in direct contact are usually lead carbonates, lead oxides, or lead phosphates. These lead-containing solids are corrosion products from the reaction of the underlying lead pipe with the water, and they form a scale on the inside of the lead pipe. There are two predominantly used water chemistry approaches to

minimize the lead solubility of the corrosion products present in the pipe scale (thereby minimizing the amount of lead that enters the water that flows through pipes). One is adjustment of the pH and alkalinity to values that result in conditions of low solubility of lead carbonate solids. Another is addition of orthophosphate as a corrosion inhibitor to provide conditions for the low solubility of lead phosphate solids.[1] Both of these approaches can be used to create conditions with low lead solubility, and addition of orthophosphate can achieve less than 15 parts per billion through formation of low solubility lead phosphate solids. Addition of sodium silicates is also a recognized approach for corrosion control, but the mechanisms for its effectiveness and the conditions at which it is most effective are not fully understood.

7. Other large water systems in the region with similar source waters and treatment plants have been able to implement lead corrosion control that results in 90th percentile lead concentrations below the 15 parts per billion.

8. Optimization of corrosion control treatment usually progresses through several stages. The first is often a desktop analysis in which different alternatives are assessed for their feasibility on the basis of existing scientific knowledge and experience with related systems. This is usually followed by a

[1] M.R. Schock & D.A. Lytle, *Internal Corrosion and Deposition Control*, in Water Quality and Treatment: A Handbook of Drinking Water (J.K. Edzwald ed., 2011).

bench-scale study in which different treatment options are evaluated using actual water and materials from the systems in batch reactors to screen their effectiveness. Based on those results, the next stage is usually a pilot-scale pipe loop study in which multiple treatment options are evaluated with the actual pipe materials and water chemistry from the system and with relevant conditions of flow and stagnation periods. Pipe loop testing is most effective when it combines measurements of multiple water chemistry aspects of the water with analysis of the scales of corrosion products on the inner surfaces of the lead pipes.

9. Optimization of corrosion control involves identifying the conditions that can result in the minimum lead concentration that can be achieved while also achieving other water quality objectives. Identification of the minimum should be based on evaluation of multiple conditions. The greater the number of conditions examined, the greater the probability of identifying a true minimum. If only three options are evaluated, then testing can only identify which of those three options results in the lowest lead concentration, but it has not established that those concentrations are the lowest that could be achieved.

10. Once a promising control strategy has been identified, it can be optimized through fine tuning of the particular conditions (e.g., pH, alkalinity,

dose of corrosion control inhibitor) until the lowest level of lead in drinking water that can be achieved—known as optimal corrosion control—is achieved. Pipe loop testing can be an effective means of performing such optimization.

11. Further assessment of the effectiveness of corrosion control treatment can be assessed at full-scale on the basis of lead monitoring results. These lead monitoring results can include the first-draw samples collected to satisfy the requirements of the Lead and Copper Rule. Sequential sampling (also called profile sampling) is an even more effective way to monitor the control of lead concentrations in the water that is in direct contact with a lead service line (see below). A system that does not have low and stable lead concentrations has not optimized corrosion control treatment. My understanding of the lead concentrations recently observed in Newark are consistent with the New Jersey Department of Environmental Protection's finding that Newark "is deemed to no longer have optimized corrosion control treatment."[2] It is also not clear that the Newark water system ever had optimized corrosion control treatment with respect to having truly identified a treatment approach that minimized lead concentrations while simultaneously achieving other water quality objectives. *See infra* ¶ 13.

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[2] Letter from Felicia Fieo, Section Chief, Bureau of Safe Drinking Water, N.J. Dep't Envtl. Prot. (July 11, 2017) (attached as Exhibit A).

12. In sequential sampling, a series of samples are collected with the tap running after some prescribed period of stagnation. In this manner each consecutive volume of water collected in the profile has lead concentrations that are representative of those in that particular volume of water as it had stagnated in the lead service line or premise plumbing. The highest lead concentrations observed are often not in the first-draw sample, but instead they are in the volumes of water that had been stagnant within the lead service line.[3] A full profile of samples determines the lead concentrations from the first draw all the way until water is being drawn in from the main. For the water samples collected after the longest periods of time, which represent water drawn from the main, the lead concentrations are often still above the detection limit. This is because the water can pick up lead in the time that it takes to move from the water main through the lead service line and into the premise plumbing.

13. The corrosion optimization study report for the City of Newark's Water System completed in June 1994 describes the approach and results for evaluating different approaches for achieving corrosion control.[4] There are

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[3] B. Clark et al., *Profile Sampling to Characterize Particulate Lead Risks in Potable Water*, 48 Envtl. Sci. & Tech. 12, 6836-43 (2014) (attached as Exhibit B); A. Sandvig et al., Awwa Res. Found., *Contribution of Service Line and Plumbing Fixtures to Lead and Copper Rule Compliance Issues* (2008) (attached as Exhibit C).

[4] City of Newark, Div. of Water/Sewer Util., *Report on Corrosion Optimization Study* (1994) (attached as Exhibit D).

several deficiencies with the approach that was used. First, the study used new lead pipes instead of harvested lead pipes. Harvested lead pipes have established scales of corrosion products that are relevant to the actual lead service lines in the system. Development of relevant scales of corrosion products can take years, and the study operated them with the baseline water composition for only six weeks. Second, the study did not provide sufficient time for initial conditioning of the pipes or sufficient time for evaluation of the treatment approaches. Some conditions were only evaluated for three months, and ideally conditions would be examined over the course of a full year. Third, only single pipe loops were evaluated for each condition. Because of the variability of the behavior of lead pipes, studying each condition with multiple samples (duplicates, triplicates, or even quadruplicates) increases the chance of discerning a statistically significant result. Fourth, the addition of sodium silicates increased both pH and the concentration of dissolved silica. With both of these variables changing, it was not possible to discern which was responsible for the observed changes in the lead concentration. Fifth, the study did not include any analysis of the pipe scales. This would have been useful at the onset of testing the treatment conditions to determine if the pipe scales were representative of those in the water system. Determination of the properties of the scales of lead service lines from the system could have been done on harvested lead pipes. Sixth, the study only evaluated the baseline condition and three treatment options. For the treatment options examined, no further optimization was performed after identifying one of those conditions (silicate addition) as the recommended approach. Further optimization could have examined the effect of a particular dose and the dependence of its effectiveness on pH.

Relationship of First-Draw Samples to Lead Exposure

14. While first-draw samples are not a direct assessment of the concentrations in water to which a customer would be exposed, the trends in first-draw concentrations and levels of exposure are correlated. If first-draw concentrations increase, then the lead concentrations of water in the lead service line during stagnation will also have increased. These increases will result in increased exposure to lead from drinking water if the water is consumed without adequate flushing of the lead service line before use for drinking or cooking. When drinking from their taps, residents can be exposed to lead concentrations significantly greater than those observed in first-draw samples. As noted above, *supra* ¶ 12, the highest lead concentrations are often not observed in the first-draw sample, but rather they are observed in the water that had been stagnating in the lead service line.

Impact of Flushing on Lead Concentrations

15. The goal of reducing lead concentrations by flushing the water is to draw water in from the main that will not have high lead concentrations because it had not been in contact with a lead service line or lead-containing components of premise plumbing for any period of stagnation time.

16. Whether or not flushing draws water in from the main depends on the flushing time as well as on the flow rate of flushing and the volume of water within the premise plumbing and lead service line that is between the tap being used and the water main.

17. Flushing may not be an effective means of reducing lead exposure. In order for flushing to be an effective method for reducing exposure, residents have to have knowledge of the requirement to flush, how long to flush, and the frequency with which they must flush. Newark has provided conflicting information to customers regarding the recommended time for flushing. The Newark Lead Sampling Plan document has text that recommends a 15-30 second flush.[5] The 2017 Water Quality Report recommends a flushing time of 30 seconds to 2 minutes.[6]

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[5] City of Newark, Dep't Water & Sewer Utils., *Lead and Copper Sampling Plan* 12 (2017) (attached as Exhibit E).

[6] City of Newark, Dep't Water & Sewer Utils., *2017 Water Quality Report* 2 (2018) (attached as Exhibit F).

18. Additionally, a water system cannot provide an accurate estimate for the necessary flushing time to avoid lead exposure without studying its individual characteristics, which Newark has not claimed to have done. Inadequate flushing times can actually result in a higher lead concentration of lead in the water at the tap. The following example illustrates this situation. If the highest lead concentrations in a profile of water samples is in the 4th through the 7th liters collected (a reasonable value based on profiles of lead service lines), and the flushing flow rate is 1 gallon per minute (3.8 liters per minute), which is a reasonable flow rate for use of a kitchen tap, then after one minute of flushing the water collected would represent the 5th liter in the profile. This fifth liter would have among the highest lead concentrations to which a customer could be exposed. In the study of Sandvig et al 2008[7] (Appendix F of the report) multiple lead concentration profiles show peak concentrations in lead that persisted for four liters (one gallon) or more at values that were greater than first-draw samples. These peak concentrations were often between the 4th and 8th liter.

19. Additionally, for flushing to be effective in reducing lead exposure, residents must flush their taps each time they use water. This is because the frequency of flushing needed to maintain low lead concentrations in water

[7] *Supra* note 3.

used at the tap is unknown. After a flushing event, the lead concentrations in the water within a lead service line begin increasing again as the water is stagnant. In the collection of sequential samples from a utility that collected samples after 30 minutes of stagnation and after 6 hours of stagnation, the median peak lead concentration after just 30 minutes was already more than half the median peak concentration achieved after 8 hours. The study also observed a strong correlation between the average lead concentrations from a sequence of samples collected from sequential sampling and those in a first-draw sample collected after a 5 minute flush and then 30 minutes of stagnation. For three utilities, the average concentration from the sequential sampling was 48% to 78% higher than in the first draw samples.[8] Thus, significant amounts of lead can accumulate in stagnant drinking water that runs to the tap even if a resident has recently flushed within the last 30 minutes.

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[8] E. Deshommes et al., *Lead Levels at the Tap and Consumer Exposure from Legacy and Recent Lead Service Line Replacements in Six Utilities*, 52 Envtl. Sci. & Tech. 16, 9451-9 (2018) (attached as Exhibit G).

I declare under penalty of perjury that the foregoing is true and correct.

October 12, 2018

Daniel E. Giammar, Ph.D., P.E.

Date