Milwaukee
Water Works

2015 MWW Water Main Replacement Program
Lead Service Line Monitoring Pilot

Summary

The Milwaukee Water Works (MWW) replaced 15.2 miles of water main in 2015. This was the first year of the six-year plan directed by the Public Service Commission of Wisconsin for MWW to increase the miles of water main being replaced each year up to 20 miles (100 year replacement cycle) by 2020. In early 2015, MWW began a lead service line monitoring pilot to gather data on the impact of water main replacement construction projects on lead levels at the taps of customers with lead services.

MWW had three major goals associated with this pilot:

- Measure lead concentration in a series of samples collected from the kitchen tap of single family residences with lead services that are involved in water main construction projects.
- Measure lead concentration at the same property approximately 24 hours after the original lead service had been left in place and connected to the new water main.
- Measure lead concentration at the same properties four to six weeks after the water main replacement.

The construction process that was used in these water main replacement projects was to connect the original service to the new water main. The lead service was cut in proximity to the original water main and a section of copper pipe was added to the lead service so that it would reach to the new water main. Then, the copper pipe extension was connected to the new water main. With this construction process, the property receives water from the new water main through the original lead service after the water main replacement. Residents were instructed on how to perform a "whole house flushing procedure" after the house was connected to the new water main.

Three sets of samples were collected from each participating residence: one to represent "baseline" conditions typical of the MWW distribution system (before the water main construction work began), a second set the day after water service had been connected to the new water main, and an additional set of samples three to six weeks later. After the water service had been connected to the new water main, the customer was instructed how to remove aerators and screens and thoroughly flush the internal plumbing of the house.

In all cases, a series of 12 consecutive 1-liter samples were collected from the kitchen tap used for drinking after the water had remained motionless in the piping for at least six hours. 12L of water represents water that was contained in 198 feet of 5/8" pipe and 138 feet of ¾" pipe. Therefore, the 12 liters would collect water that was present in the tap, premise plumbing, the lead service, and out into the water main serving the property. (The sample collection requirement for the Lead and Copper Rule is to collect only the "first draw" sample-- the first 1-liter of water that comes out of the tap after water has rested undisturbed in the pipes for at least six hours.) A 13th 1-liter sample was collected after the

water was allowed to run for at least two minutes, to represent a well-flushed sample. At some residences, this well-flushed sample was collected the day before the 12 consecutive samples were collected, and at some residences it was collected after the 12 consecutive samples. Both filtered and unfiltered aliquots of all 12 sequential samples were analyzed for lead. The unfiltered aliquot represented "total" lead, and the filtered aliquot represented "dissolved" lead. The difference between the total and dissolved lead represents "particulate" lead. Unfiltered aliquots were also analyzed for iron, aluminum and zinc. An unfiltered aliquot of the first 1L sample in some sample sets was analyzed for cadmium. This report addresses the results of the analyses for total lead.

The pilot also included MWW collaboration with the Milwaukee Health Department to ensure appropriate risk messaging was received by residents including transmitting sample analysis results. Residents who participated in the pilot received the results after each round of sample collection, with messaging on lead risk reduction tailored to sample results and presence of vulnerable populations (pregnant women, young children) in the household, as well as a materials on how to reduce exposure to lead in water, filters certified to remove lead from water, and nearby commercial laboratories that analyze for lead in water. Participants were notified in writing of all test results, with a special effort to promptly contact by phone residents in homes with elevated lead results.

Project Participation

MWW completed 15.2 miles of water main replacements in 2015. Of the 1,386 properties impacted by these replacements, 62 were single-family homes with lead service lines (LSLs). Letters were sent to 21 single-family properties inviting participation in the project. Even after personal after-hours home visits by MWW and MHD staff to request volunteers, and with incentives being offered, participation was low. A 38 percent volunteer rate of eligible homes was achieved, with eight residences participating in the pilot. Of those eight homes, six fully participated in all three rounds of sample collection. (Upon excavation, two homes were found to have already been connected to the alternate water main, so sample collection was discontinued.) Results from six homes are described in this report.

Results

In the baseline samples, one of the six residences had no detectable lead (<2 μg/L) in any of the 12 sequential samples. Five residences had detectable lead in some or all of the 12 sequential samples, including two with detectable lead in all 12 sequential samples. After construction, all residences had detectable lead in at least five of the 12 sequential samples. Results were mixed in the samples collected approximately four weeks after construction, with some residences having more and some fewer sample containing detectable lead. These results are shown in Table 1.

Table 1. Number of the 12 sequential samples that contained detectable (≥ 2 μg/L) lead

	Baseline samples	After construction	Weeks after construction
Street A, House 1	5	12	4
Street A, House 2	0	5	6
Street A, House 3*	4	8	9
Street B, House 1	1	7	9
Street B, House 2	12	11	1
Street C, House 1	12	12	11

The maximum concentration of lead in each of the sets of 12 sequential samples is shown in Table 2. Maximum lead levels in the baseline samples ranged from below detection to 30.1 μg/L. After construction, maximum lead levels ranged from 7.6 μg/L to 199 μg/L. Approximately four weeks after construction, maximum lead levels ranged from 3.2 μg/L to 33.7 μg/L.

Table 2. Maximum lead concentration in the 12 sequential samples

	Baseline samples max Pb (μg/L)	After construction max Pb (μg/L)	Weeks after construction max Pb (μg/L)
Street A, House 1	8.1	199	10.4
Street A, House 2	<2	12.1	4.6
Street A, House 3*	6.5	7.6	5.2
Street B, House 1	2.6	32.2	3.2
Street B, House 2	7.3	62.9	4.6
Street C, House 1	30.1	59.2	33.7

Lead levels in the well-flushed samples are compared in Table 3. Lead was not detected in 10 of the 18 well-flushed samples, was detected at very low levels in 7 samples, and was measured at 328 μg/L in one sample. The residence with the 328 μg/L was resampled two days later, and then after construction and four weeks later; none of the subsequent well-flushed samples contained detectable lead.

Table 3. Lead levels in well-flushed samples

	Baseline samples (μg/L)	After construction (μg/L)	Weeks after construction (μg/L)
Street A, House 1	<2	6	<2
Street A, House 2	<2	<2	<2
Street A, House 3*	First sample: 328 Resample: <2	<2	<2
Street B, House 1	<2	<2	2
Street B, House 2	3	6	<2
Street C, House 1	4	2	3

Summary

Some or all of the 12 consecutive 1-liter "baseline" water samples collected from five of six residences with building plumbing with lead services, after resting undisturbed at least six hours, contained detectable lead; samples from one residence did not contain detectable lead in the baseline samples. The highest measured level of 328 μg/L of lead occurred in a well-flushed sample ~~before any construction work had started~~* partway through the active construction phase of the project. With the exception of this sample, the well-flushed samples had no detectable lead or very low levels of lead. After the lead services were connected to the new water main, the number of the 12 consecutive samples containing detectable lead were more numerous and/or the levels of lead in the 12 consecutive samples were higher for all six residences. Three to six weeks after construction, the levels had decreased back to the "baseline" levels that were seen before construction.

*Note added 1/29/16: Upon further investigation, it was found that "baseline" samples from all three residences on Street A were, in fact, collected when the construction project was already underway. The street had been excavated and the new water main had been laid in the trench. (The service had not yet been connected to the new water main.) These samples therefore do not represent the truly undisturbed condition.

C. Lewis, January 29, 2016