Lead in Drinking Water

Preliminary Assessment

U.S. EPA Flint Task Force

12/22/2015

DRAFT

1.0 Overview

The United States Environmental Protection Agency (EPA) has offered, and the City of Flint has accepted, the assistance of EPA experts on corrosion and corrosion control. This preliminary assessment is intended to document the activities and funding necessary to enable EPA to provide advice and support to the City of Flint in optimizing and maintaining corrosion control treatment under current water quality conditions as well as during and after the upcoming transition to the Karegnondi Water Authority (KWA) pipeline.

[Note: There are many other communities scheduled to transition from their current water sources to the KWA pipeline. Although the source water will be the same for the City of Flint and all communities transitioning to the KWA pipeline source, the intended treatment planned for these communities may differ and the studies undertaken for the City of Flint may or may not be suitable for use by the other communities. It is strongly recommended that the EPA Task Force discuss with the Michigan Department of Environmental Management (MDEQ) the importance of actively working with these additional communities to ensure that proper studies on optimizing and maintaining OCCT are undertaken prior to putting the new KWA source in service for all affected communities. If such studies are not currently underway, they should be initiated as soon as possible.]

2.0 Information Request

In order to provide effective advice and assistance, the EPA Task Force should request the following information from the City of Flint.

2.1 Current inventory of homes with service line information in excel or similar format.

Pipe loops are corrosion control treatment assessment tools that enable evaluation of the effects of potential water quality changes and different levels of orthophosphate treatment on the existing pipe scales in order to select the most effective treatment before the treatment is applied on a city-wide basis. The pipe loops utilize lead service lines that are actively in service and carefully extracted so that the treatment assessment is conducted with pipes that represent conditions within the distribution system. As it would not be possible to perform service line extractions in the winter without significantly altering or dislodging the scales within the pipes, the identification and extraction of lead service lines should be given the highest priority to ensure that a sufficient number of lead pipes can be identified and extracted as soon as possible. In order to identify suitable homes with lead lines, the EPA Task Force will need current records on lead service line locations to be provided as soon as possible so that sampling can be coordinated and conducted to verify the presence of lead lines.

To minimize the need for excavation, homes with the longest lead service lines should be chosen so that multiple segments can be harvested from each lead line. The lead lines would typically be the longest where the water main is located across the street from the home and the home is set back on the property with respect to the street. An estimated 20 lead pipe segments should be carefully extracted and handled using ORD-specified procedures for use in constructing pipe loops at the treatment plant.

As the scales within the service lines have been subject to significant and iterative water quality changes in a relatively short period of time, it is also necessary to extract additional lead and non-lead portions of service lines to assess the current condition of the scales within the service lines.

2.2 All lead in water testing results for City of Flint, including those not used for Lead and Copper Rule compliance.

Studies have shown that homes served by lead service lines generally have much higher lead levels than homes without lead service lines. As it is anticipated that the City of Flint's service line records will be incomplete, the lead-in-water testing data is a supplemental tool that can be mapped to identify areas of the city that may have higher lead-in-water levels which would indicate the presence of lead service lines. This information will help the EPA Task Force in the identification and extraction of lead service lines for constructing the pipe loops and in identification of areas to test the progress of corrosion control.

2.3 Identification of areas in Flint with elevated blood lead levels.

Similar to the lead-in-water testing, identification of areas (e.g., zip codes, neighborhoods) where elevated blood lead levels are found can provide additional data which would indicate the presence of lead service lines for the identification of areas to test the progress of corrosion control.

2.4 Addresses of homes that have had water service interruptions or street disturbances (e.g., water main breaks, road/sidewalk construction, etc.) within the last year.

Streets where there have been potential physical disturbances and homes where the water service has been interrupted should be prioritized for evaluation for the presence of lead service lines as the disturbances can release very high lead and prolonged stagnation can affect the stability of the scales within the pipes.

2.5 Addresses of currently unoccupied homes.

Similar to homes where the water service has been interrupted, homes that are unoccupied should be prioritized for evaluation for the presence of lead service lines as these homes may pose a significant risk to incoming occupants if the home has a lead service line. Recently unoccupied homes also may provide important evaluation locations of water usage impacts on scale stability and lead release/exposure.

2.6 Identification of the pressure zones and location of each of the water quality parameter locations (addresses) within each pressure zone used for water quality parameter measurements (pH, alkalinity, orthophosphate, chlorine, total Coliform) in the distribution system, along with copies of the water quality parameter analytical results for past 4 rounds of monitoring.

In addition to corrosion control treatment optimization, the City of Flint must simultaneously comply with all other applicable National Primary Drinking Water Regulations (NPDWRs). A system-wide assessment of the water quality will provided information necessary to ensure that any potential issues with other NPDWRs can be identified and resolved. Information regarding the water quality in the distribution system is necessary to evaluate the stability of the water quality parameters throughout the distribution system, and to detect locations that may have the highest risk of lead release, TTHM formation, or the presence of microbial contamination.

3.0 Immediate Tasks and Timeline

The following tasks should be undertaken immediately (November/December 2015)

3.1 Determination on EPA funding commitment(s) (DRA).

3.2 Discussion with Central Regional Laboratory (CRL) regarding laboratory capabilities and support (GWDWB, ORD).

3.3 Development of EPA QAPPs encompassing the following activities (GWDWB, ORD, Others*):

- 3.3.1 Verification of presence of lead service lines*;
- 3.3.2 Pipe rig construction, operation, and maintenance;
- 3.3.3 Treatment assessment monitoring;
- 3.3.4 Evaluation of lead reservoirs within service lines; and
- 3.3.5 Evaluation of scale degradation due to stagnation events at unoccupied homes and water shut-offs*.

*If these activities are undertaken by one or more of the local partners, QAPP development should be part of the agreement.

3.4 Identification of local partners that can coordinate with the EPA Flint Task Force, MDEQ, and the City of Flint, and establishment of agreements to provide assistance on field and other activities (ORD).
[Potential local partners who have expressed strong interest and willingness to collaborate with EPA include Wayne State University, University of Michigan Flint, Michigan State University, Hurley Medical Center, and Genesee County Health Department.]

3.5 Outreach and education – specifics to be determined.
[Potential local partners Hurley and WSU have asked ORD directly if EPA can provide training/education for their staff on lead in water occurrence, sampling for lead, and corrosion/corrosion control treatment]

3.6 Assessment of information from 2.1 to verify the presence of a sufficient number of accessible homes with lead service lines that can be extracted for construction of pipe loops and to evaluate the current state and stability of the scales within the lead and non-lead portions of service lines (TBD).

3.7 Extraction of approximately twenty lead line segments with active water for construction of pipe loops, and six additional full service lines with different pipe material (two with lead and galvanized iron, two with lead and copper, and two with lead and plastic segments) for analyzing the lead reservoirs within the lead and non-lead segments of the service lines (TBD).

3.8 Risk evaluation and communication on the potential risk from physical disturbances to lead service lines, reoccupation of unoccupied homes and re-establishment of water service following water shut-offs (TBD).

4.0 Funding Needs (To Be Determined)

5.0 Optimization and Maintenance of Optimal Corrosion Control Treatment

The narrative below describes the scope of work to be undertaken in providing assistance to the City of Flint and is contingent on adequate funding being provided.

5.1 Lead Service Line Detection Methodology Development

Verification of the presence of lead service lines is necessary for identification and extraction of lead service lines, sampling for treatment assessment, Lead and Copper Rule compliance sampling, risk evaluation and implementation of a lead service line replacement program. Blood lead level (BLL) or other lead-related health evaluations also need to be able to identify all lead sources for blood-tested individuals to prioritize risk locations and mitigation strategies. This methodology development is designed to determine if a simple water sampling protocol can give a convenient means to verify with some level of confidence, whether or not a residence has a lead service line, through relatively non-intrusive water sampling. Experience with other utilities has shown that paper records may either under or overestimate the presence of lead service lines.

The strategy to be employed is based on published protocols with improvements being researched by Polytechnique Montreal (Michele Prevost, Elise Deshommes, Clement Cartier). This requires staffing for coordination with Flint paper records, resident contact, plumbing mapping, field sampling (TBD, but estimated at 20 locations with no LSLs for "control" purposes, and 50 locations believed to have LSL for validation. Development of this protocol could involve re-sampling to test techniques, and could utilize one or more Palintest electrochemical analyzers after validation vs. ICP-MS. EPA-ORD has one Palintest analyzer which can be used. Field personnel would work closely with R5 CRL to test the limits of analytical performance of the Palintest analyzer.

[Note: Verification of the locations of lead service lines for compliance sampling and for corrosion control treatment assessment is a best practice for all systems.]

5.2 Corrosion Control Treatment Optimization Evaluations

The corrosion control treatment optimization evaluations are necessarily separated into two stages. The first stage is intended to optimize corrosion control treatment with the current water source and water quality conditions. The second stage is designed to prepare for the transition to the new water source (KWA Pipeline) and water quality conditions, and to ensure that the City of Flint is able to simultaneously comply with all National Primary Drinking Water Regulations following the transition to the new source.

5.2.1 *Short-Term (Current) Lead Release Optimization Evaluation.* A lead pipe rig system will be constructed at the Flint water treatment plant with exhumed lead pipes, carefully collected and installed into the pipe rig (see example pipe rig schematic in appendix). EPA-ORD will provide technical assistance in the rig design and construction, as well as the design provisions for chemical additions. One to two people will be required to be on-site to perform periodic chemical analyses and operate and maintain the pipe rig system, as well as to troubleshoot/repair any problems and to collect samples. Laboratory

instruments for pH and colorimetric tests (chlorine residual, orthophosphate) will be needed on site. It is anticipated that the design will include a "control" loop and loops with possibly 3-4 different dosages, in duplicate. The estimated sampling frequency would be at least three times per week, using ICP for metals and ICP-MS for lead on each sample, with one complete characterization sample before each stagnation period. Filtration apparatus will also be needed.

5.2.2 *Simultaneous Compliance Optimization Pilot Testing Prior to Flint Water Plant Treatment of KWA Water.* This effort will necessarily be more expansive than the short-term evaluation. The same control pipes would carry over, but new pipes would need to be stabilized with the current water. Upstream of the lead pipe rig, there would need to be a series of jar tests or a small pilot plant established to optimize coagulation, softening (if necessary), filtration and disinfection processes to meet disinfection byproduct (DBP) limits and microbial inactivation requirements. Investigations are also needed to assess the potential impacts of different possible treated Lake Huron water qualities on chlorine, biofilm growth, water age, microbial pathogens such as Legionella, phosphate demand and scaling potential. Pilot evaluations could be done on different unit processes using anticipated Lake Huron water, using university-run pilot plants, shipped or trucked water, etc. Some pilot evaluation analyses could be done on-site with portable analytical instrumentation as is typical. When a final water quality target is determined, the target finished water would become the source water to feed into the lead (and metal) pipe rigs, and thereafter the optimization of phosphate dosing would be done on the stabilized exhumed lead pipes in the pipe rigs. A reservoir may need to be constructed to hold processed simulated Lake Huron treated water produced by the pilot plant and fed to the pipe rigs. This evaluation must be started as soon as possible to allow sufficient time for reliable results to avoid having to conduct full-scale testing on water delivered into the distribution system that could impact Flint consumers after the switch to the KWA pipeline is made.

[Note: Evaluation of Corrosion control treatment optimization using a pipe rig is a best practice for all systems changing sources/treatment.]

5.3 Lead Source/Release Diagnostic Evaluation

While the data collected from the pipe loops can provide information on the relative effectiveness of various treatment schemes, conditions at the plant are not the same as within the distribution system. Continued monitoring of lead levels at high risk sites throughout the distribution system is needed to make any necessary adjustments based on actual conditions within the distribution system. EPA estimates that approximately 45 homes will need to be identified for ongoing sampling to inform the treatment optimization process. (15 with lead & copper service line portions, 15 with lead & galvanized iron service lines and if available, 15 with lead and plastic service line portions). This evaluation is necessary for determining what the relative contributions of lead are from different plumbing sources in order to assure optimization of lead and other metal release from the service lines and premise plumbing. Two sampling rounds are the minimum expected for profile sampling which will utilize small volume samples through faucet and sink area and larger (one-liter) samples thereafter.

Sampling would involve 15 sites for each combination of plumbing materials (total of 45 sites), with an anticipated 10-15 sequential samples per site for metals per sampling event. Additional samples will be collected and analyzed to characterize the water quality and the sequential samples will be analyzed for Pb, Cu, Fe, Zn, and Al. An experienced plumber or researcher will be needed to map the plumbing at each site, field personnel will be needed to collect and ship samples, and a data manager will be needed to manage the data. If dissolved vs. total metals are desired in the analyses, an addition person with field filtration skills will be needed, in addition to the lab supplies. If meters, brass or galvanized pipe are found to be a significant source of lead, those devices should be included in the pipe rigs.

[Note: Monitoring of lead levels at high risk sites throughout the distribution system to make any necessary corrosion control treatment adjustments is a best practice for all systems changing sources/treatment.]

5.4 Pipe analyses for long-term treatment assessment and mechanisms of lead and other metals release

Optimization of corrosion control treatment requires specialized knowledge on scale chemistry as well as specialized equipment and equipment operating skills. The timeline for activities related to evaluating the progress in optimizing corrosion control treatment following the transition to the KWA pipeline source will extend beyond the current fiscal year and likely well into FY 2017. The necessary resources and expertise must continue to be made available to the Task Force for the expected duration of the project in order to ensure a successful outcome which would enable the City of Flint to simultaneously comply with all NPDWRs following the transition to the KWA pipeline.

[Note: Long-term evaluation of corrosion control treatment effectiveness is a best practice for all systems.]

6.0 Additional Recommendations and Needs

[Note: The additional recommendations in the Section 6.1 and 6.2 are advisable for all systems with lead service lines. The recommendation in Section 6.3 is specific to Flint.]

6.1 Impact of Water Use/House Occupancy on Stability and Lead Release from Lead and Other Premise Piping.

There are a large number of unoccupied homes in Flint. Homes which have been unoccupied for an extended period of time can pose a greater risk to incoming residents due to the stagnation of water within the plumbing over an extended period of time which can destabilize the scales within the plumbing and release high lead levels into the water. If access can be facilitated by the City of Flint or other organizations involved with housing, sampling will be conducted at 10-20 vacant or recently occupied homes in conjunction with a flushing program to assess how long it takes for increased water usage to improve the effectiveness of the corrosion control treatment for these homes. Sequential sampling profiles would be done for metals as well as chlorine residuals for each home. Flushing for different times would be tested and evaluated with

repeated profile sampling to see if there is any improvement in lowering lead levels with increased water use.

6.2 Protocol for Exposure Estimation Sampling for Health-Related Evaluations (Premise & Building Plumbing).

This protocol development would compare various potential options for sampling to estimate the cumulative metal exposure from the drinking water in premise plumbing or schools. Comparisons would be made with manual or automated proportional sampling, tap POU units that could log water use and be disassembled and digested for metal content, and random daytime sampling protocols. Different types of POU-suitable filtration apparatus would be tested to see if designs would permit quantitative separation of dissolved versus particulate lead and other metals. Support would be needed for setting up and operating test systems, analyzing virgin and exposed filter/device materials with accumulated metals, building and installation of proportional samplers or development of protocol for resident-collected samples, rapid turn-around Lead and other water analyses of test exposure water fed into experimental systems.

6.3 Risk communication on lead service lines

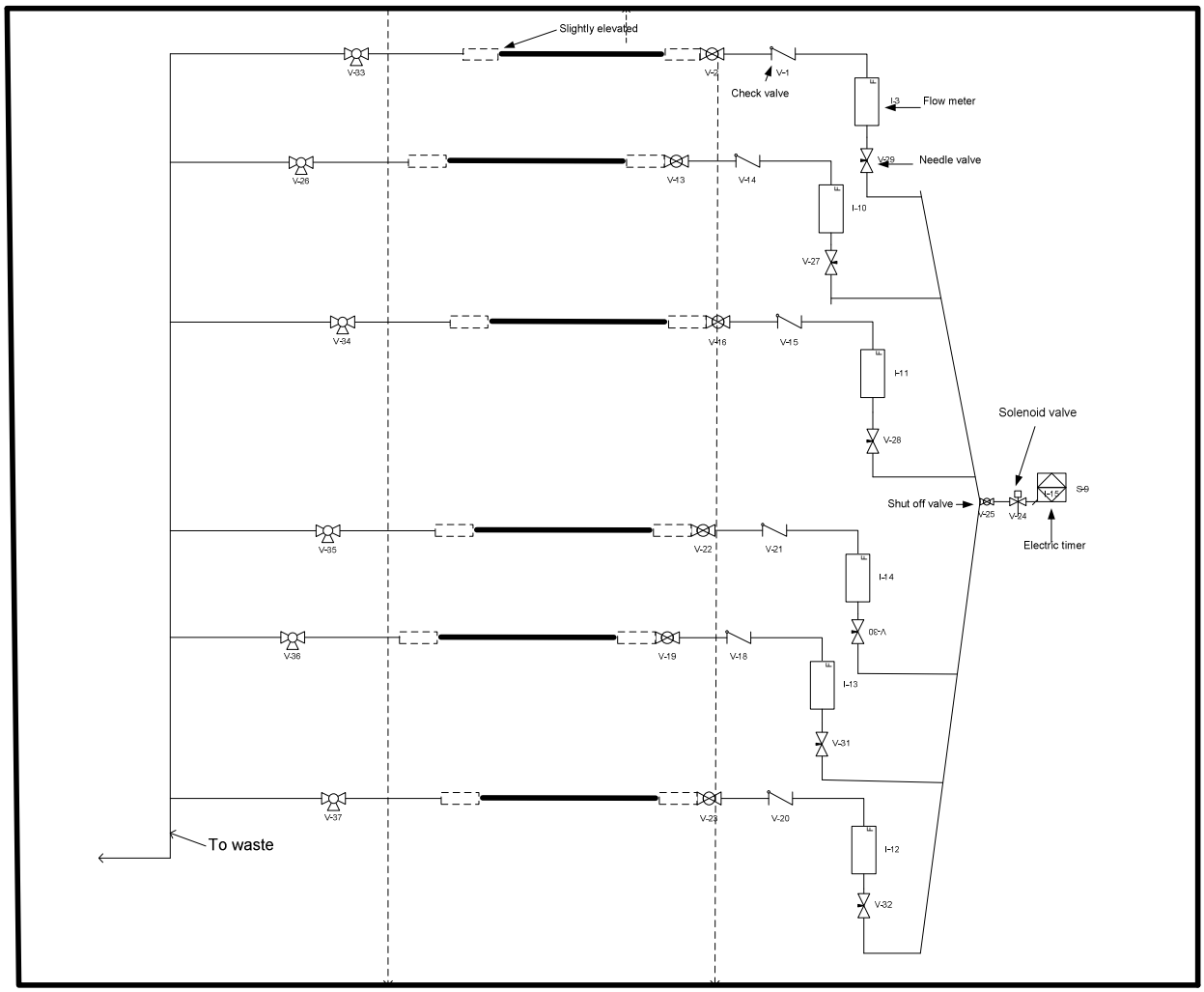
Request OEJ support/assistance for the development and dissemination of risk communication material on lead service lines, including the potential risk from physical disturbances to lead service lines and lead reservoirs in other pipes downstream of lead service lines.

7.0 Timeline

The proposed activities are contingent upon available funding. As such, it is not possible at this time to develop a meaningful timeline, with the exception of the activities in Section 2.0 and some of the activities in Section 3.0 which are discussed in those sections. Once funding is secured a detailed timeline will be developed that incorporates both funded and unfunded activities. A Task Force member will be identified as the lead person responsible for ensuring the completion of each activity or group of activities to ensure that the work is completed in accordance with the timeline.

APPENDIX

Schematic of Lead pipe rig (6 lead sections) from single water source



Shown above are 6 lead sections with a single water source. All are attached to a unistrut framework with casters. Water flows in a single pass through the pipes to waste. The source water can be turned off/on using a timer-controlled solenoid valve.