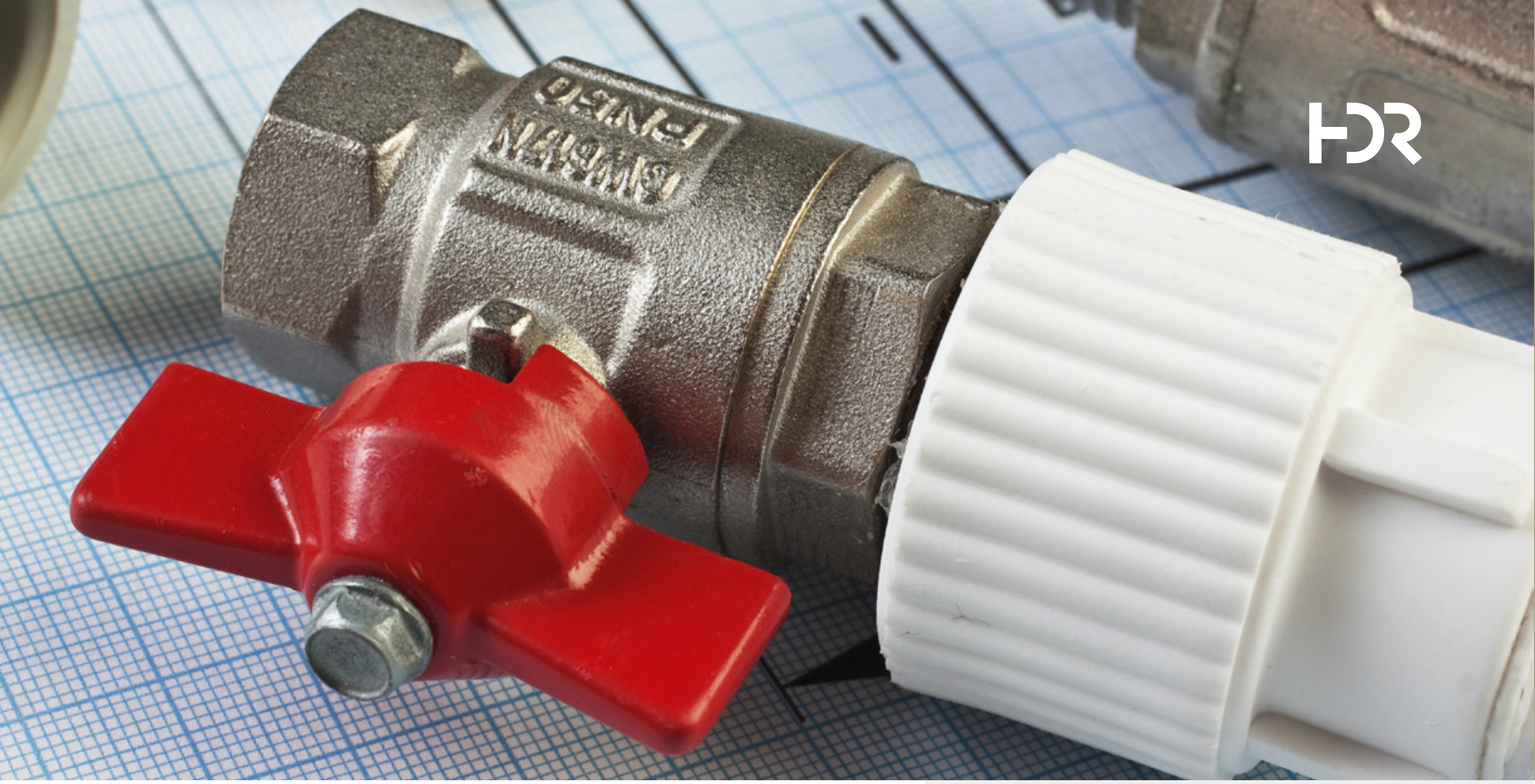

Conducting a Lead and Copper Pilot Study

Key Considerations to Evaluate and Optimize LCR Compliance

By Samantha Black, PhD, PE
Engineer, West Palm Beach, Florida

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Lead and copper corrosion mitigation in customers' taps is a challenge for drinking water utilities throughout the United States due to the historical use of lead service lines and the continued use of other lead and copper components in home plumbing systems. The Environmental Protection Agency promulgated the Lead and Copper Rule in 1991 to control lead and copper in drinking water. Application of this rule has evolved significantly over the last 30 years as our awareness and knowledge about the health risks of lead and copper exposure have increased. In an effort to further protect public health, the EPA has developed LCR revisions that were promulgated in December 2021.

The finalized LCR revisions pose new challenges for utilities. The new rule includes many new requirements and additional guidance related to:

- LSL inventory development,
- LSL replacement,
- enhancements of sampling protocols,
- improvements in reporting and public outreach,
- and significant changes to the current approach for corrosion control treatment.

Under the former rule, acceptable CCT methods included alkalinity and pH adjustment, calcium hardness adjustment, and phosphate or silicate-based corrosion inhibitor addition. The current LCR revisions exclude calcium carbonate precipitation as a means to control lead and copper release and specifies that any phosphate inhibitor must be orthophosphate-based.

These changes—along with tighter corrosion monitoring requirements—require many utilities to re-evaluate their approach to LCR compliance by performing lead and copper pilot studies. This could result in utilities initiating CCT studies for the first time and others re-evaluating ongoing corrosion control methods to optimize their CCT.

What are the Basic Components of a Lead and Copper Study?

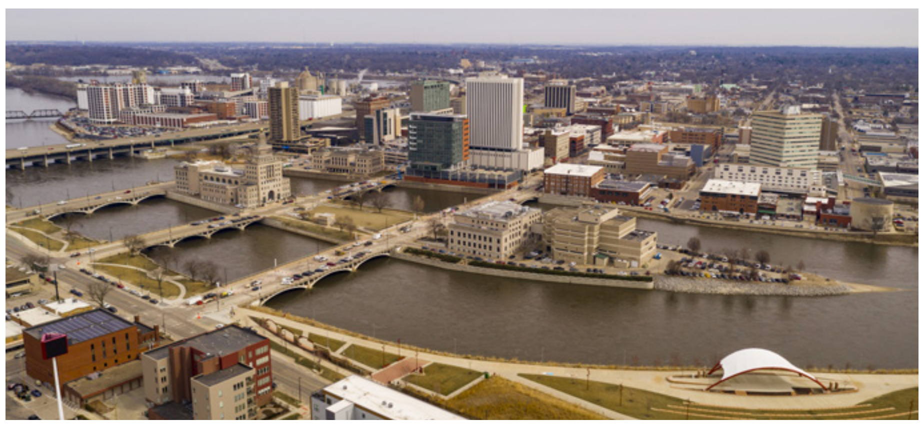
We have found the eight components below to be foundational to a reliable lead and copper mitigation study.

Table 1. Important Components of a Lead and Copper Study

COMPONENT	WHY IT IS IMPORTANT
Background Water Quality Review	Understanding current water quality at the sources, throughout the distribution system, and at customers' taps provides a starting point for evaluating lead and copper mitigation techniques and identifying water quality goals.
Test Plan Development	A robust and defensible test plan should be developed to provide utility personnel with guidance during the study and ensure all parties understand the study's components.
Communication with Regulators	Discussing the test plan with the utility's regulating agency or agencies verifies that the testing about to be performed is acceptable for LCR compliance.
Pipe Rig	A pipe rig provides a means to compare corrosion control methods and/or test how changes in water quality impact corrosion.
Lead and Copper Materials	Materials in the distribution system including LSLs, lead goosenecks, iron pipe, leaded brass fixtures/fittings, and copper components reflect the existing corrosion conditions. Harvesting and inspecting these components can provide quicker insight than new materials, which require a period to acclimate to the utility's water.
Time	Lead and copper optimization studies often require long periods of time (months to years) since corrosion is a relatively slow process and changes in testing conditions often do not immediately yield changes in corrosion results.
Operator Attention	Utility personnel play a key role through daily monitoring of pipe rigs, weekly measuring of water quality and collecting water quality samples, and periodically inspecting the pipe rig components.
Data Analysis	Routinely analyzing water quality data from pilot samples helps identify how corrosion mitigation techniques are impacting lead and copper release.

How the City of Cedar Rapids is Optimizing its Existing Corrosion Control Strategy

The City of Cedar Rapids, Iowa operates two water treatment plants that treat groundwater under the direct influence of surface water using conventional lime softening. Portions of the distribution system are served by individual WTPs and others are served by a blend between the two WTPs. The City currently utilizes zinc orthophosphate to successfully mitigate lead and copper release in customer premise plumbing. However, the City is proactively looking to further mitigate the risk of lead and copper release—enhancing LCR compliance.



To help optimize the City's corrosion control strategy, we are leading a lead and copper pilot study. As shown in the figure below, the City and HDR started with a historical water quality review and distribution system analysis, then developed a pilot test plan and communicated with regulators to ensure an effective pilot study would be conducted. The City is currently in the process of constructing pipe rig units and harvesting metal components.

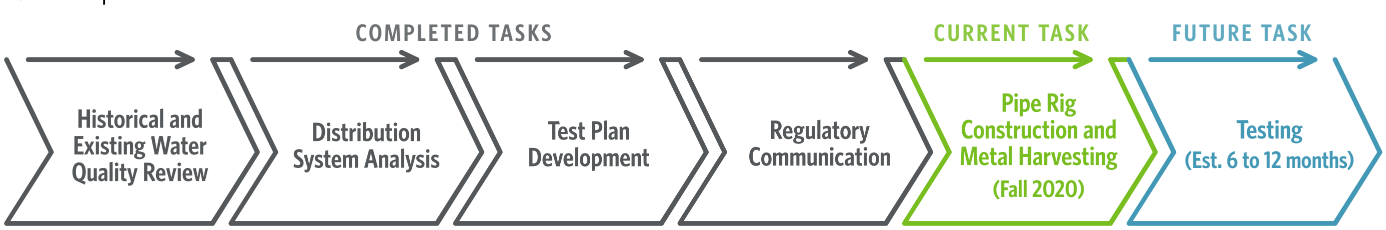


Figure 1. Lead and Copper Pilot Study Sequencing

1. HISTORICAL AND EXISTING WATER QUALITY REVIEW

The first step in CCT optimization is to evaluate historical and current water quality data. We completed our analysis of the data set, and concluded that the City's current practice of using zinc orthophosphate as a corrosion control chemical was suitable for controlling lead and copper corrosion in its distribution system under the former regulation. Simultaneously, this review also identified opportunities the City could consider to enhance its current practices to continue compliance with the LCR revisions.

2. DISTRIBUTION SYSTEM ANALYSIS AND METAL HARVESTING

After the water quality analyses were complete, the City initiated a distribution system analysis. The focus was on identifying target areas, understanding the metal components, and looking for correlations between water quality readings, component locations, and system age. LSLs were identified as major contributors to lead detections, and copper components were also observed in households. Therefore, these metal components were identified as pipe rig materials for evaluation.

LSLs will be harvested from the distribution system. Ideally, they will meet the following requirements:

- Removed intact with damage
- Uniformly ¾" diameter or larger and relatively straight
- Taken from portions of the distribution system that are uniquely under the influence of each WTP
- Historically tested positive for lead in past LCR sampling
- Can provide a single LSL sample of at least 48 feet in length
- Can be cut into six-foot or 12-foot sections on-site using a manual pipe cutter

3. TEST PLAN DEVELOPMENT AND PIPE RIG CONSTRUCTION

A robust test plan was developed for the City to provide an effective means to evaluate CCT strategies. Four pipe rig units are currently

LPR testing is a method to measure corrosion rates of various metals by applying a small voltage difference between two electrodes of the same material. This voltage difference allows for corrosion rate measurements in a conductive fluid (water) while taking into account the resistance of the solution. The current created is measured related to a corrosion rate through Faraday's Law. LPR testing provides data instantaneously, and provides reliable results as the electrodes are uniform and do not significantly vary from component to component, unlike LSLs.

Figure 2. Examples of LPR Probes with Corroded Electrodes

Figure 3. City of Cedar Rapids Pipe Rig Unit Showing Three Test Rigs

under construction, with two located at each WTP. One unit is shown in the Figure 3. These units contain valves, chemical feed points, static mixers, flow totalizers, and sample points before and after metal components. The City will harvest copper fixtures and LSLs from the distribution system and install an innovative corrosion monitoring technique, Linear Polarization Resistance.

Each pipe rig unit will include the test conditions shown in Table 2. Two LSLs will be evaluated per test condition to provide redundancy since LSL construction varies. The components will be pre-conditioned, and water quality parameters will be allowed to stabilize prior to adding test chemicals. Pre-conditioning is anticipated to require three to six months and the test period is expected to take six to 12 months, although these timeframes can be shortened pending LPR results.

The pipe rigs will operate to simulate daily household water use, and samples will be collected by City staff once per week. During the conditioning/stabilization phase, water quality measurements will be trended and evaluated. Shortly after consistent water quality is achieved, components are considered stable and chemical addition will begin. During the test phase, water quality results will be used to determine the effectiveness of each test condition by observing lead and copper results before and after metal components.

4. REGULATOR COMMUNICATION

The City held discussions with state regulators to gain approval of the test plan and identify if the state had any recommendations for enhancing the study. Discussions were also held to ensure the state would support the City in making a CCT change based on study outcomes. The City will keep an open line of communication with the state and will collaborate regarding testing progress and study results.

Summary

The City is proactively evaluating its CCT by exploring additional options for managing lead and copper corrosion. The outcome of this project will be an optimized CCT strategy that will enhance compliance with the LCR. Stay tuned for an update on this project after pipe rig testing is initiated.

Given the recent changes to the LCR and future requirements for utilities, it is recommended that utilities proactively conduct a historical water quality review and distribution system inventory to determine if a lead and copper pilot study is needed. Please contact us if you would like to learn more about the LCR revisions, how the LCR revisions may impact your utility and how we may assist you in your efforts towards maintaining or achieving LCR compliance.

Table 2. Pipe Rig Test Conditions

PIPE RIG NUMBER	TEST CONDITION	OBJECTIVE
1	Baseline / Control	Establish a baseline measurement of performance using zinc orthophosphate to serve as a point of comparison
2	Phosphoric Acid	Determine performance of a phosphate-based corrosion inhibitor that does not contain zinc
3	pH Adjustment	Determine the performance of a non-inhibitor based corrosion control strategy
4	Spare	Pipes to be conditioned and available for additional study

Contact Samantha Black, PhD, PE at **Samantha.Black@hdrinc.com** for more information.