NJIT Engineers Get the Lead Out

As Newark races to replace thousands of lead-based pipes that feed drinking water into homes, the city faces a second urgent challenge: stopping the heavy metal from leaching into the water supply while the massive remediation effort is underway.

And that's where NJIT's environmental engineers come in. To mitigate exposure over the life of the project, which is expected to take up to 30 months, a research team is working with the city to develop and test chemical methods to prevent lead-shedding corrosion in service lines that stretch from the water main located under streets into dwellings.

"As environmental engineers widely acknowledge, our understanding of the complexities around pipe corrosion and the release of metals continues to evolve. And so must our treatments," said Taha Marhaba, chairman of NJIT's Department of Civil and Environmental Engineering and a specialist in drinking water quality and analytical techniques for pollution detection. "Our team of faculty and students is developing a more precise, real-time picture of Newark's water system, in which variable water quality conditions affect the release of lead, and optimizing treatments for this dynamic environment."

Lead in pipes can become soluble and transportable if oxidized by flowing water, particularly in aging infrastructure that dates back to the middle of the 20th century and earlier in some cities, including Newark. For 25 years, corrosion-prevention in the city's largest service area, which draws water from reservoirs in the Pequannock River system, consisted of injecting a chemical, silicate, into the water supply. It formed a protective layer of material over the interior surface of the pipe to prevent lead from mobilizing. But testing determined that silicate was no longer effective.

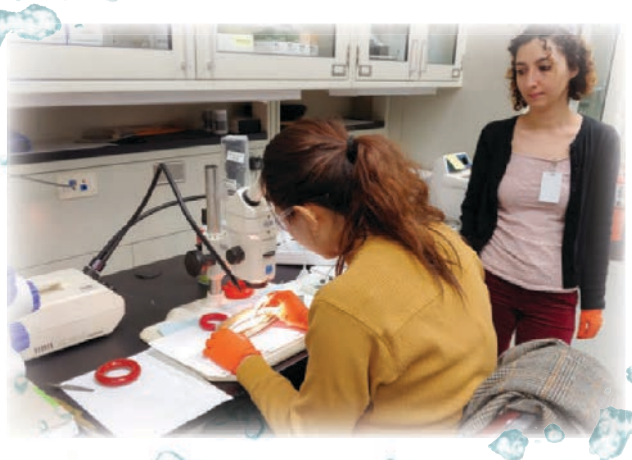
Using X-ray diffraction analysis, the NJIT team found that in addition to elemental lead, lead oxides were the compounds most present in the pipe scales. Scanning electron microscopy also revealed iron, aluminum, silicon, magnesium and calcium deposits.

"With the introduction of new sources of water, conditions changed. Water quality, including pH, temperature, and organic and inorganic material in runoff, among other factors, plays a big role in the effectiveness of anti-corrosives," said Lucia Rodriguez-Freire, an assistant professor of environmental engineering who studies the transformation of contaminants and their migration pathways. Some water samples have shown lead levels that exceed the U.S. Environmental Protection Agency (EPA) threshold for action.

Aided by her graduate students, Rodriguez-Freire launched a study this past summer of excavated service lines to determine the efficacy of a new corrosion-control chemical with an affinity for metal surfaces, orthophosphate, which was introduced into the water system last May. While widely used as a corrosion inhibitor in other water systems, where it has successfully stabilized lead, its introduction is not in and of itself an optimal solution, the researchers say.

"Because every water system is different, we have to take other factors into account, such as chemicals in the water, varying seasonal temperatures and weather conditions that can increase runoff," notes Rodriguez-Freire. "Surface water quality is complex and dynamic. As we continue with our research, we are gaining a better understanding of how seasonal changes, for example, can affect water composition and quality." The NJIT team is working with the city's consultant, engineering and construction firm CDM Smith, on the pipe analysis.

"Ultimately, we will try to pinpoint the best treatment strategies as water conditions change. Specifically, we can study how environmental factors such as pH and temperature affect lead-leaching kinetics under variable doses of orthophosphate in water," added Wen Zhang, another member of the team and an associate professor of civil and environmental engineering, who develops water treatment technologies such as chemically reactive membrane filtration to combat existing and emerging contaminants.



Boran Wang (seated) and Maedeh Soleimanifar, environmental engineering graduate students preparing to analyze lead service lines at the EPA's National Risk Management Research Laboratory in Cincinnati.

OPTIMIZING TREATMENT DISTRIBUTION

The team is setting up a lab on campus to continue testing for the presence of lead in excavated pipes and to determine how well

From left: Lucia Rodriguez-Freire, assistant professor of environmental engineering; Taha Marhaba, chairman of NJIT's Department of Civil and Environmental Engineering; Newark Mayor Ras Baraka; and David Smith of CDM Smith.

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orthophosphate is building up in the service lines to block corrosion, an electrochemical process. Team members traveled this fall for training at the EPA's National Risk Management Research Laboratory in Cincinnati, which is currently the only lab in the country to perform these tests.

The engineers also will determine whether the chemicals should be injected at different points in the distribution system other than at the water treatment plant. "We need to optimize treatment distribution as well," Marhaba noted.

Following training and certification this fall by inspection professionals, NJIT undergraduate and graduate students will evaluate pipe replacements to make sure they are being done correctly.

"We have a strong interest and involvement in lead-mitigating programs in our city, Newark," said Moshe Kam, the Dean of NJIT's Newark College of Engineering. "At the same time, we use this city-wide effort to educate the next generation of engineers. Graduate and undergraduate students from the College will experience through this project the critical societal impact of engineering; the strong connection between theoretical studies and lab experiments on one hand, and real-life challenges in the urban environment on the other; and the responsibility that engineers owe to the welfare and health of their communities."

NJIT's civil engineers work on a range of infrastructure projects with the city, from intelligent transportation systems, to dam monitoring and assessment, to water systems.

Lead in drinking water is associated with serious health effects in people, especially children, causing damage to the central and peripheral nervous system, learning disabilities, shorter stature, impaired hearing and impaired formation and function of blood cells, the team noted. The EPA's goal is to eliminate it from drinking water entirely.

"As an older, urban community, Newark has outdated lead service lines, and we look forward to modernizing our infrastructure and reducing risk for Newark's families," Newark Mayor Ras Baraka said this past March, at the groundbreaking ceremony for the pipe replacement program. Locations throughout Newark were prioritized based on the level of risk and the presence of at-risk populations, such as children. ■

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