



CASE STUDIES

A LOOK AT FIVE COMMUNITIES
REPLACING LEAD SERVICE LINES



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INTRODUCTION

Lead Service Line Removal

Decisions made now by city officials, building owners, and installers for replacement and new construction material will have effects long into the future.



Access to clean, safe drinking water is essential for public health. Unfortunately, there are an estimated 6-10 million lead service lines buried underground across the country. Recent experiences like that of Flint, Michigan; Newark, New Jersey; Benton Harbor, Michigan; Fort Worth, Texas; and Denver, Colorado have brought to the forefront the inherent risk in not addressing the country's large volume of lead service lines . A risk that with one change of the water supply or water treatment can expose men, women and children to unsafe levels of lead in their drinking water.

The most effective way to eliminate this risk and prevent future crises is to remove and replace all lead service lines.

Now, with federal and non-federal funding sources available to assist states and water utilities with lead service line replacement (LSLR), it's time to focus on selecting a safe, long-lasting replacement material. As economically alluring as it might be to pursue patchwork solutions or use cheaper materials, it is a sign of strong leadership to invest in a long-term solution that prioritizes the health and safety of residents.

Copper is the only service line piping material that offers the proven history of longevity, reliability, safety and life-cycle cost effectiveness to meet the challenges required in these infrastructure decisions.



FLINT
VEHICLE CITY

The Flint, Michigan Water Crisis

Copper Service Lines Chosen for Safe Drinking Water

A once-booming city meets a health disaster

Sixty-six miles north of Detroit is the densely populated city, Flint, a once thriving economical center known as "Vehicle City," a formerly leading manufacturer of Chevrolets and Buicks before numerous plants closed, sending the city into economic despair.

For decades, Flint received its municipal water from Lake Huron through the Detroit Water and Sewerage Department. On April 25, 2014, Flint switched the source of its water from Lake Huron to the Flint River as a cost saving measure. That fateful day marks the beginning of what came to be known as the Flint Water Crisis, awakening and transforming America's attitude toward infrastructure and safe drinking water.

The switch led to an immediate increase in concentrations of lead in the drinking water. Lead poisoning was found in some of the population and lead concentrations in the tap water were far above the maximum allowable concentration of 15 ppb set by the EPA. On October 15, 2015 the switch was made back to the Detroit water system and as testing continued, problems remained and the damage was immense.



Tens of thousands of Flint residents were exposed to dangerous levels of lead, and at least 12 people died in connection to outbreaks of Legionnaire disease. Between 6,000 and 12,000 children were exposed, the most at risk population due to the long-term effects of lead poisoning, which can include a reduction in intellectual functioning and IQ, and an increased chance of Alzheimer's disease.

The saga broke into the national media and became the focus of countless hearings and declarations of a states of emergency at various levels of government. Flint Mayor Karen Weaver declared a state of emergency in December 2015 and President Barack Obama declared a state of emergency in January 2016.

A complex and hidden danger

Lead testing continued and concentrations were consistently above the allowable limits in many Flint households. Water service lines were identified the main source of lead which needed to be replaced. The problem was compounded due to outdated records making it difficult to tell which service lines were lead and/or galvanized steel and which were copper. Water service lines installed prior to 1980 were suspect and many of the homes in Flint were built well before 1980 during the boom years of the Flint automobile industry.

Mayor Weaver appointed Michael C.H. McDaniel to lead the Flint Action and Sustainability Team (FAST). A retired National Guard brigadier general, McDaniel oversaw the group leading the lead service line replacement project.



Flint selects copper

In February 2017, Mayor Weaver announced that Flint would use copper piping for the entirety of the service line replacement. "With copper, we know we're getting a long-term solution," said Weaver.

McDaniel elaborated that the decision to use copper was made after considering the longevity of the piping and lifetime cost of the product as well as many other factors. "This decision will affect many generations to come," McDaniel said. "My team and I conducted months of research and engaged with piping experts regarding the ideal lead replacement material for superior performance."

Flint concluded that copper was the best material for the replacement pipes because copper piping is durable, reliable and long-lasting. It is also impermeable, which means outside chemicals such as petroleum products spilled on nearby streets or insecticides and fertilizers spread on yards would not contaminate the water system.

Shortly after the decision was made to use copper, the copper industry stepped in to help Flint acquire nearly 200,000 feet of copper piping at a savings of approximately \$1 million to the city. By the end of 2018, a total of 15,031 pipes had been excavated at homes in Flint. Service lines to 7,233 homes that have been identified as lead and/or galvanized steel were replaced, including 1,005 homes newly discovered in 2018.



"The copper industry will continue to provide technical guidance and educational resources wherever needed to ensure that copper piping is designed, installed and operated properly every step of the way," said Andrew G. Kireta, Jr. of the Copper Development Association (CDA). "We are committed to helping America rebuild its aging water infrastructure."



Newark Resolves Water Crisis in Short Order

Service Line Replacement Program Serves as a Model for Other Cities

Situation: A Time for Action

As evidence mounted in the 1970s and 1980s about the detrimental effects of lead on the nervous system, Congress banned the use of lead in water pipes in 1986 and by 1991, federal regulators began requiring water authorities to monitor lead levels in drinking water. An upper limit of 15 parts per billion (ppb) was established by the EPA, but even this low level of lead is considered unacceptable by medical professionals. Consequently, the current position of the EPA is that there is no safe concentration of lead in drinking water.

For many years, it was widely believed that lead from lead service lines could be kept below the 15 ppb limit through proper control of water chemistry. However, testing and monitoring revealed a different story.

The Newark water crisis began in 2016 when lead concentrations in several public schools were measured at twice the federal limit of 15 ppb. Furthermore, testing of lead in Newark homes revealed that the 15 ppb limit was often exceeded. Alarm bells sounded and it was realized that it was time to take action to resolve the lead problem once and for all in the Newark community.



Challenges: A Bullet Proof Plan

The controversy over lead concentration in the Newark drinking water occurred just as the Flint Water Crisis was receiving national attention. Newark is the largest city in New Jersey, with a population of 321,986 – more than three times larger than Flint's population of 102,434. Newark's size ranks at 62 compared to Flint's of 252, nationally.

Unlike Flint, Newark's water supply is derived from huge reservoirs. The source is clean and reliable and provides more than 80 million gallons of water per day to city residents. There was no sudden change of water supply sending lead concentrations soaring. Nonetheless, extensive monitoring revealed that the lead concentrations were too high and that chemical treatments were ineffective. The problem was the service lines between the water mains and Newark residences were more than 100 years old and many were made of lead.

The Newark community, local government officials and technical experts rallied behind a bold and definitive plan to clean up Newark's drinking water permanently and in short order. Every resident of Newark would have safe drinking water delivered to their faucets with no exceptions. The objective was to replace every lead service line with new copper pipes as quickly as possible.

It was vital to cut through the "red tape" by facilitating building access for water service line replacement. Because more than 70 percent of the people in Newark rent, it would have been a daunting challenge to obtain written permission from absentee landlords, many of whom did not live in New Jersey.



The City of Newark passed an emergency municipal law that allowed contractors to go on the property and change the water service lines without consent of the property owner. Although that approach may not work in every city, it was a good solution for Newark.

Thirdly, the technology, equipment, materials and manpower were put in place to allow the excavation of lead pipes and service lines to be replaced quickly through innovative technologies.

Resolution: Bringing Home the Copper

Newark set a benchmark for how quickly a major city could replace nearly all its lead service lines. The matter was fully resolved in five years, from the time when the over-the-limit lead concentrations in Newark schools were reported in 2016 to when practically all the service lines were replaced 2021. Excavations began in early 2019 and by spring 2021 nearly 20,000 service lines had been replaced (compared to 7,233 service lines in Flint, Michigan). The job is now considered complete in 2022, just three years after work began.

As with other municipalities, the decision was made to use copper for the replacement pipes. Newark understood the use of copper would be a sustainable solution for the long-term for its durability, reliability, and long-lasting qualities. Once the decision was made to use copper, work could begin in earnest, and it did not let up until the main objective of safe drinking water for all was achieved.



The replacement project was initially projected to take up to ten years, but it proceeded faster than expected, thanks to an infusion of state and local funds and an amendment to state law to protect homeowners from having to bear the cost. Newark's efforts drew praise from the Natural Resources Defense Council, initially a critic of the handling of the crisis.

According to Eric Olson, NRDC senior strategic director for health, the NRDC is pointing to Newark as a model for other cities to follow. Further, the state of New Jersey made additional headway in the fight against lead piping when in July 2021, Governor Phil Murphy signed a package of laws requiring hundreds of community water systems in the state to replace their lead service lines by 2031.



Benton Harbor

A Small Town Raises Big Questions about Lead in Water

Benton Harbor Water Service Line Dashboard Is a Model of Transparency

The toxic effects of lead in drinking water have been known at least since the 1970s. Medical science has established that even minute concentrations of lead can have adverse effects on the nervous system. In children, low levels of exposure have been linked to damage to the central and peripheral nervous system, learning disabilities, shorter stature, impaired hearing, and impaired formation and function of blood cells. Unfortunately, countless cities and communities across America have been slow to respond to the crisis, despite the warnings.

Big cities such as Newark, New Jersey and Flint, Michigan have been the focus of headlines in the past decade. However, lead service lines are also a problem in smaller communities such as Benton Harbor, Michigan. Benton Harbor is finally well on its way to replacing all its lead service lines. This is the story of a small, under-served community which can act as a model for transparency for communities across America faced with lead service lines.



A Big Spotlight on a Small Town

Benton Harbor is a small town on the eastern shore of Lake Michigan. Its population was 8,915 in 2022 with a median household income is \$21,916. Despite its smalltown status, Benton Harbor received outsized publicity in September 2021 when the Natural Resources Defense Council filed an emergency petition stating that lead levels as high as 889 parts per billion (ppb) were recorded in some samples. Articles appeared with graphic descriptions of the residents complaining about the taste of the water. Lead levels consistently tested well above the federal action limit of 15 ppb.

Water Was Everywhere: It's the Lead Service Lines

Ironically, Benton Harbor is close to the shores of Lake Michigan, which holds a limitless supply of freshwater. As is often the case, the problem was not with the water source or even with the water mains. The problem was with the lead service lines.

Some of the lead service lines were more than 100 years old. The town was in a state of emergency because the water was undrinkable. By October 6, 2021, the Michigan Department of Human Health Services issued an advisory recommending that residents use bottled water for cooking, drinking and brushing teeth and distributed thousands of cases of free bottled water.

The next action was testing, testing and more testing. Filters were made available. The water chemistry was tweaked to inhibit corrosion from the lead pipes. And the water was tested, tested and then tested again. All of these were stop-gap solutions. It was realized that the only real long-term solution would be to replace the lead pipes.

Something had to be done and fast!



Copper to the Rescue

To resolve the problem, the lead service lines would all need to be replaced. The funding came from the Building Michigan Together Plan that was signed by Governor Whitmer in March 2022. Through this plan, \$45 million is made available to the City of Benton Harbor for infrastructure improvements including the replacement of all the city's lead water service lines with copper piping. This funding ensures the city will replace all the lead water services lines by 2023 and in turn, ensures the safety of its residents drinking water for generations to come.

Early on, copper was identified as the best material for the new service lines. Copper piping is durable, reliable and long-lasting. Copper is also impermeable, which means outside contaminants would not contaminate the water system. Copper is naturally corrosion resistant to most soils and underground environments. There are 4,473 service lines in Benton Harbor. Since there are few accurate records available, all service lines are assumed to be lead until they are verified to be non-lead or replaced. The service lines consist of two segments: (a) service line material from the water main to the curb stop and (b) service line material from the curb stop to house.

In the interest of transparency, the [Benton Harbor Lead Service Line Status Dashboard](#) has been established. It shows the number of lead service lines replaced each day, which can be located on a map. The dashboard also displays the material currently installed in the service lines in Benton Harbor as the materials in the service lines are verified or replaced.



This accelerated replacement program and tracking system is a model for small towns across the country. Until their service lines are fully handled (meaning verified as non-lead or replaced), residents in Benton Harbor will continue to use bottled water for drinking. However, this is one town where the water crisis is well on the way to being fully resolved.

The same cannot be said to be true for the millions of lead service lines still in use across America. The [Environmental Defense Fund](#) reports that more than nine million lead service lines (LSLs) will still be used in 2023, according to the EPA's proposed Lead and Copper Rule revisions.

Benton Harbor serves as a model for every community faced with lead service line replacement. Selection of the proper materials and swift action in the interest of the residents' health and well-being is something one cannot put a price on.



Fort Worth Leads the Charge to Replace Lead Service Lines in Texas

You can't see it, taste it, or smell it. Unfortunately, all too often, this notorious neurotoxin is lurking in the drinking water in certain communities. When it enters the body, wreaks havoc on the brain and nervous system.

Worse, its effects are cumulative. This heavy metallic element builds up in the body over time. It substitutes for calcium atoms in the brain and nervous system, where it remains for years. Children are especially vulnerable as their small bodies mature into full-grown adult bodies.

The culprit is lead water service lines and lead plumbing fixtures.

Proactive Testing of Drinking Water in Texas

A long-term revision to EPA Lead and Copper rule issued in 2021 was directed at protecting children and communities from the risks of lead exposure by better protecting children at schools and childcare facilities, getting the lead out of our nation's drinking water, and empowering communities through information.



The Texas Commission on Environmental Quality (TCEQ) is the state's environmental agency. Previously, TCEQ assisted school districts in testing water. More recently, the agency has been responsible for overseeing plans to test tens of thousands of water systems that serve children throughout the state. Texas parents and guardians will receive information on whether the water in their child's school or care facility contains unsafe levels of lead. For the first time, roughly 25,000 schools and childcare facilities will need to be tested. It is noteworthy that the State of Texas did not previously have any mandatory testing requirement.

Meanwhile, the city of Fort Worth, Texas moved forward on a voluntary basis without the assistance of the recent Bipartisan Infrastructure Bill under the Biden administration. In 2016, the Fort Worth Independent School District identified 60 schools with levels of lead above the threshold during its testing initiative. The city was able to remove or replace many sources of lead contamination, such as old-style water fountains within the schools. Addressing the issue of lead inside the schools was just the start for the city of Fort Worth. The bigger problem was the issue of lead service lines.

A Deadly Legacy

The Dallas–Fort Worth–Arlington metropolitan population was 7.6 million according to the [2020 census](#), making it the most populous metropolitan area in both Texas and the southern United States, and the fourth largest in the country.

Although the population in Fort Worth more than doubled from 1991 to 2021, it already had a sizable population when Congress enacted the 1986 Safe Drinking Water Act. This "lead ban" prohibited the use of pipes, solder or flux that were not "lead free" in public water systems or plumbing in facilities providing water for human consumption. "Lead free" was defined to mean solder and flux with no more than 0.2 percent lead and pipes with no more than 8 percent lead. Tighter regulations would follow.



Not surprisingly, as is the case across America, many homes in the Fort Worth area had legacy lead service lines bringing water from the main into the home. Initially, there were few records of which service lines would need to be replaced. Lead service lines were replaced whenever a water main was replaced or in the course of other work, yet city crews and contractors were not required to document these replacements. It is estimated that approximately 400 lead service lines were already replaced when Fort Worth set a goal to replace them all.

Ambitious Goals Met

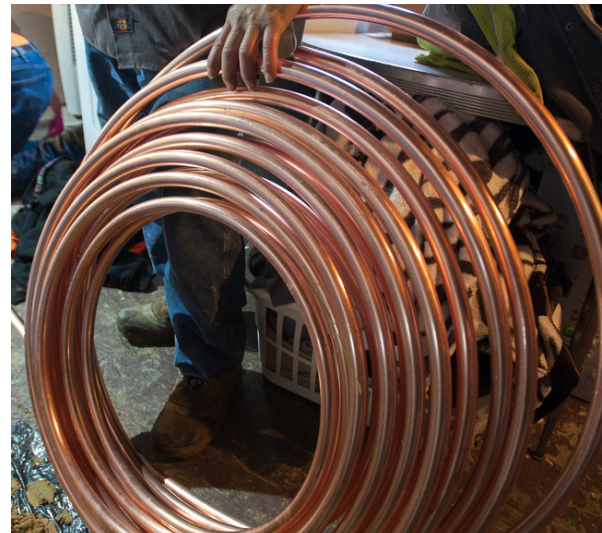
As of the end of January 2021, 1,790 lead services lines were found. Fort Worth set an ambitious goal to replace all lead service lines by the end of 2021. Their material choice? Copper, which has been the standard in Fort Worth for more than 25 years.

When a cluster of lead service lines are found on one block or several blocks, a water rehabilitation project is initiated to replace the entire water line in the street. This process can take over a year to complete.

By the end of 2021, nearly all lead service lines have been replaced in Fort Worth with copper piping. Service lines that remain unchecked are mostly in areas where development occurred long after lead pipe was banned by the 1986 Safe Drinking Water Act.

Ahead of the Game

By the time the Bipartisan Infrastructure Law went into effect, nearly all the lead service lines in Fort Worth had already been replaced.



While the federal government's new rule requires all water systems in each state be required to report lead service lines and pipes within three years, the Fort Worth Department of Water is a shining example of a large city that took initiative to eliminate lead service lines with urgency using the best material selection in the interest of the community.

The Environmental Protection Agency (EPA) also recognized Fort Worth for its lead removal efforts. "For 20 years, Fort Worth has removed its lead service lines when they are found in the course of maintenance activities," the EPA said. "Fort Worth Water plans to remove all remaining city-owned lead service lines over the coming years."

While Fort Worth took on their lead issue head on, as many as 10 million American households and 400,000 schools and childcare centers currently lack safe drinking water as defined by the EPA. The Bipartisan Infrastructure Law will invest \$55 billion to expand access to clean drinking water for households, businesses, schools, and childcare centers across the country.



Denver Water Pulls out Lead and Pulls in Copper Water Lines

Denver is an anomaly among the big cities of western United States. Its climate is semi-arid, yet it's fortunate to have access to an abundance of water from the surrounding Rockies. The challenge for Denver has been to store and convey water from rivers, streams and reservoirs on both sides of the Continental Divide to its growing urban population.

Denver's history is intertwined with Denver Water's history. Major infrastructure projects such as the Cheesman Dam and the Moffat Water Tunnel shaped the history of the Mile High City.

Trouble in the Water

Yet today, Denver is faced with another kind infrastructure problem. It has a lead problem. The EPA along with medical toxicology professionals have asserted that there is no "safe level" of lead in drinking water. Unfortunately, tens of thousands of older homes in Denver use lead service lines to connect with the water main.

Denver was founded in the 19th century and has grown steadily as railroads connected the east with the west. Service lines from that era were commonly made from lead pipes.



Lead was cheap, easy to work with and health hazards associated with lead were not well known. Growing concerns about the toxicity of lead were raised after WWII but it wasn't until 1986 that the installation of new lead service lines was banned by an Act of Congress.

And yet, the existing lead service lines continue to be used to this day. Denver Water estimates that 64,000 to 84,000 properties may have lead service lines in its service area. Homes built before 1951 are especially likely to contain lead pipes in their service lines.

The number of homes likely to have lead service lines in Denver is vast. The cost to replace all the lines could potentially be hundreds of millions of dollars. Legally, the service lines are the responsibility of the property owner. However, since lead in drinking water is health hazard, Denver Water aims to replace all the lead pipes at no direct cost to homeowners.

Denver Water Leads the Way

The dividing point is between the main and the service line. It is where the water leaves the public system and enters privately-owned facilities to serve individual premises. The service line is owned by and installed at the expense of the property owner.

Recognizing the hazards posed by lead in service lines, Denver Water agreed to replace any customer-owned lead service line that it discovers with a copper water line at no direct charge to the customer when discovered during pipe replacement projects.

Furthermore, customers who have lead service lines that are not encountered during pipe replacement work will be enrolled in the Lead Reduction Program. As part of the program, Denver Water will replace customer-owned lead service lines with copper service lines at no direct charge to the customer.



Denver Water takes pride in being a national leader in the management of clean water systems and its lead service line replacement program is no exception. It has launched a public information campaign with high quality educational videos to inform its customers about the program. It has also mapped out all the properties identified as likely to have lead service lines. Denver residents can enter their address and the [map](#) will tell them if their home is one of the estimated 64,000 to 84,000 homes with a possible lead service line.

Certain measures have also been taken to protect the health of those residents who are waiting for lead service line replacement. Residents have been provided with water filters and advised to filter any water used for drinking, cooking or food preparation. Another measure taken has been to increase the pH of the water in the mains which helps to form a protective coating over any lead pipes in the system. Denver Water also established a laboratory to study the relation between pH levels and the amount of lead released from lead service lines. In this manner, lead levels can be kept at a minimum while homeowners await the installation of copper water lines.

In addition, if property owners choose to replace their lead service line at their own expense, they may be eligible for a partial reimbursement of their total cost. A homeowner may be eligible to receive up to \$3,800 toward the cost of lead service line replacement should they decide to do it at their own expense.

Prioritization

Realistically, as with many large cities across the United States, it will take 15 years to replace all the lead service lines. One might look at the 15-year program and wonder why it will take so long. Before the acceleration was implemented, Denver Water was replacing service lines at a rate of about 1,200 per year.



Initially, data on the number of existing lead service lines was unclear. Once the total numbers were realized, it was obvious that the pace was too slow. At the original pace, it might take 50 years or more to replace all the lines.

The current program will replace about 5,000 lead service lines per year. That means that 60,000 service lines could be replaced in a dozen years or, practically speaking, Denver could be lead free in just 15 years.

Denver Water's model for prioritization determines replacement areas based on several factors, including the likelihood that lead service lines are in a given area and how many properties in a given area are identified as either having or likely to have lead service lines. The identification of elevated blood lead levels can be a factor as well as the number of critical facilities (e.g., childcare facilities and schools) identified as likely to have lead service lines. The replacement work is also coordinated with other efforts to minimize or avoid multiple disruptions to the same community. Now with several years of experience in prioritization, the model used by Denver Water is of great interest to other communities seeking to provide the maximum health benefits as quickly as possible.

Digging, Boring and Pulling Through: What to Expect

Denver Water uses copper pipe for replacement pipes because it is durable, reliable, and long-lasting. Denver Water has produced several excellent videos to inform its residents of the replacement program and what to expect once work begins. Especially informative is the video simply titled "[How does Denver Water replace lead service lines,](#)" which describes two pipe replacement methods: The first is the pull through method, which involves passing a cable through the old lead service line to the water main, attaching the cable to the copper pipe and then using an excavator to pull the lead pipe and copper pipe through to the water meter. Another pipe replacement method utilized is the directional boring technique. The lead pipe is left in place and new hole is bored through the ground from the meter to the basement of the home or from the meter to the water main. Connections are then made. Both techniques avoid having to dig a trench for the length of the pipe resulting in cost saving.

Roya Alkafaji, Manager, Healthy Communities, summarized the work of Denver Water in a blog for the Environmental Defense Fund as follows: "Denver Water has one of the most successful lead service line (LSL) replacement programs in the country. Since it began the program in 2020, the utility has replaced nearly 14,000 LSLs—prioritizing lines to buildings serving vulnerable populations, such as child-care facilities. Denver Water has also distributed over 102,000 filters to local residents. EPA should continue to support their innovative approach."





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