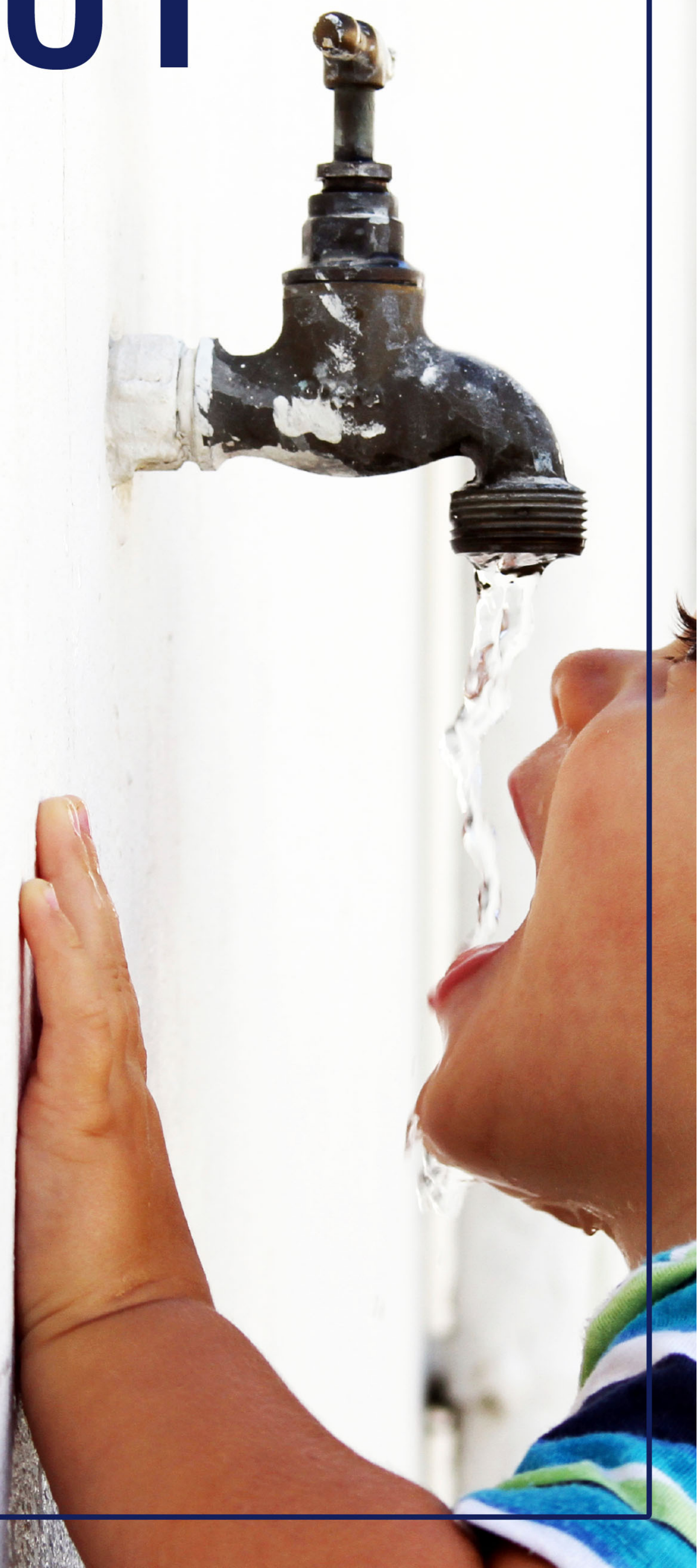
GET THE LEAD OUT ACT OF 2016



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GET THE LEAD OUT ACT OF 2016

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Executive Summary

Across the country American families turn on their faucets to brown water and lead contamination. Recurring images of distressed families evoke the unforgivable reality that our water has been poisoning our children for decades. Water, the vital resource upon which we all depend, stands as a threat to the vitality and strength of American society. Cases, such as Flint, Michigan, Washington D.C., and Minneapolis, Minnesota, call for an immediate response to address widespread lead contamination and the greater environmental injustice.

Throughout the nineteenth and twentieth centuries, manufacturers incorporated lead into paint, solders, pipes, and even gasoline. Unfortunately, lead is also extremely toxic to humans and exposure can cause neurological, cardiac, and respiratory diseases. Although several European countries banned lead use in 1909, the United States continued to incorporate lead into manufacturing and production, despite confirmed research on the detrimental health consequences. The Lead and Copper Rule of 1991 officially mandated the elimination of lead.

The Center for Disease Control (CDC) asserts that there is no safe level of lead. To achieve this goal all aging infrastructure would need to be replaced and many contaminated soils would need to be removed. Considering the impracticality, the CDC mandates a small allowable concentration of lead in water. However, the frequency of high lead exposure incidences in multiple cities indicates that, many Americans in cities across the nation continue to be exposed to unhealthy lead levels.

The Get the Lead Out Act of 2016 aims to reduce lead exposure in water through education, corrosion control, and service line pipe replacement. The bill details a $60 million per year grant program between 2017-2021 to aid communities and municipalities in replacing public and private lead service lines. Primarily focusing on children and low-income, the bill seeks to address lead exposure among those most vulnerable.

This report offers a more detailed overview of the bill, legislative history, and the science behind lead exposure. The discussion section summarizes the lead corrosion mechanisms and pertinent health consequences, as well as, the impact on local communities. Recommendations specify allocations of the grant money into education grants, planning grants and additional start-up grants. The allocated smaller grants aim to act as seed money in order to spur additional funding to support education on lead exposure and lead service line replacement. Lastly, key performance indicators are included in the proposed framework in order to effectively measure the success of the program and monitor its progress.

It is our hope that decisions and policy makers at the city, state and national level will be able to utilize this report to ascertain a more in-depth understanding of the hazardous threats of lead exposure and possible solutions. Enactment of the Get the Lead Out Act of 2016 is critical in reducing lead exposure among children and improve the health of our nation's productivity and future success. With the future in mind, the Get the Lead Out Act of 2016 seeks to reverse prevalence of lead leftover from our past and to carve a cleaner and healthier environment for generations to come.

Sincerely,

Tiara Cunningham
Manager

Marissa Sterling
Deputy Manager

GET THE LEAD OUT ACT OF 2016

1. History of the Problem

Lead (Pb) is a hazardous chemical that is harmful to the human body. Effects of lead on the human body have been known for a long time. Over 200 years ago lead was incorporated into daily life and was a crucial component in cooking utensils, paint decorations, make-up and water infrastructure. Symptoms of lead poisoning have been well documented since the time of the Romans. Roman health practitioners were well aware of the risks of lead exposure through the environment and its harmful impact on human health, including insanity and death (Lewis 1985).

Despite increased knowledge on the detrimental health effects of lead since the 19th century, particularly on the brain, lead has been marketed as a durable chemical in the U.S. and used widely in paint, gasoline, beverage cans, hobby supplies, children's products, jewelry, pottery, PVC plastics, pipes, fittings and solders (Lah 2011). Although lead paint had been banned in several European countries prior to the 1920s , its use in the United States peaked in the 1920s. In the same period, the U.S. declined to adopt it when the League of Nations banned lead paint entirely. Although Baltimore adopted a regulation banning lead paint in 1951, it was not until 1970s that lead was regulated on a national scale (Rosner et al. 2009). A series of acts and rules regulating lead proposed one after another: (a) Lead Poisoning Prevention Act in 1971 (lead paint), (b) Safe Drinking Water Act in 1974 (regulating lead in water), (c) Consumer Product Safety Commission's declaration in 1977 (ban on consumer uses of lead paint and infrastructure materials), (d) Lead and Copper Rule in 1991 (treatment of lead in water) and (e) Clean Air Act in 1996 (leaded gasoline ban) (Chronology of Leaded Gasoline 2011).

Figure 1. Lead Regulations in Europe and in the U.S.

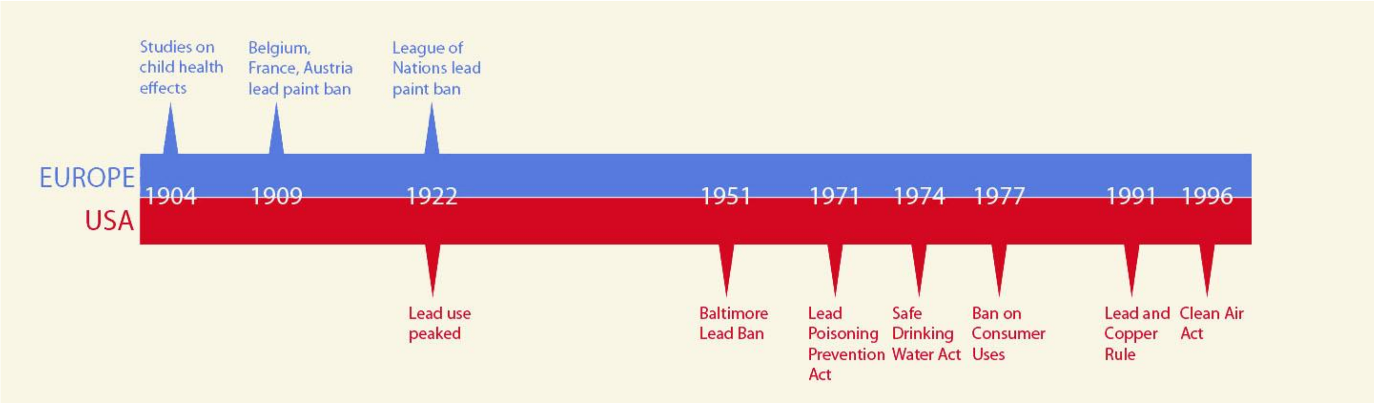
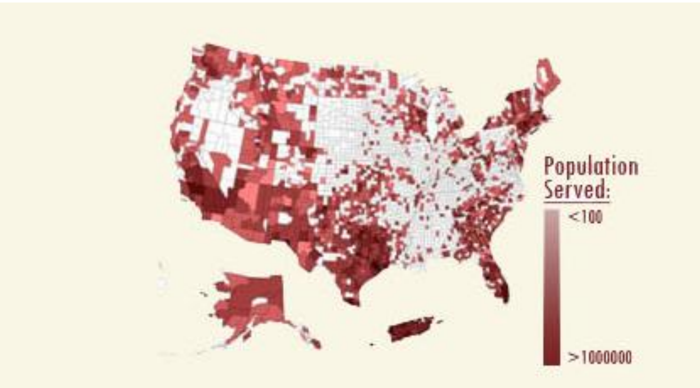


Figure 2. Lead Violations Across the U.S. (NRDC)



Despite all of the regulatory efforts to prevent lead poisoning, lead has resurfaced in the United States through the Flint water crisis since 2014. In March 2013, the Flint city council decided to stop buying water from Detroit, Michigan in order to save money and switched to Lake Hurron, which will be available to use with a new pipeline project. In response, Detroit announced they will cut Flint's water by April 2014 before the Lake Hurron project ends. Flint was forced to find another water source started getting water from Flint River. Since Flint does not buy treated water from Detroit anymore, they had to treat Flint River water and consequently treatment plants were upgraded which cost millions of dollars to the city. However, adding corrosion control agents to the water was not designed as a part of the treatment process. Lack of corrosion control caused lead particle to be released into drinking water (Wilson 2015). A sudden increase in hospitalization rates drew intense media coverage and led to the confirmation of a national crisis. Following media coverage of Flint water crisis , the situation caused an outcry throughout Flint and the nation. The Flint crisis brought to the surface 5300 systems across the country in violation of the lead rule (Ganim 2016), signaling a widespread public health crisis (Kennedy et al. 2016).

2. Exposure Pathways

In general, lead containing water supplies and plumbing systems are the primary sources of lead exposure. Direct water sources are rarely the cause of lead poisoning.

Flint was an example of this. Flint's water administrators decided to start using and treating Flint River's water after discontinuing to purchase treated water from Detroit. Consequently, the additional step of adding corrosion control agents to the water was not included as a part of the treatment process. Issues and inquiries regarding the water quality became more evident when the taste and odor of the water was abnormal. In response, city officials advised residents to boil and flush their water. The increased amounts of chloride added to the water during the treatment process, caused the abnormal taste and odor in the water. The chloride was used in order to disinfect coliform bacteria. As a result, the increased chloride levels caused corrosion to occur in pipes which released lead particles into the water.

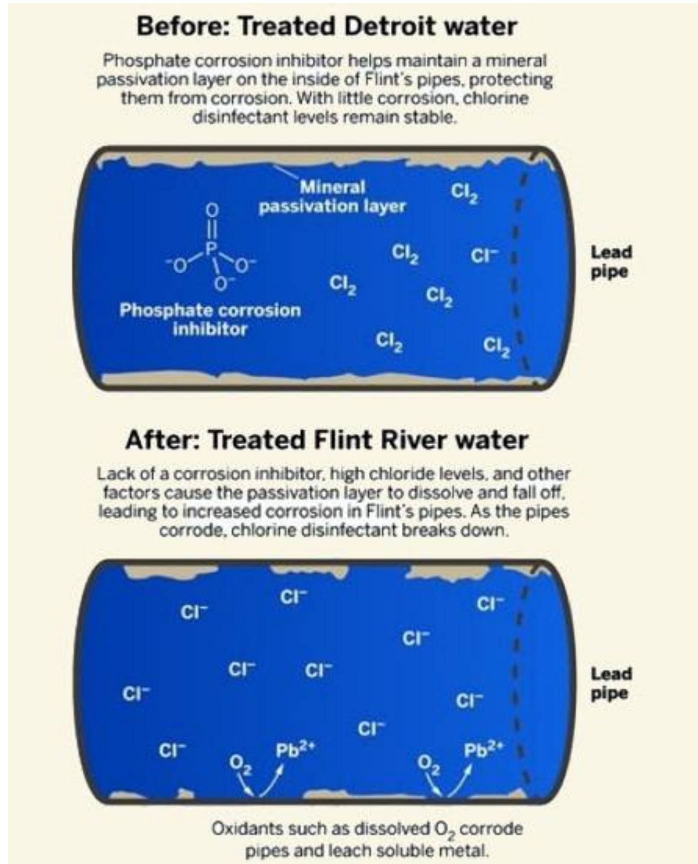
Increased exposure of lead in water systems is in fact due to old and deteriorating water infrastructure which contains lead pipes, lead based solder (Shannon et al. 1989) and leaded paint (Tong et al. 2000). Older houses built before the ban on lead in 1997 contain lead water infrastructure.

Chloride breaking down in the lead pipes releases oxygen, which reacts with the inner pipe surface and releases lead particles into the water. This chemical process is called corrosion. Corrosion occurs through electrochemical or chemical process of eating away at a material. In this case, metal pipes composed of and lined with heavy metals such as lead, cadmium and other metals will eventually corrode, diffuse metal compounds and then dissolve ions into the water. Both internal and external erosion of the pipes can occur. External corrosion occurs due to exposure of soil moisture and atmospheric oxygenation. There is a direct correlation with the amount of energy stored compressing the original metal ore and the rate at which the metal pipe will corrode over time.

Internal corrosion occurs due to the wearing of the lining of the pipe wall from various factors including: water pressure/high velocity, external pressure on the pipes, differing electron flow of two varying metals, chemical&electrochemical reactions in the form of oxidation and reduction. Varying chemical reactions of fluoride, chloride, oxygen, and hydrogen result in corrosion of various metals. In addition, corrosion can occur in particular areas of the pipe. For example there may be more corrosion where the pipe bends, at the pipe joints, pinholes, and pits. This occurs due to "a change in acidity/alkalinity levels, a change in oxygen concentration, a buildup of aggressive ion, and/or depletion of a corrosion chemical inhibitor" (Guidelines for Drinking-Water Quality 1996).

Lead can dissolve in water depending on several factors. Those factors include the presence of chloride and dissolved oxygen, pH, temperature, water softness, and standing time of the water, determines the corrosivity of water (Guidelines for Drinking-Water Quality 1996). The amount of corrosion is determined by the acidity of the entering water, the amount of lead in the pipes, the residence time of water in pipes, and the presence or non-presence of protective coatings (Lead).

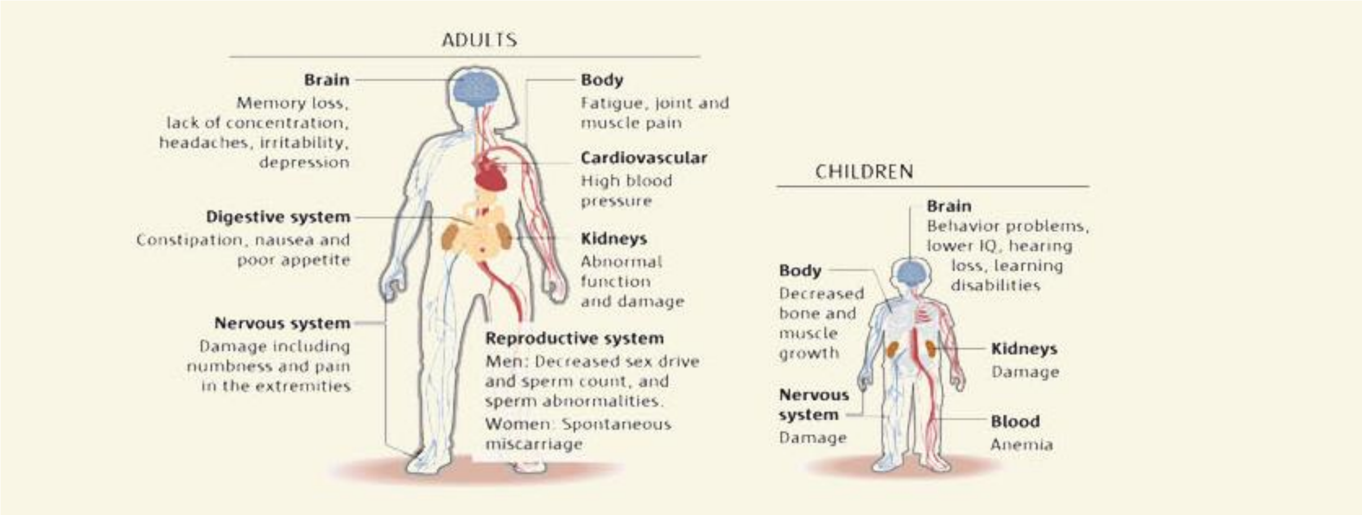
Figure 3. Corrosion in Flint's Lead Pipes (Torrice 2016)



3. Health Effects

Lead poisoning causes a variety of human health disorders, each having a combination with depending on different factors, such as exposure, quantity and age, which ultimately determines the severity and pathology lead poisoning has on an individual. This section will discuss the environmental health issues that are caused by oral and dermal lead exposure. It will also explain different health effects caused by lead exposure on adults and children.

Figure 4. Lead Caused Adult and Child Health Problems (Crosby 2016)



3.1. Adult Health

Many studies over the years have concluded that significant lead exposure is harmful to the human body. Lead can enter the body through the bloodstream from oral ingestion (drinking, eating soil, etc) or dermal pathways (washing hands, showering, etc). Small amounts of lead exposure in adults has been linked to increased chance of illness during pregnancy; harm to a fetus, including brain damage or death during pregnancy; fertility problems in both men and women; high blood pressure; digestive issues; nerve disorders; memory and concentration problems; and muscle or joint pain (Hu et al. 2007; Shih et al. 2007).

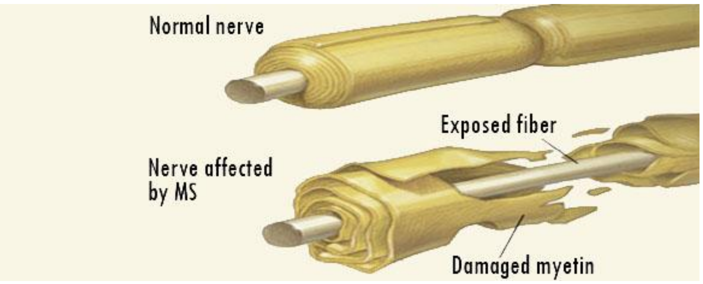
According to one study published in 2008, in the medical journal, PLOS Medicine, long term lead exposure is associated with reductions in grey matter volume of the brain in adults, which can result in degradation of a person's mind. Exposure to lead can also lead to deficits in “cognition, executive functions, social behaviors, and motor abilities” of those exposed.

In 2006 the scientific journal “Circulation”, discovered that long term exposure of lead can also be a “significant determinant of cardiovascular mortality.” Lead exposure is harmful and in the worst cases has the potential to cause death in adults. Although lead poisoning has a more adverse effect on children than in adults, no level of lead poisoning is deemed safe (Cecil et al 2008; Menke et al. 2006).

3.2. Child Health

There are several factors that affect the absorption, distribution and toxicity of lead. Children are more exposed to lead than older groups. Children’s normal hand-to-mouth activities may introduce many non-food items into their gastrointestinal tract (Lin-Fu 1973). It is important to note that lead exposure in children has a greater impact on their health in comparison to lead exposure in adults.

Figure 5. Lead Caused Nerve Damage (Mayo 2016)



According to the Centers for Disease Control and Prevention (CDC) blood lead levels (BLLs) of 10 µg/dl serve as the threshold of concern in young children (Standard Surveillance Definitions 2016). However, recent studies reported the possibility of adverse health effects at lead levels below 10 µg/dL, suggesting that there is no safe level of exposure (Fernando 2005).

Childhood lead poisoning can cause adverse health effects later on in adulthood including renal effects, hypertension, reproductive problems and developmental problems like attention deficit hyperactivity disorder (ADHD; CDC 2007). There is also evidence linking between ADHD and hearing impairment in children increase with increasing BLLs, and that lead exposure may disrupt balance and impair peripheral nerve function (ATSDR 2005).

A severe impact of lead poisoning on children is issues within the central nervous system (CNS), specifically issues with children's cognitive development. When lead enters into the CNS of a child, it can breakdown the myelin sheath, which is responsible for insulting the pathway of neurons which are responsible for passing signals throughout the brain from nerve cell to nerve cell (Figure 5). Essentially, damage to the myelin sheath can cause learning disabilities in individuals by affecting the speed and efficiency of neural messages throughout the brain (Moyer 2009).

4. Socio-economic Consequences

Besides its hazardous health effects, lead exposure is also related to socioeconomic realities. The presence and effects of lead exposure do not only depend on biological factors, but on economic and social conditions. Lead-sourced health problems are more serious for minority, urban and low income families (Brody 1994). Federal bans on consumer uses of lead in the U.S. were proposed in 1977. Most houses built before 1977 contained lead in the water infrastructure. Low income neighborhoods tended to have elevated blood lead levels (Knorr 2016).

A recent study on the lead incidences in Flint shows significant increases in blood lead levels after Flint's main drinking water source changed. Although, the previous BLLs were already high, not all parts of the city were affected equally (Hanna-Attisha et al. 2016). Other studies in different cities and states also indicate positive relationships between poverty and lead exposure (Nriagu et al. 2006; Knorr 2016). Socio-economic status renders communities. Financial constraints restrict prevention and recovery actions, such as moving to a new home, renovation, pipe replacement, and tap filters (Knorr 2016; Nriagu et al. 2006).

> "Significantly, the biggest changes in predicted BLL since 2013 were also found in these impoverished neighborhoods; more stable neighborhoods in the far north and south of the city may have experienced improved predicted BLLs because of prevention efforts taken by the more-often middle-class residents in response to the water source change."
> (Hanna-Attisha et al. 2016)

5. Solution: An Overview of the Bill

In response to crumbling national water infrastructure, the Get the Lead Out Act of 2016 intends to address the crisis of unsafe drinking water and inadequate water protection of, specifically, low-income communities. The bill, proposed by Senator of Maryland, Benjamin Cardin, acts as an amendment to the 1974 Safe Drinking Water Act (SDWA). An earlier version of the bill was introduced by Congress in 2010 to redefine "l7ead-free" as 0.2% or less in lead concentration. Deterring from a focus on acceptable lead-levels, the Get the Lead Out Act of 2016 focuses on providing grants of $60,000,000 for each year from 2016-2021 to reduce lead in community drinking water supplies and delivery systems through the replacement of lead-pipe service lines. The act specifies eligible public and private entities, prioritizing low-income communities and entities providing for children. Furthermore, the bill stipulates that grants may only be given to entities that support water for human-consumption and have attained a record of actions to reduce lead in these sources.

Exposure to lead is associated with damages to the central nervous system and low-blood levels, which result in neurological and behavioral effects. The health consequences are both detrimental and irreversible. In 1974, the Safe Drinking Water Act (SDWA) sought to address many issues of water contamination, including lead exposure. Section 1417, Prohibition on Use of Lead Pipes, Solder, and Flux, set the maximum allowable lead content of pipes, pipe fittings, plumbing fittings, and fixtures to 0.25 percent lead. Later acts lowered allowable lead-levels to 0.2 percent and established requirements for community water systems serving more than 3,300 individuals to conduct vulnerability assessments and prepare emergency response plans. However, the recent catastrophe in Flint, Michigan and the ensuring water crisis has triggered national attention to continued prevalence of deleterious lead-levels in community water systems across the nation. In particular, the crisis in Flint has revealed the phenomenon of high water lead-levels in low-income communities. The Get the Lead Out Act of 2016 seeks to provide the financial assistance to enable low-income communities to avert similar tragedies. In offering public grants to support lead-pipe service line replacement for public entities and stipulations for associated private entities, the bill addresses the transboundary nature and socio-economic disparities connected with lead exposure.

Get the Lead Out Act of 2016 may also be cited as Grants and Education To Tackle Homeowner Exposure to Lead Ensuring America Drinks Only from Unpolluted Taps Act of 2016. This bill aims to provide grants for lead reduction projects to eligible entities. Eligible entities include community water systems, water systems in an Indian tribe territory, nontransient noncommunity water systems, qualified non-profit organizations, and government municipalities or states. A community water system is defined as a public water system that either serves 15 service connectors in year-round use or a public water system that serves at least 25 residents. In addition, the grant may only be used toward projects that address lead concerns in water for human consumption. Eligible entities must also have demonstrated multiple alternative attempts to reduce lead in drinking water. This must include an evaluation of corrosion control options.

A lead reduction project refers to any project that seeks to reduce lead-levels in water for human consumption. Projects may include replacement of portions of public service lines containing lead; testing, identifying, and addressing places of vulnerability and implementing corrosion control practices; provide assistance to low-income homeowners to replace private service lines; and providing education to consumers. The bills stipulates that replacement of portions of service lines still connected to lead service lines are not considered lead reduction projects.

The bill is targeted to support communities in need of financial assistance and at the greatest risk. Low-income will therefore be defined by the authority of the jurisdiction. In addition, a municipality may include any public entity pursuant to State law, as well as Indian tribes.

This bill aims to provide grants for lead reduction projects to eligible entities. Eligible entities include community water systems, water systems in an Indian tribe territory, nontransient noncommunity water systems, qualified non-profit organizations, and government municipalities or states. In addition, the grant may only be used toward projects that address lead concerns in water for human consumption. Projects must also have identified the source of lead in the water. The bill also grants the Administrator the right to evaluate and assess projects methods and applicability. Eligible entities must have also demonstrated multiple alternative attempts to reduce lead in drinking water. This must include an evaluation of corrosion control options. The bill also grants the Administrator the right to evaluate and assess projects methods and applicability.

This bill is not intended to fund all lead pipe replacements. It is instead targeted to support communities in need of financial assistance and at the greatest risk. Entities will be prioritized based on a 3-year track record of lead levels. In addition, the proposed project must address lead levels in water for human consumption at facilities that either primarily serve children or vulnerable populations. Such other priorities may determined by the administrator. Proposed projects must be consistent with the goal of reducing lead levels that are of concern for populations.

The grant is intended to enable public entities to replace lead service lines. The bill mandates that the non-federal share of the total cost of the project shall not be less than twenty-percent. However, the administrator may waive all or part of this cost due to financial need. Assistance may be used toward the replacement of lead service lines sections owned by low-income homeowners. For low-income homeowners, grants may not exceed the cost of replacement.

Public entities must inform customers before proceeding. In addition, due to the transboundary nature of lead contamination, public entities must ensure that connected private lines do not contain lead. Therefore, the grant also aids private entities to replace portions of the lead services lines that are privately owned. Due to the nature of the grant, lead service line replacement is available to non-low-income homeowners at the cost of replacement. Grants are available to support low-income homeowners at the cost of the difference between replacement and eligible financial assistance. If all criteria are met, the Get the Lead Out Act authorizes grants of $60,000,000 between the years 2016-2021 to fund lead service line replacement.

6. Implementation

Copper and Crosslinked Polyethylene (PEX) pipes are two practical alternatives to lead pipes. Essentially, both of them are relatively non-toxic and function effectively for plumbing systems. About 80% of pipes are copper and %20 are plastics. In recent years, use of crosslinked polyethylene (PEX) has grown by about 40% each year. PEX is equally reliable as copper, but less expensive and easier to install (Romano 2006).

Crosslinked polyethylene and copper have been widely used in newer water service lines. PEX is a polyethylene (plastic) material which has undergone a change in molecular structure using a chemical or a physical process whereby the polymer are chemically linked. (Kelly 2014) This modified structure significantly improved the chemical stability of the pipes in terms of high temperature, pressure strength, resilience to acidic or alkalic environment, abrasion and stress-crack resistance. As a dielectric material and a non-conductor, PEX will not corrode like most metal pipes. Moreover, the smooth interior of the PEX pipes can prevent mineral buildup in either hard or soft water. The safety of PEX pipes has been strictly regulated ASTM F 877 (Standard Specification for Crosslinked Polyethylene (PEX) Plastic Hot-and Cold-Water Distribution Systems). The water safety of PEX pipes is certified by third-party testing institutions such as the National Sanitation Foundation (Plastic Pipe Institute 2012). With the exception on being place outside, PEX pipes cannot be placed outside due to reaction with UV radiation, PEX pipes can be installed easily and for a variety of applications (Emil 2014). They do not require the use of solders, flames or chemicals for household installation. Use of PEX piper can enable households to reduce pressure drops, maximize fast delivery of hot water, and reduce wasted water to save water bills (Plastic Pipe Institute 2012).

Copper belongs to the Group 11 element in the periodic table, which is the same group as gold and silver. They share a few common chemical properties - durable, galvanic, corrosion resistant, and unaffected by UV radiation. In particular, copper can withstand 1,000 psi of pressure. Due to its ability to form stable compounds, copper is more resistant to corrosion and corrodes more slowly than other metals. Compared to silver and gold, copper is less expensive and lighter. The ductile quality of copper pipes helps eliminate elbows and joints during installation, which makes it more economically reasonable for pipe usage. Compared to plastic, copper is more environmentally friendly because it is a natural mental without any artificial materials and it can be recycled over time (The advantage and disadvantage 2014). About half of the copper used in the U.S. is made of recycled scrap (Ten Advantages of Copper).

Based on these properties, copper can be joined easily by soldering for plumbing systems. From the toxicological perspective, copper is an essential element for living organisms that is needed in the final steps to produce energy. Copper has many functions within the body including: fixing calcium in the bones, building or repairing all connective tissues, producing energy, estrogen metabolism, stimulating the production of the neurotransmitters epinephrine, norepinephrine and dopamine, all of which deeply impact our brain function (Uauy 1998; Watts 1989).

7. Controversies

7.1. Controversy on PEX Pipes

Cross-linked Polyethylene (PEX) pipes pose long-term threats to the ecosystem because they cannot be recycled. PEX pipes form an impermeable membrane, which aggravates the accumulation of pollutants in pipes. A 2014 study found sixteen types of unsafe organic chemicals in PEX pipes. Many of these chemicals are linked to cancer, birth defects, genetic changes, chronic bronchitis, ulcers, skin diseases, deafness, vision failure, indigestion, and liver dysfunction. (Kelly 2014)

Leaching and weathering of the pipes can contribute to elevated levels of organotin in drinking water. Organotin has a wide range of adverse health effects, including the human nervous system. These chemicals can also impact wildlife negatively, such as through disrupted fish metabolism. (Jones-Lepp et al. 2001). Wildlife can also be negatively impacted by these chemicals, such as the adverse effect on fish metabolism (Jones-Lepp et al. 2001).

PEX pipes are also characterized as “flexible conduits,” meaning they have a high capacity to strain from soil. This means that they will deflect at least 2% of loads without any sign of rupture or cracking. Engineers have expressed benefits of deflection, as well as concerns that deflection could cause pipe failure. They provide much less strength than more rigid pipes, however, they can achieve greater strength when the proper pipe/soil balance is achieved. In addition, plastic piping systems are predicted to have a lifetime of minimum 50 years and possibly exceeding 100 years.

7.2. Controversy on Copper Pipes

The major concern with copper is toxicity. Copper pipes have been proven to have long-term durability in non-acidic installations. Copper is also biostatic, which means it can inhibit bacterial growth (Builders Websource 2014). However, soft, low alkalinity waters will cause relatively high copper corrosion by-product release in plumbing systems (Edward 1986).

There is still much uncertainty involved in the assessment of copper toxicity. Although copper is not classified as a human carcinogen by the United States Environmental Protection Agency (USEPA), many question its safety and long-term impact on humans.

Copper can affect any organ of the body, including the nervous system and reproductive system. Copper has also be known to cause cancer, Alzheimer's disease, Parkinson's disease, and cardiovascular disease. Children under the age of one are particularly susceptible because they have not developed the mechanisms to cope with the toxic effects of copper corrosion (Uttara et. al. 2009; Networx 2011)

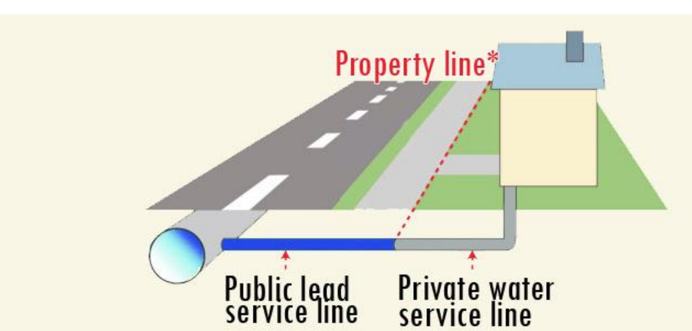
In addition, the use of copper pipes is associated with the negative impacts of copper mining, including alteration of land use water pollution, heavy metal dispersions (iron, sulphur, lead, cadmium, zinc, and manganese), and health hazards over the long-term (Wilson, 2007).

Tradition acid mine drainage causes sulfides to leach into the surrounding environment through percolation and drainage (Pandey 2007). Copper exposure can also have serious health consequences.

An unsafe dose of copper can lead to Wilson's disease and Menkes disease. Both genetic disorders result from a mutation in an enzyme involved in the transport of copper into cells. Chronic exposure to copper also leads to incremental risk factors for coronary heart disease and lung cancer. The long-term exposure to the high concentration of the copper can affect the intelligence in young people (Adam, 2001). Copper mine workers often suffer from excessive external exposure to copper during smelting, conversion, and electroplating process. Further studies are needed to decide what level of copper exposure will cause non-cancer effects on nervous and reproductive systems. Animal testing exposes contact with copper can cause a decrease in fetal growth. The impact on humans has not been tested.

With the recent development of mining technology, it is expected that the negative impacts of copper mining can be diminished significantly in the future. For instance, in-situ recovery (ISR) has been more widely used in copper mines, which is a more environmentally friendly extraction design. In particular, ISR does not require digging up the host rock to remove the minerals or metals, reducing damage to groundwater systems. In addition, ISR includes a looped system. It also includes a closed loop system to recycle water during the extraction process and reduce noise and dust emissions (Excelsior 2016).

Figure 6. Public and Private Service Lines



7.3. Partial Replacement Problem

The Lead and Copper Rule, which became effective in 1991, initially required all lead pipes to be replaced whether they were publicly or privately owned. However, this decision lead to controversies over affordability. In 1994, the EPA restricted the Lead and Copper Rule to public portions of lead service lines. Consequently, the Lead and Copper rule was revised to allow partial replacements and allow the public utilities to offer this service to homeowners at cost. Current controversies regarding pipe replacement mainly focus on partial replacement and the health impact of alternative materials.

The partial lead service pipe replacements (PLSPRs) have been debated for years regarding whether they are safe and effective or hazardous and ineffective (Renner 2010). Based on the research on the Washington, DC lead pipe replacement case, even after the PLSPR, the affected children still had 10 µg/dL or more blood lead levels, higher than the EPA's safe level for lead (CDC 2010). Results also suggest that PLSPR causes increased blood levels compared to no pipe replacement. After the Flint lead crisis, the issue of lead exposure was on public radar and the risks of PLSPR gained national attention. Consequently, a lawsuit was filed against Chicago city government related to partial pipe replacement (Bliss 2016).

Another pilot study on PLSPRs indicates that partial replacement of lead pipes with copper pipes causes lead levels to increase by 40%. Without the installation of copper pipes between the iron main and lead pipe, the iron could protect the lead pipe from corrosion catholically. Thus, replacing the publicly owned portion of lead pipes with copper is ineffective in ameliorating the corrosion condition. Decision makers must be aware of the possible consequences of their actions (Justin et al. 2016).

Despite the increasing amount of research regarding PLSPR, most of the evidence lacks solutions that aid in mitigating the associated health risks. Many confounding factors can create bias between the differences in lead in blood between a household with a PLSLR and a household with an intact lead service pipe. Moreover, most incidences of blood lead level increases occur during the initial stage. Blood lead levels stabilize within two weeks of exposure.

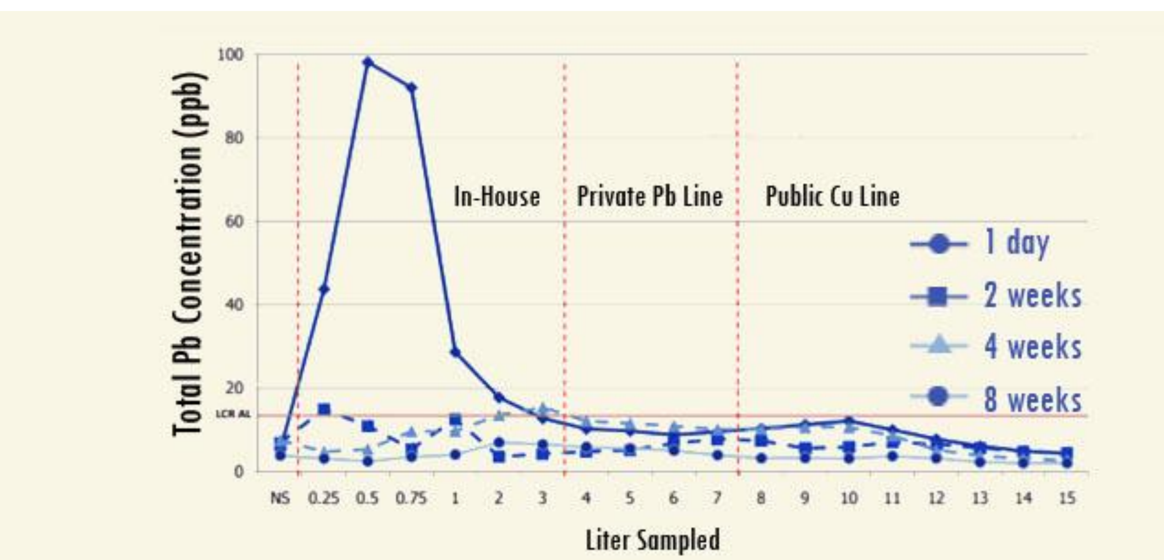
According to the Washington DC Water and Sewer Authority, research linking a relationship between BLLs and PLSPR are not representative for all cases and are inconsistent across different places (Figure 7). DC eventually stopped the partial lead pipe replacement program in 2008 (Renner 2010). Further research is necessary due to the limitation of the data and the long-term relationships between PLSLRs. Children's BLLs remain controversial.

7.4. Lead Disposal Problem

The EPA defines all disposed products containing lead as hazardous waste. They must be managed and treated according to the hazardous waste protocol. Lead pipe extraction has become a huge threat to the health of local workers and residents within close proximity to landfills and waste sites. Also, lead can leak into the atmosphere, soil and water from the site to the hazardous waste depository. While the protocol gives clear guidance on how to dispose of lead wastes, EPA has not clarified the different levels of health impact associated with variant exposure frequencies. There are still ongoing debates over how to minimize the hazardous effects from lead disposal.

Integral pipe replacement is not financially feasible to solve all lead problems in the water system due to tremendous financial costs. Although partial pipe replacement, PEX pipes, and copper pipes remain controversial, the government needs to invest more funds into new technology to reduce the pollution from copper mining and recycled PEX pipes.

Figure 7. Lead Release Due To Partial Replacement, DC (EPA 2011)



8. Measuring the Success

Measuring the effectiveness of policies and programs require definitive objectives. Achieving the primary goal indicates the successfulness of the program. The objective of the Get the Lead Out Act is to efficiently and effectively reduce the amount of incidences of lead exposure. Assessing the effectiveness of the program requires measuring the degree of improvement and counting the number of people exposed. Replacing corroded pipes and educating residents will help minimize lead exposure. Blood lead levels and water assessments will indicate reduced lead levels in water. Lastly, lead awareness and behavior change tests will verify the impact of education.

The CDC indicates allowable lead levels of 10 ug/dl, even though there is no safe level of lead (Environmental Health 2016). To measure lead levels of lead-polluted communities, two blood tests will be administered among residents, one before the pipe replacement and one after the pipe replacement. Differences between blood tests will reflect the impact of removing corrosive pipes on exposure to lead through drinking water. In addition to measuring the lead level through blood testing, the source of lead contamination, drinking water, can also be assessed. Drinking water is one of the main routes of exposure, and is one of the easiest to target and address. Water sampling tests will be conducted pre- and post- pipe replacement to determine any changes in lead levels. The initial tests will be conducted pre-pipe replacement and used as a baseline. If results from the second tests are significantly lower than the baseline, then the pipe replacement can be deemed as effective in eliminating lead contamination.

A recent study observed people who are exposed to educational programs experience priority and goal changes (Ranney et al. 2011). Randomized control trials (RCT) for residents in the lead-polluted communities will assess the intervention's benefits and longevity. Randomized sampling of the population is necessary to avoid omitted variable biases. One group of residents will receive the education (experimental group), and the other group will not be given any education until the late period (control group). Groups will be compared pre, mid, and post educational programming. Final tests will assess long-term retention. Results from the RCT will determine the significant contributing demographic, economic, and environmental factors that impact lead awareness. The final tests will determine if the interventions yield any significant differences after a delayed period. Ghisi et al. 2014 found correlation between education and behavior. There are a few simple ways of monitoring results. Assuming educational programs have taken place nationwide, one of the best ways to measure behavioral change is through surveys conducted by email, website, or telephone.

Figure 8. Measures of Success

Researchers can ask randomly selected people if they change their behavior after becoming aware of lead exposure through drinking water. Benchmarks can track changes from baseline metrics. Successful education programs will implicate statistically significant change between pre- and post- education behavior.

9. Recommendations

The Get the Lead Out Act of 2016 focuses on providing grants of $60,000,000 (each year from 2016 to 2021) to reduce lead in community drinking water supplies. Specifically, the bill discusses using education and lead replacement as a means to address the issue. Based on our analysis of previous lead remediation plans such as the DC water crisis, a mechanism of educational and infrastructure grants was created to help resolve this crisis.

It is pertinent to note that $60,000,000 is not a sufficient amount of money to fully address this issue, but it serves as "seed money", incentivizing stakeholders to take more action to rectify the lead issue in America. This section will provide a thorough financial breakdown of the educational and infrastructure grants that we crafted to reach the highest outcome.

Addressing lead exposure and elevated bloods levels requires both service line replacement and lead education. Given the constrained funds we recommend that from 2016-2021 $3-5 million dollars be allocated toward educational grants and the remaining $55-57 million be allocated toward infrastructure grants. The $3-5 million allocated toward educational grants will focus on teaching multiple audiences about: health issues that arise with lead poisoning, preventive solutions to eliminate lead exposure, ways to test for lead and outlets to explore if an individual is exposed to lead.

Based on social cognitive theory, individual learning can be triggered by simply observing the model of behavior and the consequence of that behavior (Luszczynska 2005; Bandura 1977). The intended goal is that education on the health issues of lead and the diverse pathways of exposure will lead to new practices to minimize exposure. For instance, households might arrange regular water testing and individuals might participate in regular blood lead level screenings.

In addition to knowledge itself, diverse communication channels, especially the use of the internet will increase the spread and effectiveness of lead education with considerably low marginal cost. From 2005 to 2009, participation in social networking sites more than quadrupled (Jones 2009). Although social media can be an incredibly powerful teaching tool that can change attitudes and culture, digital technologies are not uniformly distributed across age groups. Additional forms of education are necessary, such as newspaper coverage and face-to-face contact (Chou et al. 2009). Education serves an imperative part of combating lead issues in America.

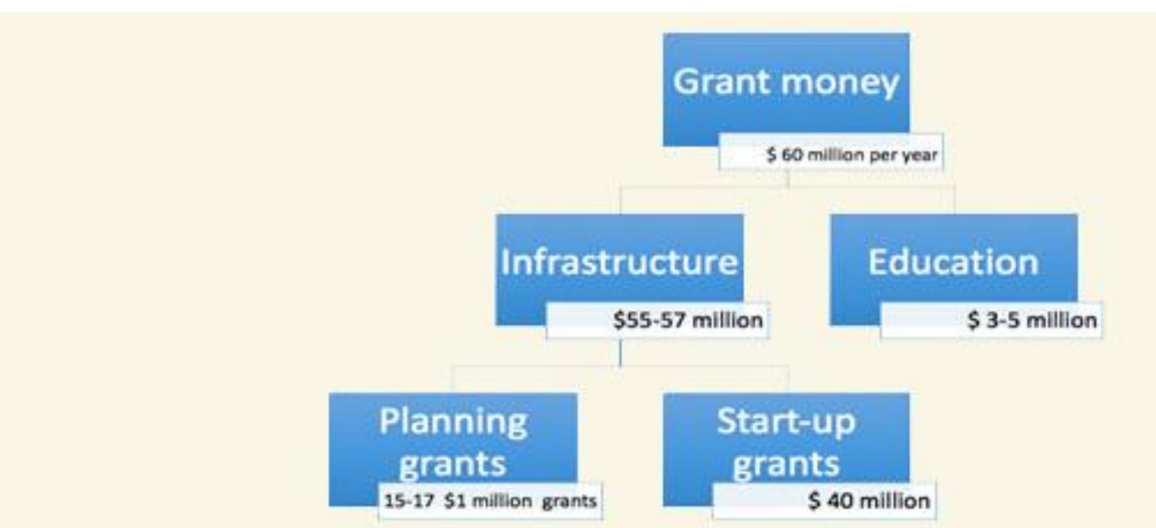
As it pertains to infrastructure grants the $55-57 million should be separated into 55-57 $1 million planning grants for the first year. This will be dispersed to 55 cities across the country. For the remaining years infrastructure grants should be allocated to include more planning grants and an option to apply for start-up grants. Specifically, fifteen $1 million grants will be made available for planning grants and $40-million for startup grants. Extending the option for planning grants allows applicants to conduct the necessary first steps in pipe replacement in order to garner further funding. The grants ensure that planners address all aspects and consequences of the project, including health and finance. This required step of accessing one's problem via planning grants also ensures that people are educated about all aspects (health and finances) that goes along with lead pipe remediation.

In assessing the lead issue in America, it is important to note that $60 million is not enough to support the type of large scale of replacement and remediation. In fact, DC alone spent more than $350 million in 2004 to mitigate their lead pipe issue and still more than half of homeowners in DC have lead in their pipes. Service line replacement projects involve the replacement of both the public and private infrastructure at one time. In larger communities, costs can reach into the billions of dollars. For example, the start-up cost for pipe replacement in Flint is estimated to be nearly $55 million (Dolan 2016). $60 million allocated toward this bill serves as "seed money" incentivizing stakeholders to take more action and create more financial assistance opportunities to rectify the lead issue in America.

10. Conclusion

Due to the pervasiveness of lead in our infrastructure, the project of reducing lead exposure will most likely require a multibillion dollar investment to replace all of America's lead service lines and to remove lead from soils and paints. The Get the Lead Out Act of 2016 aims to implement more immediate low-cost steps to address a widespread public health disaster. Education, corrosion control, and planning grants are crucial steps to avert serious long-term health consequences. Although complete replacement and removal will be necessary, as there is no safe level of lead, these small steps greatly reduce toxicity. In addition, the funding that the bill provides helps children and low-income families achieve rightful health. It is our hope that through The Get the Lead Out Act of 2016, American will be able to make great strides toward a lead-free, healthy, and productive society.

Figure 9. Proposed Distribution of Grant Money



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Appendix

PEX: Cross linked polyethylene

PVC: Polyvinyl chloride

CPVC: Chlorinated polyvinyl chloride

CDC: Centers for Disease Control and Prevention

ADHD: Attention deficit hyperactivity disorder

BLLs: Blood lead levels

IQ: Intelligence quotient

PLOS: Public Library of Science

HHS: U.S. Department of Health and Human Services

EPA: U.S. Environmental Protection Agency

UV: Ultraviolet

FDA: U.S. Food and Drug Administration

RCT: Randomized control trial

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