Our Health, PVC, and Critical Infrastructure

CEH
CENTER for ENVIRONMENTAL HEALTH

About CEH

The Center for Environmental Health (CEH) is a nonprofit organization committed to protecting people from toxic chemicals by working with communities, consumers, workers, government, and the private sector to demand and support business practices that are safe for public health and the environment. CEH assists large purchasers from government, education, healthcare, and private businesses to prefer healthier products and leverages their buying power to move the market towards safer products.

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Executive Summary

Polyvinyl chloride, commonly known as PVC, is a plastic resin present in many consumer and industrial products. This report outlines the adverse public health and safety risks, environmental impacts, and costs of widespread PVC usage in municipal water and sewer infrastructure. As national, state and local decision makers wrestle with replacing and upgrading billions of dollars worth of critical infrastructure systems, this report aims to provide clear evidence for reducing or eliminating PVC use in municipal systems for health and economic reasons.

"Our Health, PVC, and Critical Infrastructure" delves into the following:

- Harmful chemicals associated with the production of PVC pipes;
- Long- and short-term costs associated with PVC pipes;
- Health and safety hazards of PVC exposure;
- Moving beyond PVC: Passing legislation to reduce PVC and educate consumers about its presence in their lives.

The report also discusses the lobbying efforts of the plastics industry on city, state, and federal agencies to adopt legislation that would require water utilities to utilize plastic piping materials. More studies are needed to better assess the dangerous impacts of PVC across the country. Second, the depth of pro-PVC activities should be investigated and exposed. Finally, CEH also supports efforts to promote environmentally friendly pipe solutions.

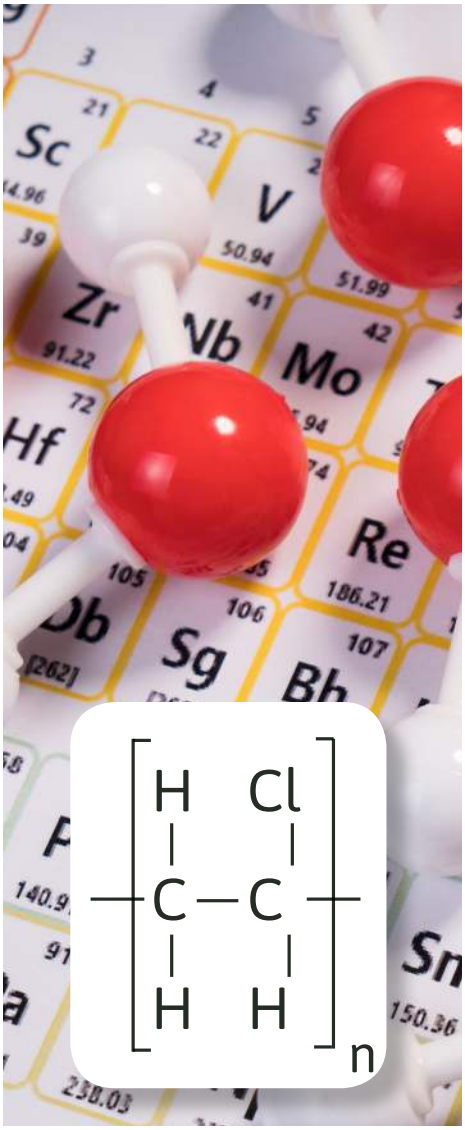
Introduction

Polyvinyl chloride, commonly known as "PVC" or "vinyl," is a plastic resin that is used in many consumer and industrial products such as furniture, medical supplies, containers, packaging film, electrical insulation, water-distribution systems, flooring, windows, and irrigation systems.[1] The environmental and health dangers of PVC used in children's clothing and lunchboxes, baby bibs, gloves, and furniture have been the focus of past successful Center for Environmental Health (CEH) campaigns to eliminate the use of toxic PVC plastic in these common items. CEH has also supported efforts to protect workers from hazards of installing PVC pipes. In addition to the dangers of the chemical involved in the production of PVC, many PVC products contained toxic additives such as lead to increase stability, which can cause learning and developmental problems, and phthalates to increase flexibility, which can cause reproductive harm.[2]

This report focuses on the dangers of the widespread use of PVC pipe in municipal water and sewer infrastructure. Numerous local and regional governments around the world have proposed policies to avoid PVC in construction,[2] and the Bay Area cities of San Francisco, Oakland, and Berkeley have each passed resolutions to reduce, and in some cases phase out, the use of PVC products.[3]

The issue has also been actively debated by advocates for green and sustainable building. In 2007, the U.S .Green Building Council (USGBC)'s review of building materials that would potentially qualify for their LEED standard sparked such a debate. As part of the review, a study of the "health effects and negative environmental impacts of PVC" was undertaken. The report filed with the USGBC found that further deliberation was necessary to determine whether credit in the LEED program should be awarded for avoidance of PVC in construction projects. But the study authors also noted that "when we add end of life with accidental landfill fires and backyard burning, the additional risk of dioxin emissions puts PVC consistently among the worst materials for human health impacts."[4] However, many other cities throughout the U.S. are investing in PVC pipes because they can initially be cheaper than using other materials such as cement, steel, copper, or iron, although the latter materials have proven to be more reliable, durable, and longer lasting. Despite the toxic nature and the inherent dangers of plastic to our health and the environment, PVC and chemical lobbyists in the U.S. have attempted to leverage legislative advantage in governments at all levels throughout the country.

This report outlines the adverse public health and safety risks and environmental effects of PVC as well as the long-term economic costs that make plastic PVC pipes a poor and often ill-advised choice for municipal infrastructure projects, specifically at the city level. Moving forward, CEH believes further studies are needed to better assess the deleterious effects of PVC across the U.S., and that the breadth and depth of pro-PVC lobbying in local government should be investigated and exposed. CEH also supports efforts to promote environmentally friendly pipe solutions.



Harmful chemicals associated with the production of PVC pipes

PVC products are made from toxic chemicals. Three core chemicals are part of the PVC production process: chlorine gas is converted into ethylene dichloride (listed by the U.S. EPA as a "probable carcinogen"[5]), which is then converted into vinyl chloride, the primary building block compound of PVC.[2] Vinyl chloride is currently used almost exclusively by the plastics industry to produce PVC and copolymers.[1] It is listed as a known human carcinogen by several governmental agencies, including the U.S. Department of Health and Human Services,[1] the U.S. Environmental Protection Agency (EPA),[6] the World Health Organization,[7] and the California EPA under Proposition 65.[8] The U.S. Occupational Safety and Health Administration (OSHA) has also regulated workplace exposure to vinyl chloride since 1974.[9] Since vinyl chloride was first listed by the Department of Health and Human Services in 1980 as a carcinogen, numerous studies have continued to provide strong evidence that exposure to vinyl chloride increases the risk of a rare form of liver cancer in humans.[6]

Totaling approximately 40 percent of the chlorine produced globally, PVC production represents the largest use of chlorine gas in the world, and PVC is the only major plastic that contains chlorine, used in buildings.[2] The chlorine chemistry necessary to make PVC releases toxic byproducts from its manufacture to its disposal. These accidental, yet unavoidable, by-products include organochlorines and dioxins, two different groups of chemically-related compounds that are classified as persistent organic pollutants (POPs) and included in the United Nations "Dirty Dozen" most harmful chemicals known to science. Numerous studies have found that exposure to organochlorines, even at extremely low doses, can cause serious health problems, such as endocrine dysfunction, developmental impairment, birth defects, reproductive dysfunction and infertility, immunosuppression, and cancer.[2] Exposure to dioxins can also result in cancer, birth defects, dysfunctional immune and reproductive systems, greater susceptibility to disease, and even diminished intelligence.[10]

Some experts argue that there is no known safe dose of dioxin, and some studies have not been able to establish a "threshold" dose below which dioxin does not cause biological effects.[2]

When considering PVC's entire lifecycle, including chemical reactions during production, accidental fires during use, and intentional burning of used PVC products and/or hazardous wastes from production, our partners at the Healthy Building Network associate PVC with more dioxin formation than any other single product. They also point out that the same chlorine chemistry that results in the production of dangerous chemical byproducts is a result of an "energy-intensive industrial process" and thus is a major contributor to the environmental effects associated withenergy production such as global warming, air pollution, acid rain, mercury emissions, and the generation of radioactive and other wastes from the mining, processing, and consumption of nuclear fuels.[11]

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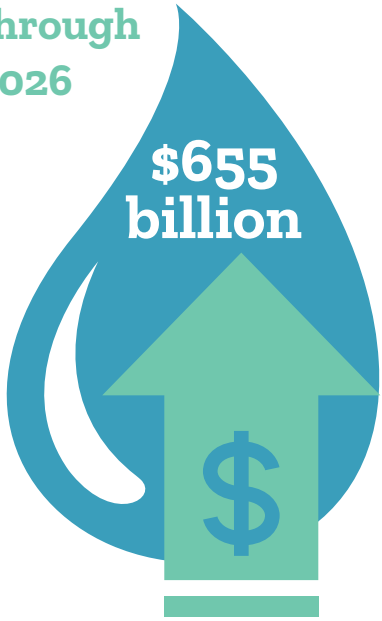

PVC water pipes: short- vs long-term costs

With a large portion of the 1.6 million miles of underground water and sewer pipes throughout the U.S.[12] currently ranging in age from 50 years old to over a century, the U.S. EPA has projected that over $655 billion dollars will be needed for drinking water and wastewater infrastructure through 2026.[13] This represents big money for pipe and hardware companies, benefitting from an estimated $300 billion, or 57% of municipal capital expenditures over this period.[12] In 2017, The New York Times featured a story on the industries involved in the lobby efforts around aging water infrastructure, calling the situation "a battle of titans, raging just inches beneath our feet."[14]

Although traditional materials like iron or steel make up almost two-thirds of existing municipal water pipe infrastructure, the president of the water advisory firm, Bluefield Research, predicts, "over the next decade, as much as 80 percent of new municipal investment in water pipes could be spent on plastic pipes."[14]

Seizing the opportunity, the plastics industry has partnered with political groups in an attempt to influence public policy at city, state and the federal level to adopt legislation that would require water utilities to utilize plastic piping materials, even when the utility and their engineers may determine that other materials would provide more benefits to their water system.[14] These efforts to influence lawmakers and legislation are pushing to require utilities to put a greater consideration of only the up-front cost for municipal piping bids, ultimately seeking to advantage the installation of "cheaper" PVC pipes, without consideration of other key factors for the utility, in turn resulting in a dangerous short-term gamble.

For local leaders, choosing piping materials involves both economic and public health considerations, and the reality of tight budget constraints leaves municipal accountants, lawmakers, project leads and engineers, and utilities no choice but to invest wisely in the materials they use. The 2008 financial crisis exposed a very real and ongoing tense conflict between shrinking budgets, rising costs, and needed government services. A decade later, municipal leaders search for new revenues to avoid raising taxes, fees, or passing expensive bond measures. With options increasingly limited, the prospect of less costly materials, such as PVC pipes for water infrastructure projects, can be an attractive solution. Unfortunately, cheaper up-front costs can end up only being short-term fixes. Unlike surface roads, highways, and bridges where costs to rebuild and repair can be shared over numerous jurisdictions, water infrastructure projects tend to be closed systems so one community must bear the costs. State and federal grant dollars only partially fund the work, and often come with strings attached as to how the money can be spent.

Researchers at Tufts University's Global Development and Environment Institute examined "The Economics of Phasing Out PVC" and found that, while choosing PVC pipe for water systems could be cheaper than other materials, "the continued use of PVC offers small short-term gains in some areas, and none at all in others." Over the long-term, the authors concluded that PVC products won't hold up as well over time; PVC poses health and

safety hazards over the course of its lifecycle; and the alternatives to PVC, which provide equal or better performance for almost every use of PVC, are either already comparable in cost when measured over the product's lifetime, or may currently be more expensive but will eventually decrease in cost as their "market share expands."[3]

The Tufts researchers stress two main points to project leaders:

- "The health hazards associated with the production, use, and disposal of PVC are, for the most part, avoidable. Alternatives are available across the range of PVC products. In some cases, the alternatives are no more expensive than PVC; in other cases, there is a small additional cost. Often there are good reasons to expect the costs of alternatives to decline over time."[3]
- "...rather than making a decision based on initial costs alone, purchasers can save money by comparing the full costs over the product life cycle of buying, installing, using, maintaining, and ultimately disposing of alternative products."[3]

Two neighboring cities in Michigan faced with the need to update their water infrastructure provide on-the-ground context for this type of cost comparison. In Flint, Michigan, the country witnessed a major public health crisis begin to unfold in 2014 after the city's water was found to be contaminated with lead. Today, after considering other materials including an offer of free PVC pipe, Flint is installing a new water system using copper pipes at an estimated cost of over $140 million, which is in direct alignment with the Tufts researchers' recommendations of prioritizing the long-term, lifecycle costs of piping materials. The retired Michigan National Guard brigadier general in charge of replacing the water pipes, Michael McDaniel, sums up the decision by saying, "When you take that inherent issue that we needed to rebuild trust of the citizens in the water system, we felt that copper was the way to go."[14] In stark comparison to this measured approach, and instead based on a reliance entirely on short-term economic considerations, the nearby city of Burton decided to save $2.2

Flint, Michigan

million in upfront costs to replace its aging water system with PVC pipes. “I’ve got to get the best bang for the buck, because bucks are hard to come by these days,” said Burton’s Mayor, Paula Zelenko.[14] The plastic industry supported American Legislative Exchange Council (ALEC), openly criticized and lobbied against the fiscally prudent, long-term, lifecycle approach deployed in Flint as an exercise in “[un]competitive bidding”.[14 15]

Water system failures on the municipal level are complex, costly, and pose serious health risks, inconveniences, and lifelong consequences to the affected community. CEH considers the lesson of Flint, Michigan to be that long-term economic, environmental, and public health considerations should take precedence in any local decision-making process.

Health and safety hazards of PVC exposure

There are a substantial amount of environmental and human health hazards that can result from the manufacture, use, and disposal of PVC pipes.[2] These include health and safety hazards to workers at PVC production and disposal sites and to neighboring communities, the release of highly persistent and bioaccumulative chemicals from production and disposal, accidental fires during use, and PVC accumulation in landfills due to its difficulty to recycle.[16] Additionally, as vinyl chloride, a known carcinogen, is produced almost exclusively for PVC, the U.S. Agency for Toxic Substances and Disease Registry states that "individuals located near or downwind of vinyl chloride production facilities, hazardous waste disposal sites, and landfills may be exposed to atmospheric levels higher than ambient background levels.[17]

Mossville, Louisiana

The toxic pollution PVC creates during its manufacture harms workers and community members near PVC plants, such as in Mossville, Louisiana. The industrial boom that took place in America following World War II found its way to this small, historically African American town in southwest Louisiana, where chemical plants and other manufacturing facilities took root. PVC plants brought jobs and prosperity to an unincorporated area of Calcasieu Parish, but over the course of three generations, those plants also brought sickness and despair.

Mossville, home to four vinyl production facilities, including two major vinyl chloride manufacturers, is considered the unofficial PVC capital of America.[18] According to the U.S. EPA's Toxic Release Inventory, thousands of pounds of carcinogens such as benzene and vinyl chloride are released from the facilities near Mossville each year. In both 1998 and 2001, the federal Agency for Toxic Substances and Disease Registry tested the blood of twenty eight Mossville residents and found dioxin levels three times the national average. While industry claims that emissions from the plants, "have no ill effects on the local community," like many others in the area, Mossville resident, Herman Singleton Jr., 51, has cancer and has also lost his father, two uncles, and an aunt to cancer.[19]

Santa Rosa, California

In 2000, Mossville residents petitioned the EPA to clean up their town. Edgar Mouton, Jr., former president of Mossville Environmental Action Now (MEAN) testified at the EPA National Environmental Justice Advisory Council meeting that, "People are sick and dying in our community because of the high levels of dioxins found in our blood... We have a lot of people sick. There's a lot of people with some type of illness, lungs, or some with cancer that I know of. There's a lot of sick people there that the doctors don't know what's wrong with them."[20] In 2002 the U.S. EPA issued emissions regulations for PVC plants, but only provided emission standards for vinyl chloride as a surrogate for all other air toxins. A decade later, the EPA adopted new regulations that included reductions for dioxins and hydrogen chloride.[21] However, according to the Center for Health, Environment & Justice (CHEJ), the EPA "reversed its plan to protect the community in the final rule," resulting in a lawsuit filed by CHEJ and partners "to challenge the weaker protections as unlawful and arbitrary."[22]

Additionally, after the 2018 Sonoma County wildfires, the Fountaingrove water system was found to have unsafe levels of the toxic chemical benzene flowing throughout the system from melted plastic water pipes. Thus far cleaning, flushing, and replacing effected parts of their water system have failed to get the known cancer agent out of their system. Conservative estimates have projected that it will cost upwards of $43 million to repair and make the water clean again for the residents of Santa Rosa.[23]

The release of toxic lead (a stabilizer that was once used in the production of all PVC but is no longer used in the manufacture of PVC pipe in the U.S.) through leaching or incineration can also be of concern if imported PVC pipe is being used. Plastics News reported in 2013 that although Chinese national standards banned lead stabilizers in PVC pipes used for water supply in 2006, lead remained the "stabilizer of choice" in over 90% of China's PVC pipe due to lack of government enforcement. India, the Middle East, and South Africa were also noted as using lead in large portions of their PVC pipe systems.[24] In extremely small doses, lead can damage brain development and reduce cognitive ability and intelligence.[2]

In 2015 approximately 6300 million metric tons of plastic waste had been generated

9% of which had been recycled

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79% accumulated in landfills or the natural environment.

Researchers also note the need for additional research into how plastic pipes, including those made from PVC, interact with chemicals used to disinfect drinking water.[25] Scholars, in the 2015 Journal - American Water Works Association, found that some plastic pipes have leached chemicals into the water supply that are carcinogenic in nature while other leached chemicals have been found to actually be conducive to bacterial growth in certain water systems.[26]

In July 2017, Science Advances published a study that stated, "As of 2015, approximately 6300 million metric tons [Mt] of plastic waste had been generated, around 9% of which had been recycled, 12% was incinerated, and 79% accumulated in landfills or the natural environment. If current production and waste management trends continue, roughly 12,000 Mt of plastic waste will be in landfills or in the natural environment by 2050."[27] For PVC specifically, very little postconsumer product is recycled at all, with most instead discarded in landfills, and the remainder burned.[2] In contrast, metal pipes are highly recyclable and are often already made from recycled materials. Due to the complexity of recycling PVC (#3 plastic) as a result of some products containing other toxic additives, in 1998 the American Association of Postconsumer Plastics Recyclers stated it would now consider PVC products "unrecyclable contaminants in the municipal waste stream" due to their failed efforts to recycle PVC.[28]

With the recycling of PVC not a viable disposal option, most winds up in landfills. The Healthy Building Network stresses three main concerns with PVC in landfills:

1. PVC typically lasts for centuries in a landfill, posing a significant burden on the demand for landfill space.
2. The release of any additives in the plastic can contaminate groundwater.
3. Fires can occur during or after disposal, releasing hazardous substances into the air, such as cancer-causing dioxins.[2]

Passing legislation to reduce PVC

In The Economics of Phasing Out PVC, the Tufts researchers agree that "at the end of its life, PVC can release toxic substances into the environment when it is burned in an incinerator or rural trash barrel, and can leach toxic stabilizers and plasticizers when it is buried in a landfill. Dioxins, which threaten human health at extraordinarily low concentrations, can be released when PVC is burned, either intentionally or accidentally."[3]

Moving beyond PVC

As local governments across the country assess the use of PVC in their water infrastructure, some U.S. cities have adopted policies to reduce and in some cases phase out the use of PVC products. In California, the City of San Francisco has adopted an ordinance that states "all departments shall obtain non-PVC plastics where appropriate alternative products composed of non-chlorinated materials are available," and has included a preferred list of "PVC alternatives" for all of the main building materials commonly made of PVC.[29] New York City has also passed legislation to reduce the City's purchase of PVC, along with Buffalo, Boston, and Seattle.[29] The cities of Berkeley and Oakland have adopted dioxin reduction policies that include the reduction or elimination of PVC purchasing to reach their goal.[30] Internationally, almost all European Union nations have restrictions on uses of PVC, with Sweden leading the charge since 1995 to eventually eliminate

the use of both flexible and rigid PVC. Other examples include: hundreds of cities in Germany with policies to phase out or restrict PVC; as of 2002, fifty-two cities in Spain were "PVC-free," with strategies adopted for safer alternatives for construction materials; and the four largest cities in the Netherlands having specifications to avoid PVC whenever possible in construction.[29]

Some of the largest global brands are also taking note of the environmental and health concerns of PVC products and have been phasing out PVC plastics from their operations since 2005, examples include: Apple, Hewlett-Packard, Kaiser Permanente, Microsoft, Catholic Healthcare West, Wal-Mart, Firestone Building Products Company, Johnson & Johnson, Ikea, and numerous car manufacturers including Toyota, Honda, and Volkswagen.[31] The Healthy Building Network is leading a global campaign to transition away from PVC building materials,[31] while building materials rating systems, such as the Living Building Challenge building certification and Cradle to Cradle product certifications are recommending avoiding PVC altogether.[32]

For CEH, the bottom line is there is no way to safely manufacture, use, or dispose of PVC products. PVC's many risks have already led some communities to ban flexible PVC products, such as plastics bags, or demand that retailers and manufactures of food containers and wrapping find other materials for their products. Still, few people blink when their local leaders announce that plastic pipes will carry drinking water to their homes, schools, libraries, shopping centers, and businesses. The true value of water pipelines must include more than just the purchase and installation cost. Maintenance and replacement must also be considered since PVC is not easily recyclable and there are manyhazards involved with PVC pipe disposal. Life-cycle analyses show that over the duration of PVC pipe use and disposal, the costs run considerably higher than its initial purchase price.

The U.S. has no choice but to replace its aging water infrastructure over the next two decades, and infrastructure projects are big business. Building, maintaining, repairing, and replacing parts

and components are all part of the investment that municipal and project leaders must consider when designing these systems. Water infrastructure holds special challenges in that pipes must stand the test of time and last for generations. Unfortunately, many governments are faced with smaller budgets and a growing list of priorities when deciding whether to invest in pipe material that is less expensive upfront. While this may make economic sense in the short-term, the health, safety, and environmental risks along with potentially high maintenance and replacement costs of incorporating PVC piping into municipal water infrastructure does not make sense in the long-term.

Moving forward, in those communities that opt to continue the use of PVC materials, CEH encourages utility operators to include disclosures like those required in California under the Safe Drinking Water and Toxic Enforcement Act of 1986, commonly known as Proposition 65, to alert water users to the presence of plastic water pipes when they are installed within their water systems. Such notifications would go a long way in increasing consumer awareness about health and safety risks associated with PVC piping, as well as the environmental consequences of their water utilities investing in a material that has so many potential adverse impacts associated with its use.

Ultimately, CEH urges policy makers at all levels, including local, state and the federal government to take a lifecycle approach to their evaluation of water infrastructure upgrades, as well as follow the lead of major U.S. cities, such as New York, Boston, and San Francisco, and major U.S. businesses, such as Apple, Microsoft, Kaiser Permanente, and Wal-Mart, to phase out the use of toxic PVC products.

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Dr. Dorsey is a serial organization builder and leader in for-profit, non-profit, scholarly and governmental realms. In the for-profit arena, Dr. Dorsey is an active investor. Dr. Dorsey maintains active relationships and agreements in the US and beyond with various partners from Barrett Capital, to the California Clean Energy Fund, to Silverleaf Partners, the Royal Bafokeng Holdings (South Africa), Univergy (Japan/Spain), the World Bank and many other institutions and high-net-worth individuals driving the global renewable revolution. Over decades Dr. Dorsey has been featured or provided his insights on environmental matters in the world's leading lay television, radio and print outlets from *Al Jazeera*, the *Associated Press*, South Africa's *Business Day*, CCTV, CNN, *Democracy Now!*, *The Los Angeles Times*, *The New York Times*, the *Orlando Sentinel*, *The Sacramento Bee*, *The Thom Hartmann Show*, *US News and World Reports* and many other outlets.

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