PVC: The Most Tested, Certified, and Accredited Pipe Material

The Health, Safety, and Environmental Performance of PVC Pipe

Health and Safety

PVC pipe is widely used around the world for water and sewer systems. One reason for the material's success is its health and safety history from raw material extraction through end-of-life disposal. For more than 70 years, PVC pipe's raw materials, production, and usage have been evaluated and approved by governmental and accredited third-party testing and certification agencies. These evaluations have shown that PVC pipe is a safer and healthier alternative than pipes made from other materials. The U.S. Food and Drug Administration, Consumer Product Safety Commission, and similar organizations have confirmed that PVC is safe. PVC pipe meets or exceeds all required health and safety standards and regulations governed by the U.S. Safe Drinking Water Act, Guidelines for Canadian Drinking Water Quality, and other international statutes.

Maximizing Safety

PVC pipe has an industry-leading safety profile throughout its life cycle — from raw materials to installation and use. All ingredients in PVC pipe are publicly listed and approved for use in drinking water systems. PVC pipe is lighter than other pipe materials (which reduces CO_2 emissions), easier to handle, and safer for workers to install. In use, PVC pipe is leak free, not vulnerable to corrosion, and has the lowest break rate, helping ensure a reliable and efficient piping system over its service life of more than 100 years.

Health and Safety Attributes of PVC Pipe

Some of the most important health and safety characteristics of PVC are provided below.

The ingredients used in the manufacture of PVC pipe are publicly listed and have been verified as safe for use in drinking water delivery systems. This level of transparency for ingredients is not available with any other pipe material. All listed ingredients are individually tested and certified for use by third-party certification agencies to NSF/ANSI/CAN 61 and NSF/ANSI 14.

No toxic metals are present in PVC pipe. Unlike some other pipe materials, PVC does not contain or release lead, arsenic, barium, mercury, chromium, cadmium, copper, or other metals. Cement-mortar lined ductile iron pipes can leach barium, cadmium, chromium, and aluminum. The tin compounds used in the manufacturing process of PVC pipe are certified as being safe for use as stabilizers for drinking water pipe. The safety of PVC pipe is evaluated and confirmed on an ongoing basis by NSF and other organizations.

No vinyl chloride is released from PVC pipe. Modern PVC resin manufacturing removes vinyl chloride monomer (VCM) to non-detect levels. Testing by the U.S. Environmental Protection Agency (EPA) found no VCM leaching from gasketed PVC water pipes manufactured in North America. This is verified regularly by rigorous third-party testing to the NSF/ANSI/CAN 61 standard.

No benzene or other contaminants are released from PVC water pipes during wildfires. Wildfires do not impact PVC water and sewer infrastructure since pipes are buried underground, insulated from heat generated above ground. The primary source of benzene in forest fires is combustion of trees. Secondary sources are burning of homes and other structures.

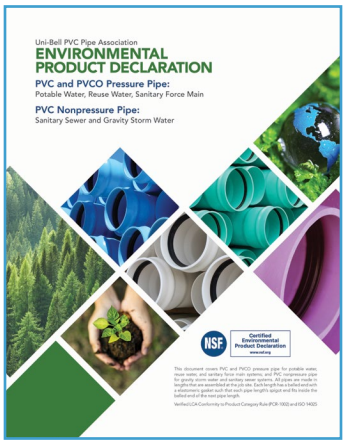
No microplastics are associated with PVC pipe. Studies have shown that PVC pipe's smooth inner walls do not pit or deteriorate over time, preventing the release of microplastics, and enabling PVC pipe's superior hydraulic performance to be maintained throughout its 100+ year service life. The primary sources of microplastics are tires, clothing, and personal care products.

No phthalates or bisphenol-A are present in PVC pipe. These substances are not used in the manufacture of PVC pipe for drinking water or wastewater systems.

Dioxin emissions for PVC pipe are the lowest of any pipe material. Although PVC pipe manufacturing emits zero dioxins, PVC resin production does produce small amounts. Since 1987, dioxins from industrial sources have decreased by 90% while PVC resin manufacturing has increased more than 300%. John D. Wagner, a green building expert, states in *Seven Myths About PVC — Debunked* that: "If PVC were the source of dioxin in the environment, dioxin levels would have risen over time, not declined." Dioxins are much more of a concern for iron and concrete piping. EPA data has shown that dioxin emissions released from an iron pipe foundry were almost six times higher than a PVC resin facility. Ductile iron facilities can also release metals including lead, mercury, chromium, manganese, and zinc, organic chemicals like benzene, xylene, phenol, methanol, and triethylamine as well as ammonia.

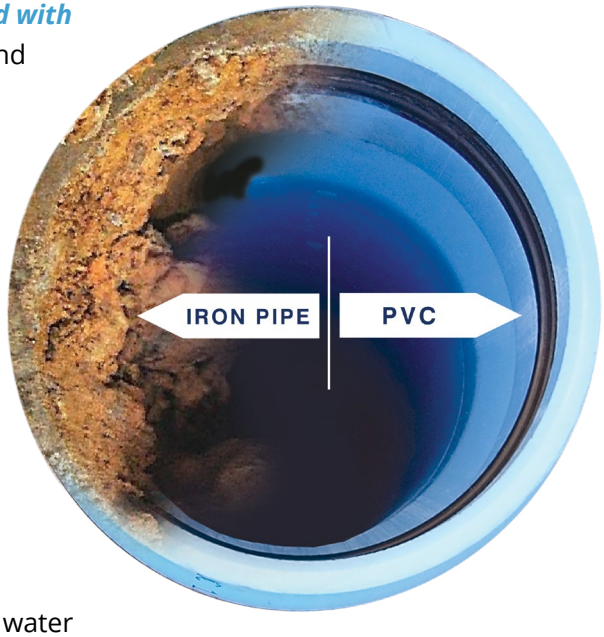
Organotin (tin) stabilizers are not a health concern for PVC pipe. There are many different types of organotin. One organotin, dibutyltin dichloride (DBTDC), may be an endocrine-disrupting chemical and cause adverse health effects. However, this substance is not present in PVC pipe's raw materials, nor is it formed at any point during pipe manufacture, installation, or use. PVC pipe does not contain DBTDC. Tin stabilizers used in PVC pipe have been tested and deemed safe for use in potable water applications and are not a health risk.

"PVC pipe and fittings are resistant to chemicals generally found in water and sewer systems, preventing any leaching or releases to ground and surface water during the use of the piping system. **No known chemicals** are released internally into the water system. **No known toxicity effects** occur in the use of the product."



— **Environmental Product Declaration, ISO 14025/NSF (March 2023)**

No known per- and polyfluoroalkyl substances (PFAS) are associated with PVC pipe production. No findings have shown a link between PFAS and gasketed PVC pipe.



PVC pipe's corrosion resistance helps ensure the safety of drinking water. Corrosion within metallic pipes can affect drinking water quality. Corrosion and corrosion by-products (tuberculated iron pipe in photo) can deplete disinfection chemicals such as chlorine, potentially making water supply unsafe. Corrosion can also promote the growth of bacteria inside the pipe, creating biofilms. Biofilm contamination has been linked to numerous E. coli and Legionnaires' disease outbreaks in North America. PVC pipe is inert, corrosion resistant, and does not support the growth of biofilms.

Independent testing confirms that PVC pipe meets or exceeds all North American water quality standards and regulations. The NSF/ANSI/CAN 61 and NSF/ANSI/CAN 600 standards ensure that drinking water pipes are safe on an ongoing basis based on three components: regular testing, toxicology evaluation of the results, and unannounced audits. Other independent agencies and governmental bodies, namely Underwriters Laboratory (UL), the Canadian Standards Association (CSA), and the EPA, also test PVC pipe to verify that the water transported through it is safe.

Occupational health and safety is a category in which PVC pipe is a leader. This is due to the light weight and long service life of the pipe, as well as low break and leak rates. PVC pipe is easier to install and maintain than the alternatives. According to the U.S. Bureau of Labor, the plastic piping industry has an outstanding record with respect to worker safety, experiencing far fewer injuries and illnesses in every phase of production, on average, than old-technology industries such as iron pipe manufacturing.

PVC Pipe is the Safest Choice

More than 50,000 North American water utilities use PVC pipe today and more than 2.5 million miles of PVC water and sewer piping are in service. More than 10 million water-quality tests conducted on water carried through PVC pipe confirm that the pipe is safe. Seven decades of experience in the U.S. and Canada have shown conclusively that PVC pipe is the safest choice for long-term, reliable delivery of clean drinking water. PVC pipe's safety is verified on a regular basis through testing, thorough evaluation, and verification by independent third parties and governmental organizations.

MORE THAN
50,000 North American water utilities use PVC pipe today

MORE THAN
2.5 million miles of pipe are in service

MORE THAN
10 million water-quality tests conducted

Environmental Performance

Municipal infrastructure, including water pipes that deliver drinking water and sewer pipes that carry away waste, have impacts on the environment throughout their entire life cycle — from raw-material extraction through end-of-life disposal.

PVC Pipe has the Lowest Environmental Impacts

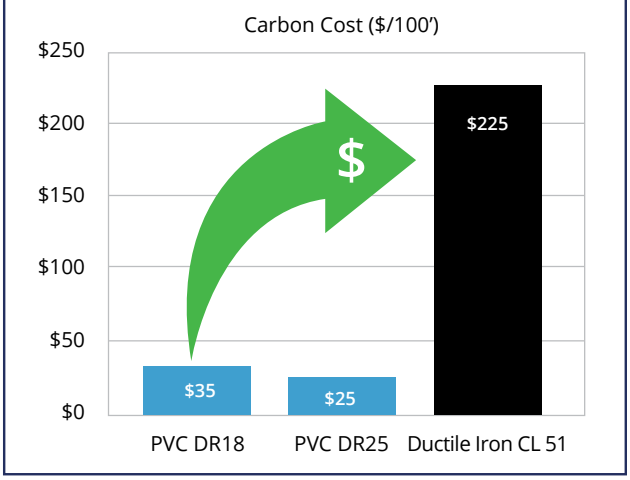
Environmental impacts are both unavoidable and undesirable, so it is critical that the most sustainable alternative be selected. The best choice combines a long service life and the lowest life cycle impacts. When viewed through a sustainability lens, PVC pipe is the number one choice for delivery of drinking water and removal of sewage. Compared to alternatives including iron, steel, concrete, clay, polyethylene, and fiberglass, PVC has by far the lowest life cycle impacts, including the smallest carbon footprint. Some of the environmental performance attributes are discussed below.

Sustainability Measures

The most important sustainability characteristics of PVC are revealed through detailed Life Cycle Analysis (LCA) and scientific studies.

Greenhouse gas (GHG) emissions are lower for PVC pipe through its entire life cycle than for alternatives. Selecting PVC is consistent with the GHG-reduction goals that many North American jurisdictions are working towards. McKinsey reports that PVC sewer pipes have 35% lower GHG emissions than ductile iron pipes and 45% lower GHGs than reinforced concrete. For water pipes, it takes four times the energy to manufacture concrete pipe and twice the energy to make iron pipe compared to PVC pipe. Taking the cradle-through-installation carbon output for PVC and equivalent 8-inch ductile iron pipes, ductile iron would be ranked 6 to 9 times higher as shown in Figure 1.

FIGURE 1: MONETIZED CARBON OUTPUT COMPARISON OF 100 FEET OF 8" PIPE



Source: Life Cycle Assessment of PVC Water and Sewer Pipe and Comparative Sustainability Analysis of Pipe Materials

PVC pipe has the lowest total embodied energy (TEE). TEE refers to the total amount of energy consumed during the life cycle of a product, including during raw material extraction and transport; pipe manufacture; pipe transport and installation; pipe operation and maintenance; and pipe disposal at end-of-life. There are several reasons why PVC pipe has lower TEE than alternative piping materials. First, it takes much less energy to manufacture PVC pipe than any alternative. Second, PVC pipe has a very long service life of more than 100 years. Third, the energy needed to pump water through PVC pipes is lower than any alternative.

PVC pipes align with the key principles of the circular economy. The aim of a circular economy is to ensure products are used efficiently and in use for as long as possible, minimizing waste and pollution. PVC piping systems achieve this with their low environmental impact — from design, manufacturing, operation, and recycling — and long life.

Corrosion resistance is another sustainability feature of PVC pipe. Unlike metallic pipes, PVC pipe does not corrode. This means there are no costs associated with corrosion management for PVC pipe. In contrast, metallic pipes are susceptible to both internal and external corrosion, increasing the costs for operation, repair, and maintenance. Corrosion on the outside of metallic pipe reduces its lifespan. An AWWA Water Research Foundation study showed that ductile iron pipes in moderately corrosive soils may have a life expectancy as short as 11 to 14 years. Corrosion inside metallic pipes makes the inside wall rough, increasing pumping costs and reducing its lifespan. To mitigate corrosion of metallic pipes, phosphates and/or other chemicals must be added to drinking water. These substances are then released into the environment, potentially creating harmful algae blooms.

PVC pipe is a recyclable and highly sustainable material. PVC pipe manufacturing in North America produces virtually no waste because internal regrind/scrap is put back into the manufacturing process. Also, more than 99% of the PVC pipe for infrastructure projects is utilized, so virtually no scrap is sent to landfills or burned in incinerators. Any PVC pipe that is landfilled remains stable and does not contribute to landfill leachate or gas emissions. PVC pipe can also be recycled back into new pipe up to eight times or used to make other products. According to the white paper, *Seven Myths About PVC — Debunked*, PVC is one of the most sustainable materials available: "With the versatility of PVC and its high recyclability, the manufacture of PVC may be one of the few manufacturing processes that can achieve zero waste."

Leakage and break rates for PVC pipe are the lowest of all commonly used water pipes. Combined with a very long service life, this translates into reduced environmental impacts related to maintenance and replacement.

Economic and sustainability benefits flow from reduced costs compared to alternatives. These benefits are related to the lower amortized capital cost of the infrastructure, the reduced cost of pumping water through PVC pipe, and lower maintenance and eventual replacement costs. Fewer leaks and breaks for PVC pipe also reduce loss of water from the system, contributing to further cost and environmental advantages.

PVC pipe has undergone the most rigorous and transparent environmental evaluation of all pipe materials. PVC pipe has been reviewed through a comprehensive, third-party LCA under the stringent guidelines of the International Organization for Standardization (ISO) 14025 and 14040 standards, which are the most recognized environmental industry standards in the world. PVC is the first piping material in North America to publish an environmental product declaration (EPD) and LCA conducted according to ISO standards.

PVC pipe manufacturing is climate-friendly because it is powered by the electrical grid. As a result, producers can take advantage of renewable wind, solar and other green energy sources — enabling the industry to continually reduce its carbon footprint as more clean energy becomes available. Contrast this with metallic and cement piping which rely on coal and petroleum coke in their manufacturing, producing dangerous quantities of CO_2.

PVC Pipe: Infrastructure for a Greener World

PVC is the most cost-effective and best performing pipe material with the lowest environmental impacts compared to alternatives. Together, these attributes make PVC water and sewer pipe the most sustainable choice for underground infrastructure.

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National and International Statutes & Organizations for Standards, Testing, and Certification

American National Standards Institute

American Water Works Association

ASTM International

Bureau de normalisation du Québec

Guidelines for Canadian Drinking Water Quality

Consumer Product Safety Commission

FM Approvals

Health Canada

International Association of Plumbing and Mechanical Officials

International Organization for Standardization

National Sanitation Foundation

U.S. Bureau of Labor

U.S. Environmental Protection Agency

U.S. Food and Drug Administration

U.S. Safe Drinking Water Act

Underwriters Laboratory

Utah State University Water Research Laboratory

The above list includes some of the organizations that have published PVC pipe standards, tested PVC or PVC pipe, or certified PVC pipe products in North America.

PVCPIPE association

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