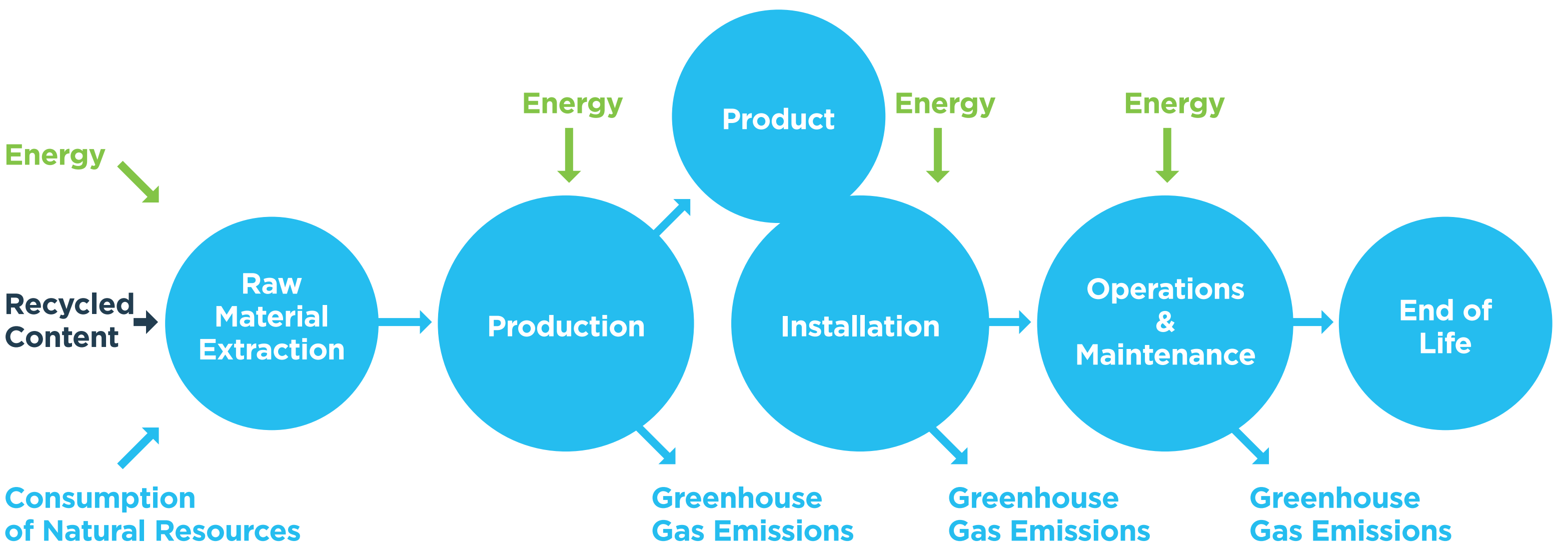
Life Cycle Cost Analysis Tool

Ductile Iron Pipe is the More Cost Effective Material Over a Pipeline's Service Life

A University of Michigan Study shows Ductile Iron Pipe has significant economic and environmental advantages over PVC. Key findings show Ductile Iron Pipe has a longer service life, lower frequency of repairs and better pumping performance for lower life cycle costs. Ductile Iron Pipe also has better environmental performance due to lower greenhouse gas (GHG) emissions in both production and operations phases. The research and model from the University of Michigan help decision-makers as they evaluate the true cradle-to-grave costs and benefits of pipeline materials in their water pipeline infrastructure.

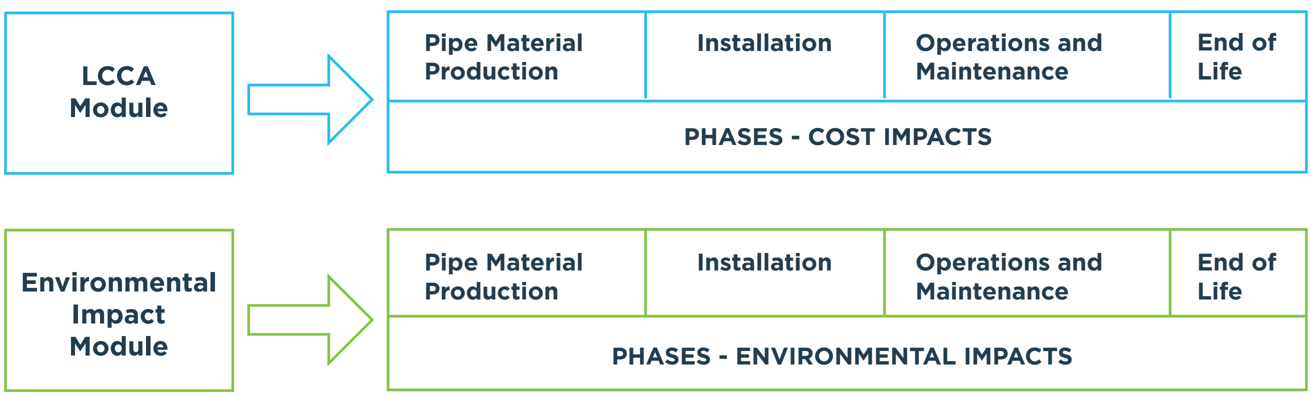


Strength and **Durability** for **Life**®

dipra Ductile Iron Pipe Research Association

Overview

With a Life Cycle Cost Analysis model, utility officials and professional engineers can compare the true cost of alternative materials for water pipelines using various scenarios. The tool, developed by a team of researchers at the University of Michigan (UM), uses multiple factors to evaluate the least cost of pipe material alternatives over the project design life. The primary factors on which the researchers conducted their evaluations were:



A comprehensive literature search to evaluate a consensus of expected service lives, compilation of cost factors from industry and utilities for purchase and maintenance, and evaluation of the impact of energy use of Ductile Iron Pipe and PVC pipes.

The research tool was designed to allow comparisons between alternative materials, with the first model comparing Ductile Iron Pipe versus PVC pipe, two of the most commonly used pipe materials in drinking water conveyance.

- For more than 100 years, the Ductile Iron Pipe Research Association has provided research-based engineering information to utility and consulting engineers.
- The University of Michigan Civil Engineering Department is ranked 7th in the United States, according to U.S. News & World Report surveys.
- This peer-reviewed paper can be found in *ASCE Pipelines 2016: Out of Sight, Out of Mind.*
- This study and model were developed as a service to the water infrastructure industry.

Defensible Data for Decision-Makers

"With this new tool, the true value of the pipe, as an asset, can be understood, allowing for investment to be made in a good way."
Carol C. Menassa, PhD, University of Michigan
Civil & Environmental Engineering Department

The UM study on both economic and environmental impacts is important for utility decision-makers as they seek to balance fiscal concerns over immediate and long-term needs as well as the environmental impact of pipeline materials across production, design, installation, operations and maintenance, and planned end of life. For local government leaders, utility officials and engineers designing pipeline systems, the LCCA model serves as a tool to test various scenarios to determine the right solution for site-specific conditions and community values, as well as provide the necessary defensible data to support those decisions.

Research Team & Data Sources

The UM research team was led by Carol C. Menassa, PhD, A.M., ASCE. She is an Associate Professor and John L. Tishman Faculty Scholar in the Department of Civil and Environmental Engineering at the University of Michigan. She received her PhD in Civil and Environmental Engineering from the University of Illinois at Urbana-Champaign (UIUC). Menassa directs the Sustainable and Intelligent Civil Infrastructure Systems Laboratory at the University of Michigan. Dr. Menassa was assisted by Albert Thomas and Bharadwaj R.K. Mantha.

Data for the LCCA model was obtained from various participating U.S. utilities, and the literature review from associations including, but not limited to, the American Water Works Association (AWWA), American Society of Civil Engineers (ASCE), Ductile Iron Pipe Research Association (DIPRA), Plastic Pipe Institute, U.S International Trade Commission, U.S. Environmental Protection Agency and the Water Research Foundation. DIPRA sponsored the research project.

A copy of the UM paper, "A Framework to Evaluate the Life Cycle Costs and Environmental Impacts of Water Pipelines," can be obtained from the ASCE library under Conference Proceedings for Pipelines 2016: Out of Sight, Out of Mind, Not Out of Risk.

Why We Need to Rebuild Water Infrastructure and Close the Investment Gap

U.S. EPA Reports (EPA 2013)

- More than 1 million miles of water lines in the US
- 240,000 water breaks occur every year
- 4,000 to 5,000 miles of water mains are replaced annually

American Society of Civil Engineers (ASCE) Report Card (ASCE 2013)

- Average Infrastructure Grade: D+
- Water services have a grade of D or below

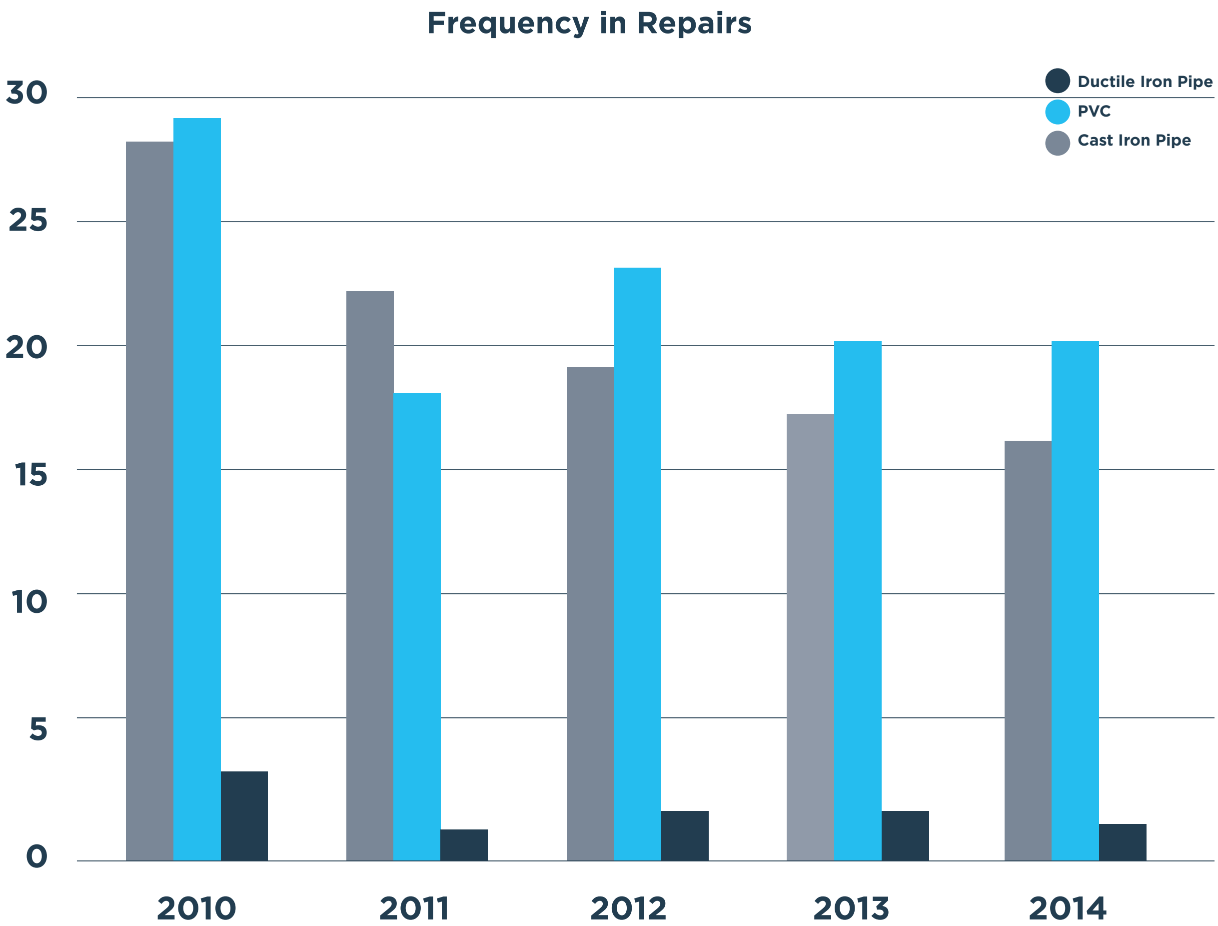
University of Michigan Findings

The research showed that initial costs do not necessarily translate into least cost over the project design life. In this example, Ductile Iron Pipe is the more cost-effective material over the pipeline's service life. Main conclusions are:

CONCLUSION 1

Initial cost of a material does not necessarily determine the lowest cost when considering the operational phase of a pipeline. The operations, maintenance, actual service life and environmental impact need to be considered.

LCCA-Operations & Maintenance Phase

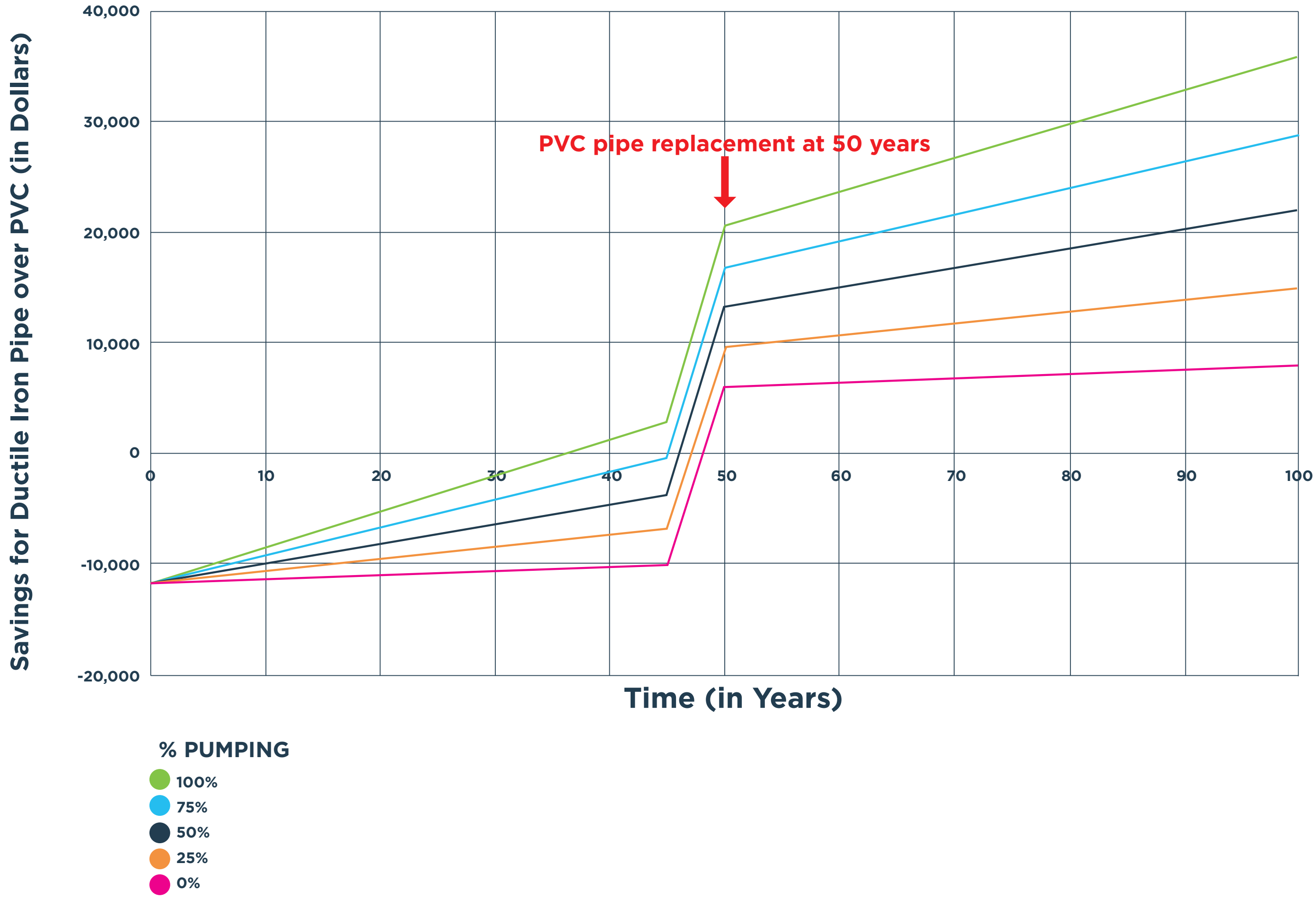


- Frequency and average cost information collected from utility sources
- The cost of individual repair and maintenance is obtained from literature (RSMeans 2015, Haas 2012)

CONCLUSION 2

The actual expected service life of a pipeline is a primary consideration when determining total life cycle costs, including emissions costs during production.

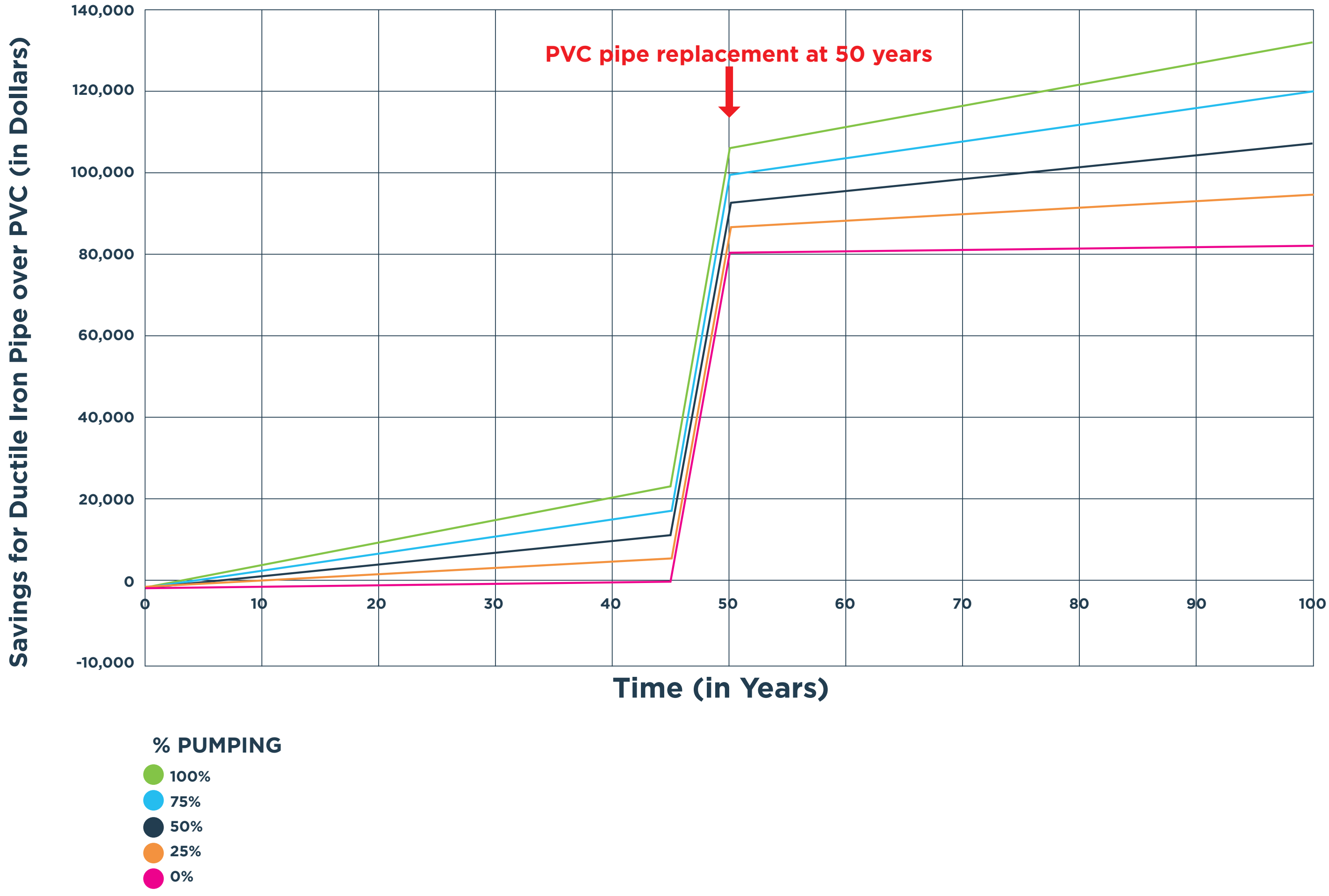
Ductile Iron Pipe over PVC (8″ Diameter)



CONCLUSION 3

Energy consumed in pumping significantly impacts the total life cycle costs and emissions for all pipe diameters – advantage to Ductile Iron Pipe due to larger inside diameter.

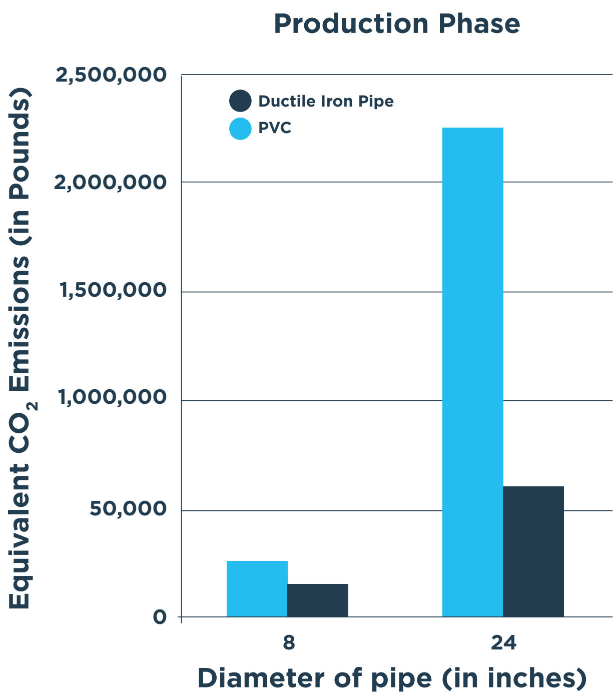
Ductile Iron Pipe over PVC (24" Diameter)

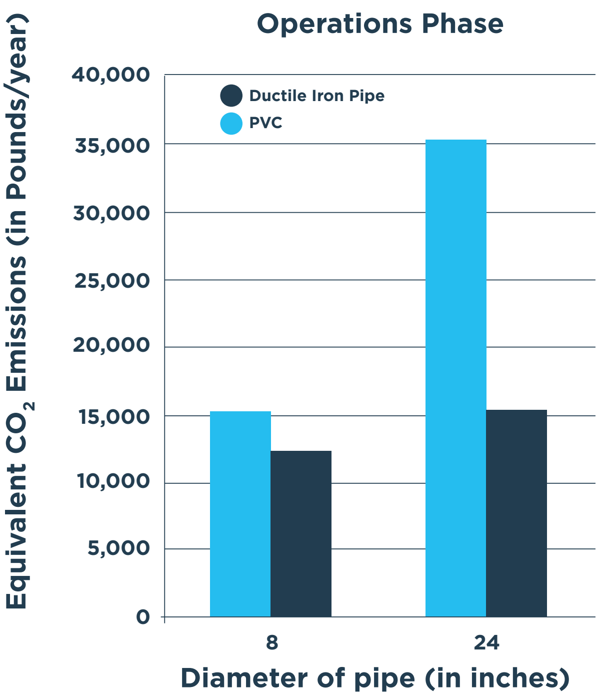


CONCLUSION 4

PVC pipes have the highest environmental impacts.

CO_2e Emissions for 8″ and 24″ Diameter Pipe





Total equivalent CO_2 emissions assuming 25% pumping during operations phase