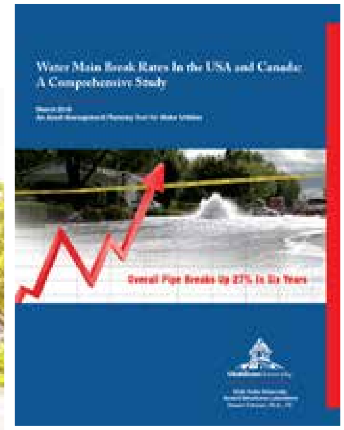
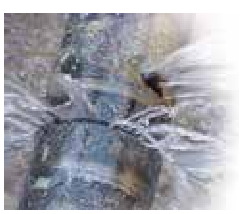


Our Underground Infrastructure
Water Main Break Rates – A Wake-Up Call

The Issue – Our Aging Water Infrastructure



Quality drinking water brought to the tap through elaborate underground distribution systems is a critical component to our public health and economic well being. Our water infrastructure is now in decline after decades of service. The signs of distress surface daily as water mains break, creating floods and sink holes. The loss of water service is more than an inconvenience, since it causes significant social and economic disruptions and jeopardizes public health. In 2009, the American Society of Civil Engineers issued an Infrastructure Report Card and gave a D- to drinking water and wastewater infrastructure. **The Federation of Canadian Municipalities reports that there is a major need to rehabilitate water and sewage infrastructure, especially in larger older cities such as Montreal, where 33% of water distribution pipes have reached the end of their service life in 2002**.

The Measurement

The most important and critical factor used to quantify the condition and occurrences of failing underground pipe networks is water main break rates. Water main break rates are calculated for all pipe materials used in the transport of water to create a measurement to judge pipe performance and durability. Water main break rates for each utility can vary year to year and even seasonally. However, in aggregate, break rates produce a compelling story which can aid in asset management decision making as it relates to defining pipe criticality and costs of repairing and replacing our underground water pipes.

The Primary Researcher

Dr. Steven Folkman is a registered Professional Engineer, a member of AWWA and a member of the Transportation Research Board Committee on Culverts and Hydraulic Structures, and has oversight of Utah State University's (USU) Buried Structures Laboratory. The Buried Structures Laboratory at USU has been involved in analysis and testing of all kinds of pipe and associated structures for over 50 years. **The USU Buried Structures Laboratory is recognized as one of two laboratories in the United States for performing large scale tests on buried pipes. It is from this expertise and background that the surveys of water main breaks were developed and analyzed to complete this comprehensive study**.

The Results

Break Rates Have Increased 27% in the Past Six Years

Between 2012 and this 2018 report, overall water main break rates increased by 27% from 11.0 to 14.0 breaks/(100 miles)/year. **Even more concerning is that break rates of cast iron and asbestos cement pipe, which make up 41% of the installed water mains in the US and Canada, have increased by more than 40% over a 6-year period**.

Pipe Material Use Differs by Region

Water main pipe material usage varies significantly over geographic regions (see Figure 1). **This suggests that the selection and use of pipe materials are based on historical preference versus comparative cost analysis or environmental conditions**. The upper northwest and eastern half of the USA (Regions 1, 4, 6, 7, and 8 as illustrated in Figure 1) have either cast iron or ductile iron pipe for much of the installed pipe length. Regions 3, 5, and 9 have more PVC pipe than any other material. The most common pipe material in Region 2 is asbestos cement and it is unique in that respect.

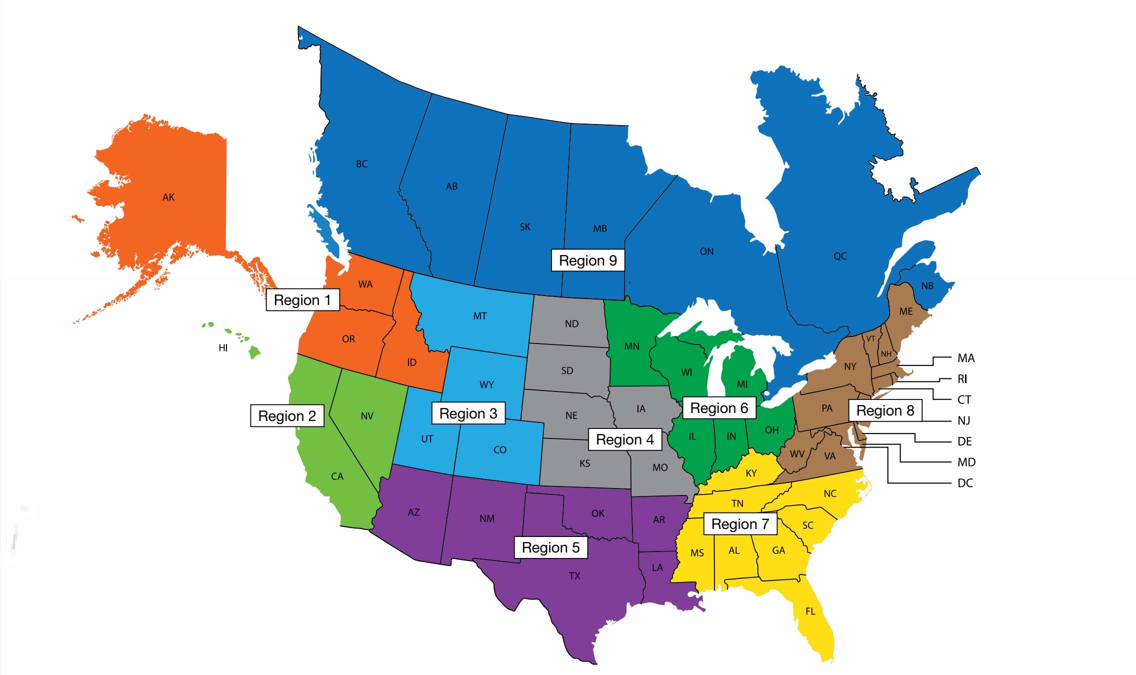


Figure 1: Regions Used to Report Survey Results

Corrosion is a Major Cause of Water Main Breaks

75% of all utilities surveyed reported one or more areas with corrosive soil conditions. **Utilities with a higher percentage of iron pipe may experience a higher percentage of corrosion related breaks**. This would especially apply to pipe installed without an increased investment in condition assessment, pipe monitoring and corrosion control measures. Corrosive soils and other environmental risks drive up the total cost of ownership. The most common failure mode reported in the detailed survey is a circumferential crack which is the most common failure mode of cast iron (CI) and asbestos cement (AC) pipes. Corrosion issues can be a contributor to many failure modes.

80% of Utilities Use Some Form of Corrosion Protection for Ductile Iron Pipe

80% of respondents to the detailed survey indicated they utilized some form of corrosion protection for ductile iron pipe with polywrap being the predominate method.

Construction Related Failures are the Same for Both Ductile Iron and PVC Pipes

The detailed survey asked utilities to report the number of failures related to construction activities and identify the pipe material that failed. The vast majority of construction related failures involved either ductile iron (DI) or PVC pipe and the number of failures for each material was essentially identical. Therefore, **DI and PVC pipe have an equivalent rate of construction related failures. This points to the need to improve construction practices for underground infrastructure regarding installation, location services and inspection**.

Acceptance of PVC Pipe for Use in Water Systems Has Increased by 23% Since 2012

PVC pipe approval has increased from 60% of water utilities allowing its use in 2012 to 74% of utilities allowing its use in 2018. The number of utilities approving of ductile iron, concrete steel cylinder, and steel pipes for use in water systems remains essentially the same.

PVC Pipe Has the Lowest Overall Failure Rate

When failure rates of cast iron, ductile iron, PVC, concrete, steel, and asbestos cement pipes were compared, PVC had the lowest overall failure rate. This was also the case in the 2012 survey and is confirmed by other industry sources. A lower failure rate contributes to a lower total cost of ownership and helps confirm the performance and longevity of PVC pipes. PVC is not subject to corrosion, unlike ferrous and concrete steel cylinder pipes.

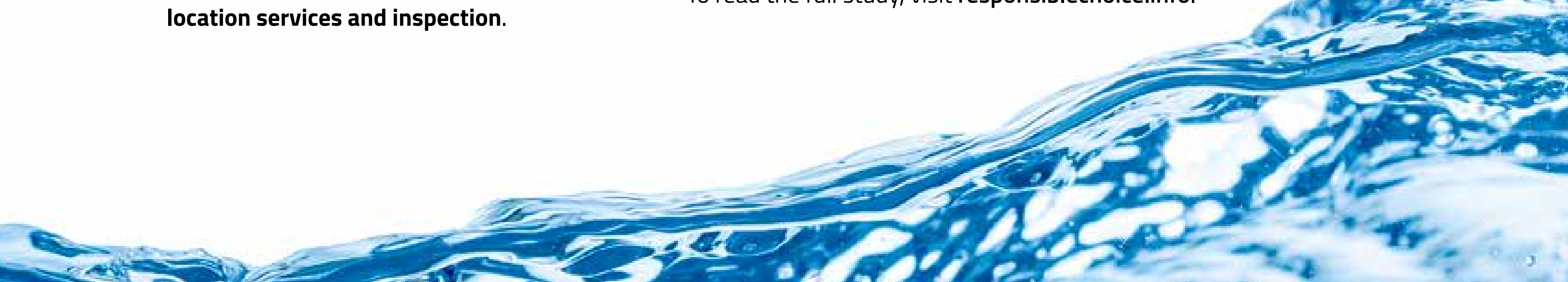
SUMMARY OF FAILURE DATA

Pipe Material	Length in Miles	No.of Failures	Failure Rate # / 100 mi / year
Cast Iron	48,471	16,864	34.8
Asbestos Cement	21,589	2,240	10.4
Steel	4,765	362	7.6
Ductile Iron	47,595	2,627	5.5
Concrete Pressure Pipe	4,940	152	3.1
PVC	37,704	878	2.3

The Future

The replacement of pipes installed up to the 1950's is hard upon us and replacement of pipes installed in the later half of the 20th century will dominate the remainder of the 21st. It is hoped that studies such as the one completed by Utah State will be helpful to utility managers in making better decisions regarding possible changes in their management practices and successfully make cost-effective pipe replacement decisions for our future.

To read the full study, visit **responsiblechoice.info**.



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