continued from page 1

EDMONTON BACKGROUND

Edmonton is the capital city of Alberta. It is a prairie city located about 300 miles north of Alberta's border with Montana. The local economy is resource based: oil, gas, forest products, farming, and ranching. The population of Edmonton is 730,000 and another 270,000 people live in the surrounding metropolitan area.

Epcor Water Services, Inc. (EPCOR) is the water utility that serves the one million people that live in Edmonton and 40 surrounding communities. Figure 2 maps the major components in the EPCOR water system.

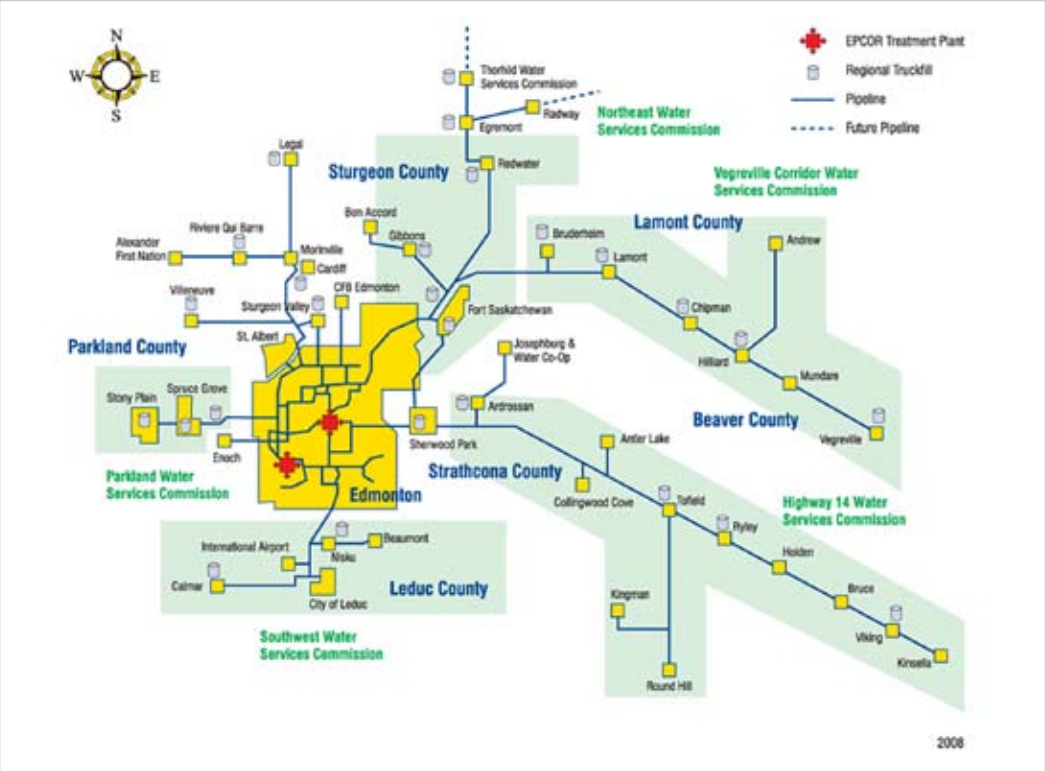

Figure 2, EPCOR Regional Map for Greater Edmonton

Trust but Verify

Доверяй, но проверяй

doveriai, no proveriai

This Russian proverb was Ronald Reagan's signature phrase during the Intermediate-Range Nuclear Forces Treaty negotiations of the late 1980s, and it is the phrase that comes to my mind when reading the 2007 AWWA conference paper by Doug Seargeant, "PVC Water Distribution Pipe, 25 Years Later." Part of that paper describes the excellent track record that Edmonton has experienced with its PVC water pipe. (The Edmonton PVC experience is detailed in "The Edmonton Story" starting on page 1.) That track record, however, is a retrospective view. Interestingly, the paper also offers a summary of EPCOR's (EPCOR Water Services is Edmonton's water utility) investigations into what it may expect from its PVC in the future. A successful track record is normally a good indicator of future performance - but not always. In determining whether or not EPCOR should trust that the relatively trouble-free performance of its PVC will continue, it gathered data for verifying this hypothesis by testing some of the oldest PVC in its water system.

A few statistics will put into perspective the physical assets needed to serve a population this large:

- Pipe: Over 3,200 km (More than 2,000 miles)
- Water Meters: Over 230,000
- Hydrants: Over 15,000
- Reservoirs: 12
- Water Treatment Plants: Two
- Average Daily Demand: 365 ML (More than 96 million gallons)
- Daily Capacity: 530 ML (140 million gallons)

PIPE MATERIAL PREFERENCES

As Edmonton grew, and as other pipe materials and manufacturing processes became available, the utility's preferred pipe material changed. Figure 3 tracks that preference over time.

PIT CAST IRON: Edmonton's water distribution system began in 1903 and consisted of 10.5 km (6.5 miles) of cast iron pipe. The type of cast iron pipe installed would now be referred to as "sand cast" or "pit cast". The original system had 50 fire hydrants and a 330,000 liter (87,000 gallon) elevated storage tank and served 4,176 customers. From 1903 until WWII, pit cast iron pipe was the City's pipe material of choice. This type of manufacturing process produces a comparatively thicker walled pipe.

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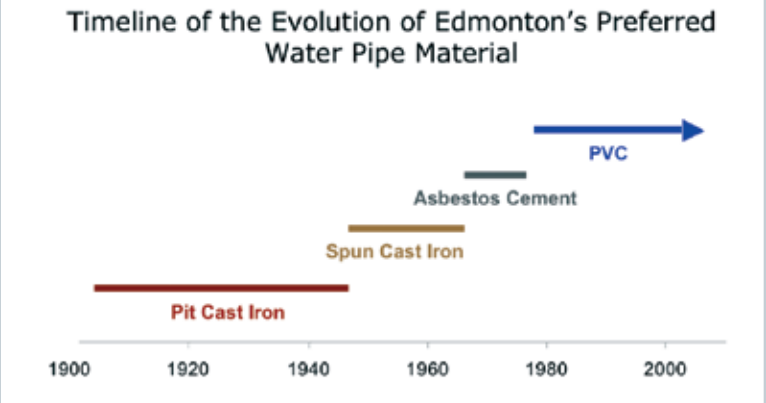


Figure 3, Pipe Material Timeline

Two rounds of testing were conducted. The first round was carried out in 1994 and the second in 2005. The full battery of tests required by the AWWA C900 standard was conducted, as well as a few others. Figures 1, 2 & 3 show photos of some of the tests performed.

1994 TEST LOCATIONS:

AWWA C900 pipe was first installed in Edmonton in 1977. Thus, the oldest pipe available for testing in 1994 was 17 years old. Two locations in the southeastern corner of Edmonton with the 1977 vintage PVC were selected. 25-foot lengths of PVC were exhumed at each location. One was 8-inches in diameter, and the other was 10-inches. Both exhumed sections had gasketed bell-and-spigot joints.

2005 TEST LOCATIONS:

This time, PVC installed in 1978 in the northeastern corner of the City was selected. As before, one location had 8-inch C900 and the other had 10-inch. A similar length of pipe was removed at each location, and each section had an intact joint. The pipe was in-service for 27 years prior to its removal.

The AWWA C900 standard requires that brand new pipe pass the following:

- Dimensions are checked per ASTM D2122.
- Pipe is flattened per ASTM D2412.
- Extrusion quality is tested in accordance with ASTM D2152.
- Joints are qualified per D3139.
- Elastomeric gaskets must meet ASTM F477.
- Burst pressure is tested per ASTM D1599.

Results of the dimension measurements are summarized in Table 1 on page 11. Table 2 lists the test results for the other requirements in AWWA C900.

continued on page 10

Trust but Verifty...
continued from page 3

Examples of Tests Conducted on 17- and 27-Year-Old PVC Pipe
(All four photos reprinted from *Proceedings of 2007 AWWA Annual Conference*, by permission.

Figure 2, Acetone immersion is used to check fusion quality. All specimens passed.

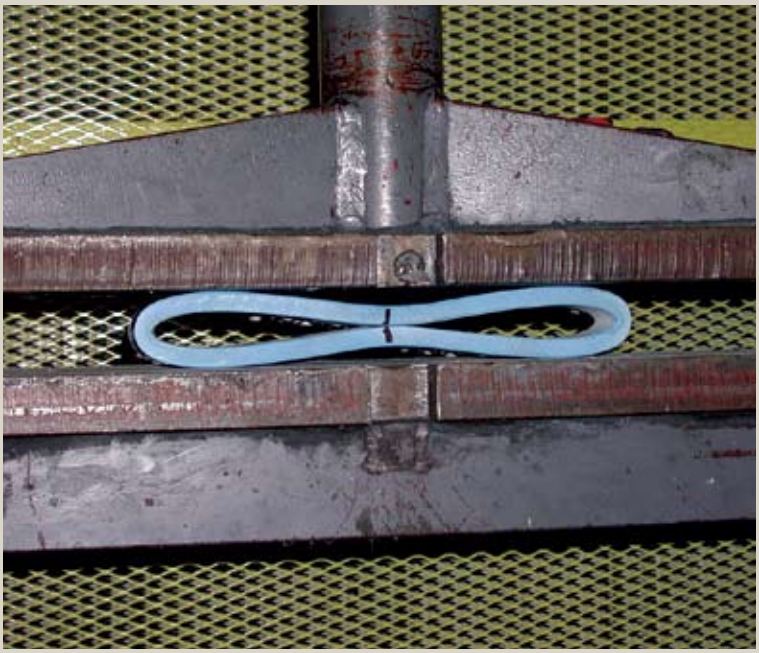


Figure 1, The standard requires flattening to 40% of the original diameter without signs of cracking or delaminating. The pipe was able to go wall-to-wall, well in excess of the standard's requirements.

Figure 3, Burst test results ranged from 940 to 980 psi, which is well above the 785 psi burst strength requirement in the standard.

Table 1a, Dimensions Measured on 8-Inch Pipe

Diameter & DR	8-inch, DR18	8-inch, DR18	Specification
Age at Testing (years)	17	27	In-Plant Test at Time of Manufacture
Wall Thickness (mm)	12.32 Min.	13.30 Min.	12.78 to 14.30
Outside Diameter (mm)	229.62	230.12	229.90 ± 0.38

Table 1b, Dimensions Measured on 10-Inch Pipe

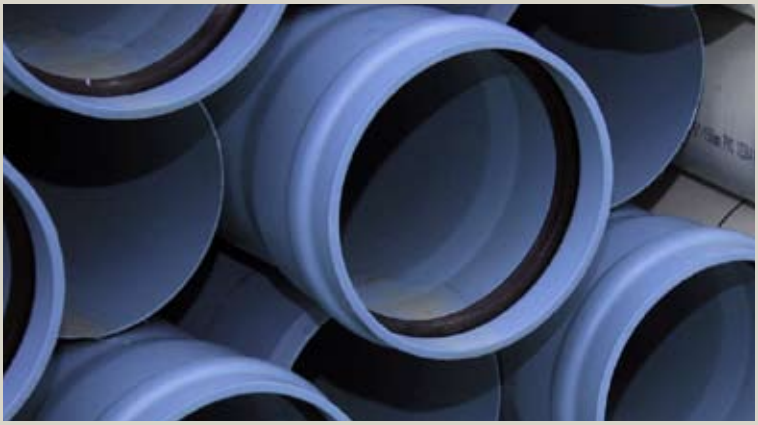
Diameter & DR	10-inch, DR18	10-inch, DR18	Specification
Age at Testing (years)	17	27	In-Plant Test at Time of Manufacture
Wall Thickness (mm)	16.08 Min.	15.34 Min.	15.67 to 17.55
Outside Diameter (mm)	282.07	282.02	281.90 ± 0.38

Table 2a, Other AWWA C900 Test Results for the 8-Inch Pipe

Diameter & DR	10-inch, DR18	10-inch, DR18	Specification
Age at Testing (years)	17	27	In-Plant Test at Time of Manufacture
Pipe Flattening (Percentage Passing)	3 of 3 (100%)	3 of 3 (100%)	3 of 3 (100%) at 60% Deflection
Extrusion Quality (Pass / Fail)	Passed	Passed	No Flaking
Burst Strength (psi)	940	980	755
Vacuum Test for Joint (Pass / Fail)	Passed	Passed	10.8 psi vacuum for one hour w/o leakage
Pressure Test for Joint (psi, minutes)	600 psi for 60 min	600 psi for 60 min	375 psi for 60 minutes

Table 2b, Other AWWA C900 Test Results for the 10-Inch Pipe

Diameter & DR	10-inch, DR18	10-inch, DR18	Specification
Age at Testing (years)	17	27	In-Plant Test at Time of Manufacture
Pipe Flattening (Percentage Passing)	3 of 3 (100%)	3 of 3 (100%)	3 of 3 (100%) at 60% Deflection
Extrusion Quality (Pass / Fail)	Passed	Passed	No Flaking
Burst Strength (psi)	960	950	755
Vacuum Test for Joint (Pass / Fail)	Passed	Passed	10.8 psi vacuum for one hour w/o leakage
Pressure Test for Joint (psi, minutes)	600 psi for 60 min	600 psi for 60 min	375 psi for 60 MINUTES



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The 17- and 27-year-old pipe met all of the AWWA C900 requirements except for the minimum wall thickness. The minimum wall of the 17-year-old, 8-inch pipe was 0.46mm too thin. The minimum wall of the 27-year-old, 10-inch pipe was 0.33mm too thin. To put this in perspective, a medium weight piece of paper is roughly 1.0mm thick. Also note that the minor discrepancy did not prevent the pipe from passing all the other requirements of AWWA C900.

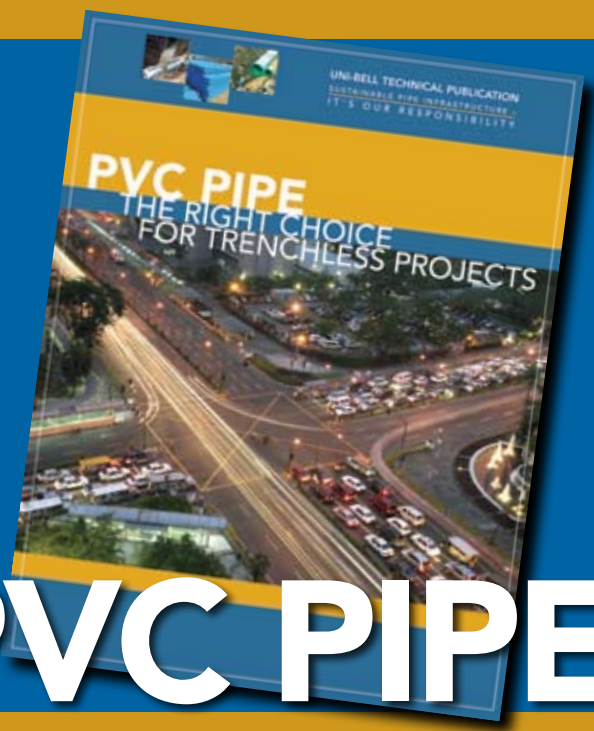
EPCOR conducted several other tests. The quality of the water in the exhumed pipe was analyzed. The results fell within the normal parameters for Edmonton's treated water. The pipe gaskets were checked against the AWWA C900 and ASTM F477 requirements, and they passed. The hydraulic efficiency was quantified using the Hazen-Williams "C" factor. The average values ranged from 145 to 148. Cold weather (0°C ± 2°C) impact tests were in accordance with CSA B137.3 were performed. 93% of the 17-year-old specimens passed as did the majority of the 27-year-old specimens.

With the exhaustive testing conducted on the oldest PVC in its system, along with the lack of deterioration exhibited, EPCOR has added to the growing body of knowledge that demonstrates the longevity and durability that PVC offers in buried water applications.

While open-cut installation procedures continue to be the standard method for installing new municipal infrastructure, trenchless methods are growing in popularity as the technology matures and the equipment improves. For new constructuion, trenchless installation is typically considered when installing a line in a built-out urban area or when facing a challenging water crossing. For replacing or rehabilitating existing infrastructure, trenchless methods are often more economical.

The PVC pipe industry has a wide range of products available for pressure and non-pressure trenchless projects. A new Uni-Bell publication, "PVC Pipe, The Right Choice for Trenchless Applications," describes the vinyl options available for trenchless installation methods like sliplining, horizontal directional drilling and pipe bursting. To get your copy of this new publication, use the order form on page 16 or download an electronic copy from the "Literature and Software" section of the Uni-Bell website.

The performance advantages that have made PVC pipe the most popular choice for open-cut projects often make it the best solution when going trenchless.



PVC PIPE

THE RIGHT CHOICE FOR TRENCHLESS APPLICATIONS