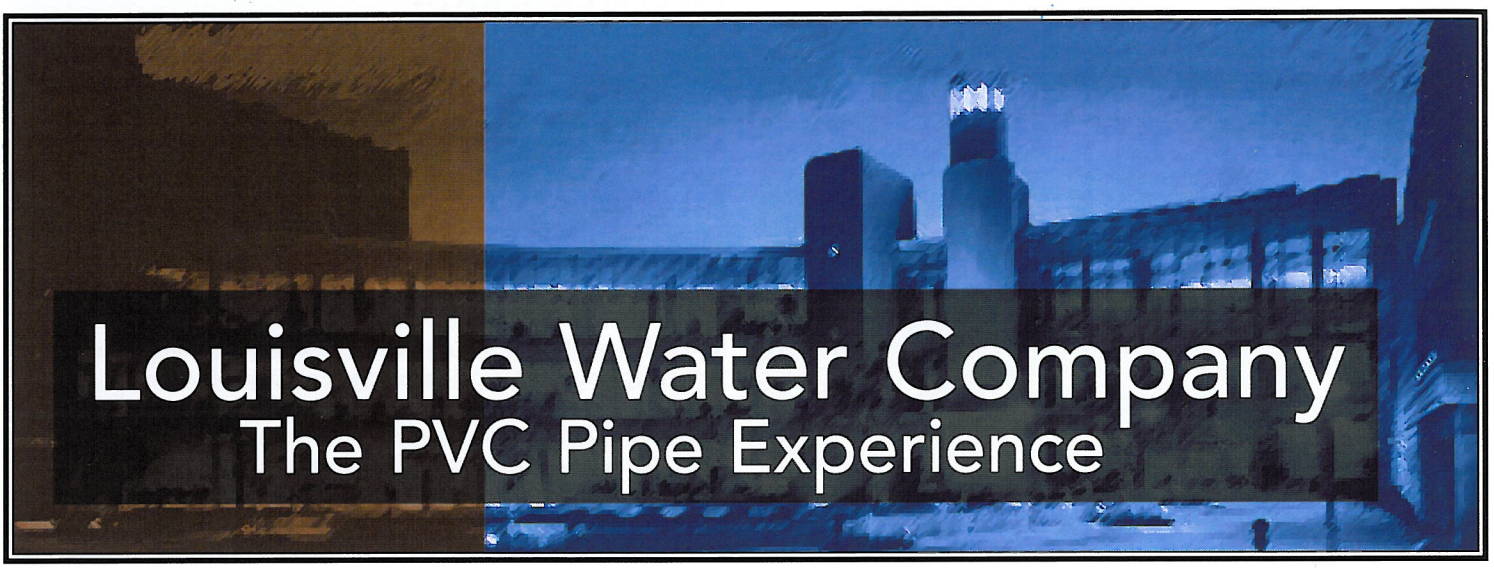
PVC PIPE news



Louisville Water Company
The PVC Pipe Experience

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The Louisville Water Company (LWC) has long been considered a national water industry leader as demonstrated by its longstanding AWWA involvement, recognition by its peer utilities, staff leadership, research and development initiatives, financial management, and progressive capital investment programs. LWC's mission is to be a water industry leader in quality, customer satisfaction, and value. LWC's unique ownership structure includes an annual dividend paid to the City, which is the sole stock holder. LWC continues to be one of the best managed water utilities in the country.

Located in Louisville, Kentucky, LWC is supplied from the Ohio River and is a regional provider for 800,000 people through 285,000 service connections and 3,800 miles of pipe. LWC first began operation in 1860 and is now one of the largest water utilities (both in the miles of water mains and in number of customers served) in the US, delivering an average of 130 MGD of water and generating $105 million in annual revenue. LWC's system is comprised of cast iron, PVC, ductile iron, concrete, asbestos cement, and HDPE piping materials. Figure 1 shows the percentage of each pipe material and the time period it was installed.

Louisville's retail service area is spread over 622 square miles within a three county region. The varied terrain and soil deposits have continued to influence the design, installation, and maintenance of the delivery system. LWC operates eight pressure zones with pressures varying from 40 psi to 110 psi, and water temperatures ranging from 35° to 75° F. In addition, a USDA soils survey indicates no less than seven major soil types in the area, including swampy poor draining areas, expansive clays, high water tables and sand.

LWC has successfully implemented funding mechanisms to grow and maintain its infrastructure. For example, in 2006 LWC identified $20M for Transmission and Distribution projects; with another $4M in Supply and Pumping Facilities; and $6M for Meters, Services, and Hydrants. The primary programs responsible for new water main installations include: subdivision development, main replacement, extensions, and transmission. As with most water systems, LWC buried water mains represent the largest portion of its asset management responsibilities. When put into a financial perspective, approximately 65% (or $375M) of its total capital assets ($576M) is buried infrastructure. Figure 2 shows just the mileage for PVC and ductile iron mains installed from 1985 to 2003.

LWC RESPONSE TO MAIN BREAKS

Since the mid 1960s, LWC has kept records on water main breaks and leaks. In the 1970s, LWC management began to take notice of the system break rate and various failing cast iron pipe segments. The 1980s brought an even bigger rise in iron main breaks resulting in higher operating costs and staffing necessary to address them. The rising break rate trends for older water mains indicated that corrosion was a contributing factor. To combat this growing corrosion problem, LWC implemented polyethylene encasement for new ductile iron installations starting in 1980 and the use of select backfill shortly thereafter. During this same time, LWC began to

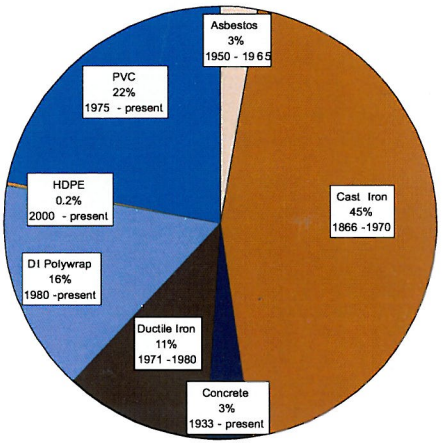


Figure 1. LWC Pipe Materials, 2005

WITH POSITIVE RESULTS AND INTERNAL COMMUNICATION, PVC WAS ACCEPTED WITHIN LWC BY 1987 AND SOON BECAME THE PREDOMINATE MATERIAL SELECTED FOR THE EXPANSION OF NEW HOUSING DEVELOPMENTS. WITH A COMBINATION OF NEW INSTALLATIONS AND ACQUIRED FACILITIES, SOME 750 MILES (OR 22% OF THE SYSTEM) OF PVC PIPE ARE IN SERVICE AT LWC.

install and test PVC pipe. Over time, the standards and performance of PVC pipe was observed, which allowed its transition from a pilot program to an accepted material. LWC also started to provide funding for the removal of failing water mains. In 1993, LWC implemented a 15-year Main Replacement and Rehabilitation program, with an expected investment of $150 million through 2007. Improvements in the use of materials and reinvesting in the infrastructure has resulted in controlling the main breaks with a downward bending in the slope of the long-term main break frequency. (See Figure 3.)

INTRODUCTION OF PVC

As discussed above, LWC had experienced an increase in main breaks and was concerned about corrosion; thus, the door was opened for alternatives such as PVC. In 1977, LWC installed its first PVC project in a swampy area. The field crews were unfamiliar with PVC pipe and the installation in the swampy area was not standard. The lack of familiarity with PVC resulted in improper assembly at the iron fittings. While installing the PVC spigots into the iron fittings, most of the bevel should have been cut off so that the gasket would have sealed against the barrel of the pipe rather than the bevel. By neglecting to cut off all but a quarter inch of the bevel, leaks occurred from insufficient gasket compression at some of those locations. LWC considered this first installation of PVC a learning experience and kept an open mind with regard to its use.

Concerned with aging water mains and a growing corrosion problem with iron, Foster Burba, CEO of LWC at the time, thought PVC might be a suitable alternative pipe material for LWC. Based on Foster's background with several utilities in Louisiana, Kansas, and Colorado and LWC's experience, he asked staff to further evaluate PVC in the early 1980s. LWC continued to evaluate PVC with several pilot installations on main replacement projects in city streets. LWC continually evaluated and adopted construction methods for items like service tapping, joint restraint, handling, backfill methods, and locating pipe with tracer wire.

With positive results and internal communication, PVC was accepted within LWC by 1987 and soon became the predominate material selected for the expansion of new housing developments. With a combination of new installations and acquired facilities, some 750 miles (or 22% of the system) of PVC pipe are in service at LWC. Overall, the length of PVC may seem like a small percentage; however, all of this growth has occurred in just the last 20 years in a system that is over 140 years old.

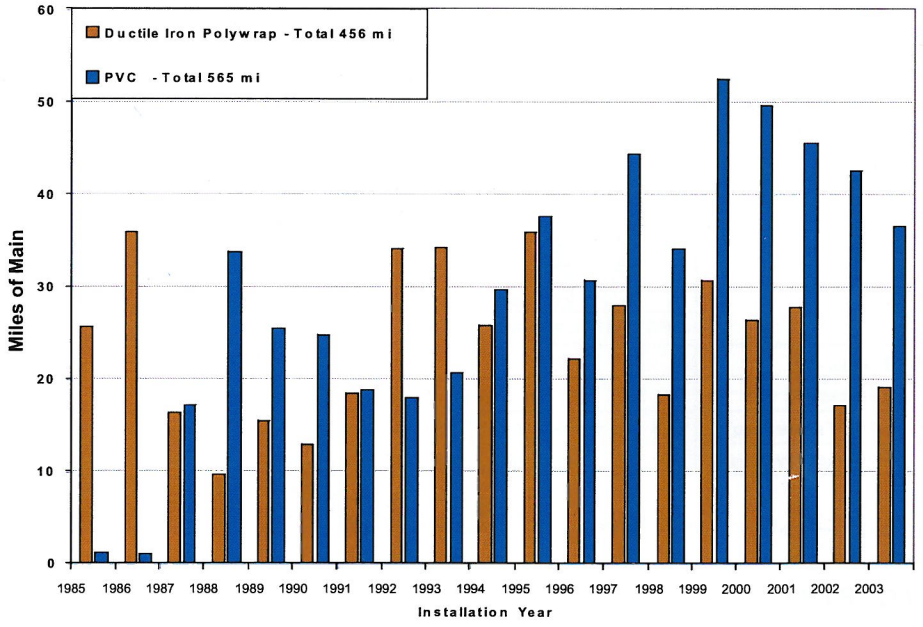


Figure 2. New PVC and Ductile Iron Installations, 1985 to 2003

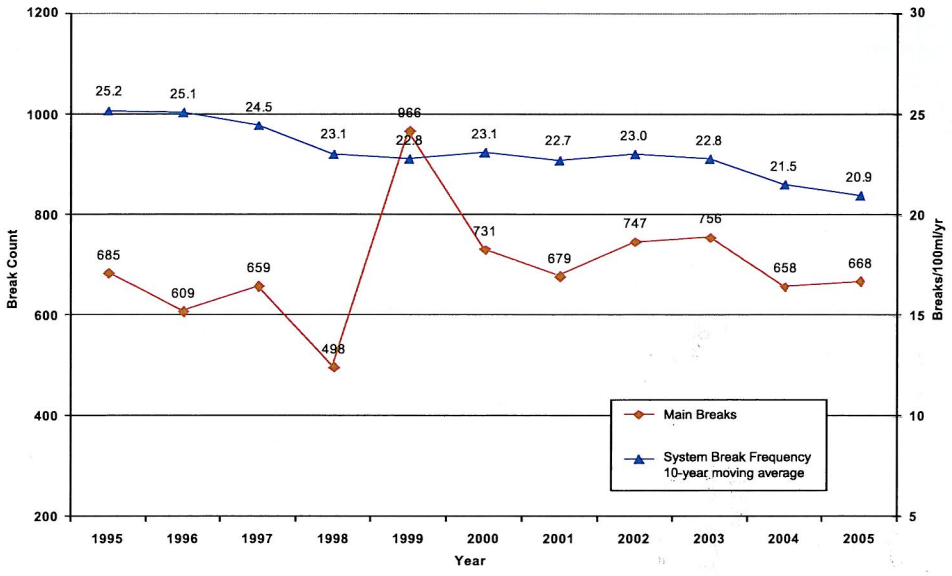
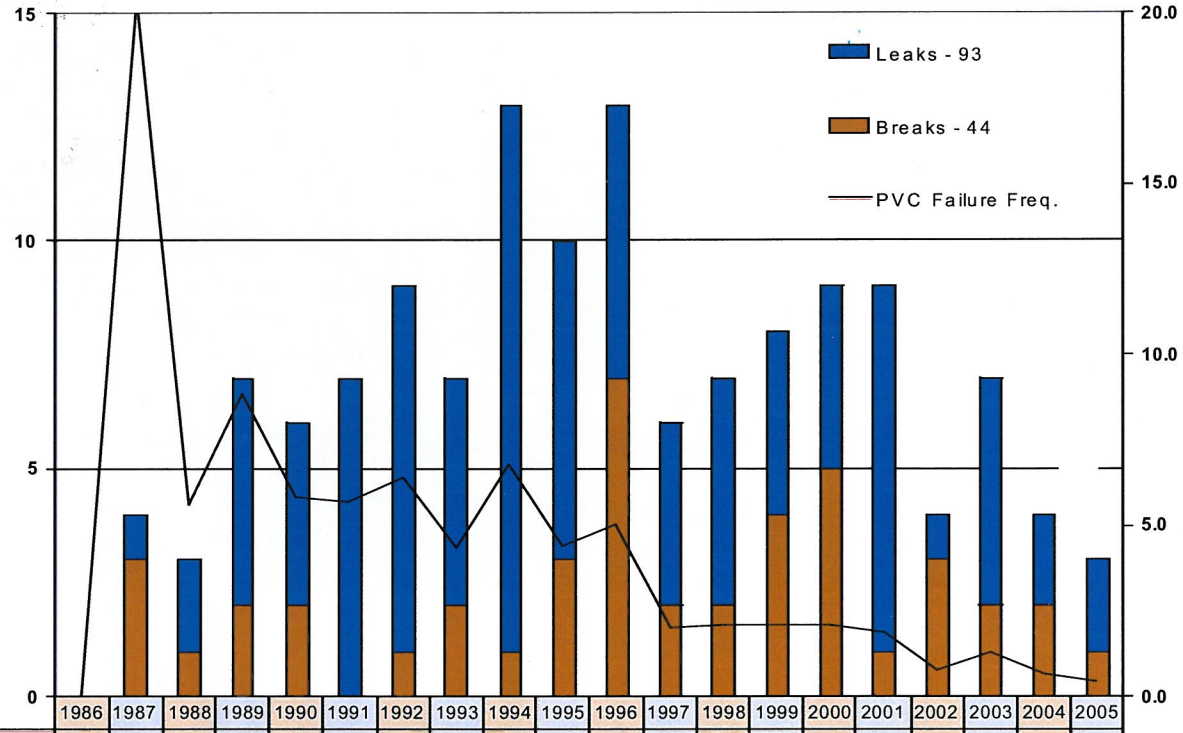


Figure 3. LWC System Main Breaks and Frequency 1995-2005



	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Leaks - 93		1	2	5	4	7	8	5	12	7	6	4	5	4	4	8	1	5	2	2
Breaks - 44		3	1	2	2	0	1	2	1	3	7	2	2	4	5	1	3	2	2	1
PVC Failure Freq.	0.00	20.36	5.61	8.86	5.78	5.71	6.39	4.33	6.80	4.37	5.01	1.97	2.07	2.05	2.09	1.89	0.78	1.27	0.68	0.47
PVC Mi (LWC only)	2	20	53	79	104	123	141	162	191	229	260	304	338	391	430	476	516	552	592	632

Figure 4. PVC Pipe Failures and Frequency

PVC PIPE PERFORMANCE

A review of PVC pipe failure data indicates the annual average for PVC main breaks stands at 2.2 per year, with leaks at 4.6 year, and construction damage at 5.3 per year. For purposes of this report, it was important to separate those water mains installed to LWC standards from the mains acquired through acquisition of other water districts as well as failures caused by construction damage. For example, out of a total of 429 PVC pipe failures, only 137 involved a break or leak from LWC installed facilities. Figure 4 depicts the number of annual break and leak failures on LWC installed pipe along with the failure frequency for that pipe. The early spike in the frequency is representative of the low mileage of pipe in the system at that time.

LWC CREWS HAVE INDICATED THAT FINDING PVC WATER MAINS WITH PROPER TRACING WIRE IS SELDOM AN ISSUE.

A review of failures by installation years revealed a unique factor. Figure 5 depicts how early installation attempts have influenced the failures of PVC pipe, clearly indicating a reduction in recent years.

Looking at the time of failure more closely, Figure 6 shows the break patterns based on age of pipe. Fifty percent (50%) of PVC breaks have occurred within the first three years of installation, indicating a connection with construction practices. Additionally, almost all remaining breaks occur within 10 years of installation, signifying there is no trend towards long-term failure problems.

An analysis of construction damage reporting indicates a lack of proper locates (knowing the pipe's location) or operator error. The higher construction damage rates can also be attributed to the predominate use of PVC in new subdivisions and the acquisition of surrounding water districts, which did not require tracing wires, as-built records, and similar items that LWC has developed through its experience with PVC.

LESSONS LEARNED

From the LWC perspective, there have been several key lessons learned about PVC and the introduction of a new piping material. They are as follows:

SERVICE TAPPING

About 15 years ago, LWC compared direct and saddle tapping methods on 3/4-inch-service lines and found them both to be acceptable, but now we use a stainless steel and brass saddle for all taps. New service tapping is done by in-house personnel, supplemented with contractors when demand for new houses exceeds the ability to meet turnaround time. On average, the number of PVC service connections made annually is around 4,000. (3,600 of the service connections are 3/4" and 400 are 1" and above.) Early on, LWC had experienced problems with splitting the pipe while tapping.

THE MOVE TO DR18, WITH A 150 PSI PRESSURE CLASS, DID NOT COMPROMISE ANY DESIGN STANDARDS AND WOULD PROVIDE ADDITIONAL SAVINGS. LWC NOW SPECIFIES DR18 C900 PVC PIPE FOR 4"-12" PIPE, FOR MOST APPLICATIONS.

The root causes were found to be to over deflected joints, improper tapping procedures, and saddle induced stresses. Nowadays with education and attention to detail, LWC has almost eliminated the problem and has a successful tapping rate of 99.95%.

LOCATING

Metal detectors are not able to locate a non-metallic product, like PVC. In order to be able to locate buried PVC pipe, LWC requires the installation of a #12 gauge coated tracing wire, and good records are kept of measurements on hydrants, gate valves, fitting locations, as well as service lengths of water main to meter. LWC crews have indicated that finding PVC water mains with proper tracing wire is seldom an issue.

LARGE DIAMETER TAPPING

In 2000, LWC acquired an existing water district in neighboring Bullitt County. This water system has extensive installations of PVC SDR 21 pipe over the last 30 years. In order to bring the system up to a more urban design standard, approximately 360 fire hydrants have been installed using a tapping sleeve arrangement with 200 of those being tapped on the SDR21 PVC pipe. The photo in Figure 8 shows the field crew and the PVC coupons removed. The success rate for these large diameter taps was 99.5%. After more than 30 years of service, this is quite a testimonial for PVC.

PRESSURE DESIGN

LWC approached PVC conservatively and originally specified the thicker walled DR14 pipe to garner the assurance from the strongest Pressure Class. However, after a reviewing market pricing and user trends, a consensus emerged in 2003 to switch to DR18 pipe. The move to DR18, with a 150

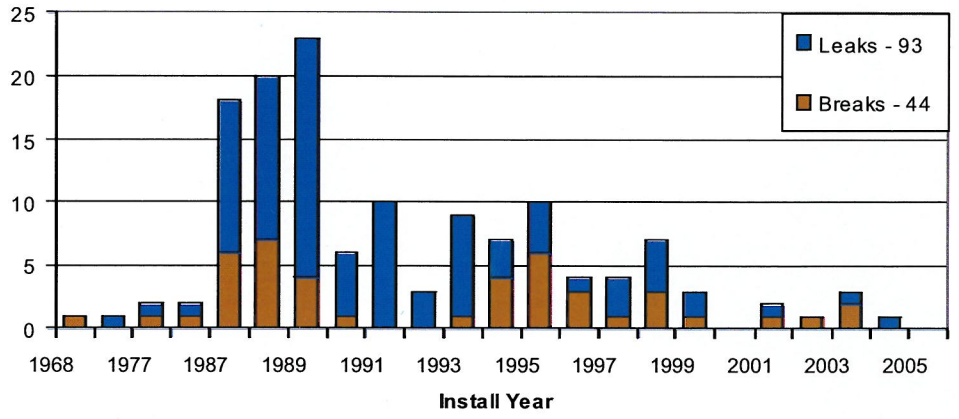


Figure 5. PVC Pipe Failures by Installation Year

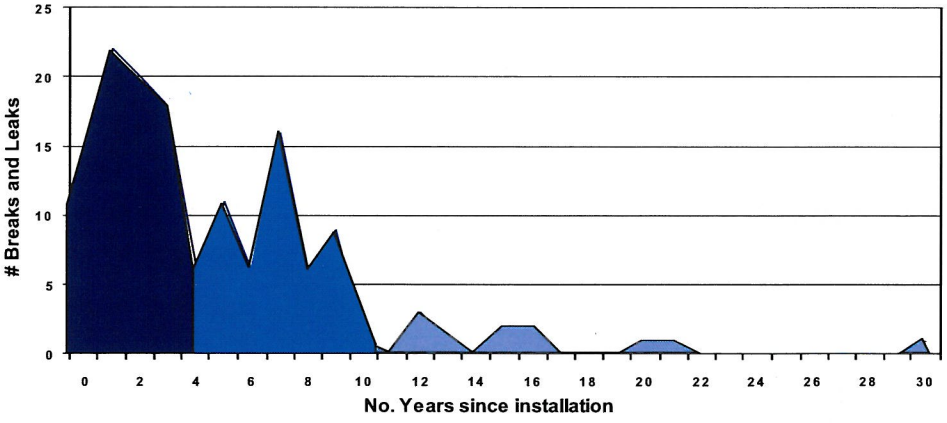


Figure 6. PVC Pipe Failures by Installation Year

Figure 7. LWC Service Installation Crews

Figure 8. PVC coupons from tapping in tees for installing fire hydrants.

THE IMPORTANT LESSONS TO BE TAKEN FROM LOUISVILLE ARE FOR UTILITIES TO MONITOR AND MEASURE THEIR PIPE MATERIALS' PERFORMANCE AND TO CULTIVATE A MANAGEMENT ENVIRONMENT THAT IS WILLING TO CONSIDER ALTERNATIVE MATERIALS.

psi Pressure Class, did not compromise any design standards and would provide additional savings. LWC now specifies DR18 C900 PVC pipe for 4"-12" pipe, for most applications. LWC reverts to DR14 for higher static pressures.

MATERIAL SELECTION

Historically, LWC has installed some 50 miles of new pipe and made 4,000 new service connections annually over the last 10 years. This growth is attribute to the proliferation of new housing subdivisions and a county-wide extension program in the Louisville area. Most of this pipe has been installed as PVC pipe and continues to provide good service without any noticeable performance issues.

RESEARCH AND DEVELOPMENT

LWC continues to evaluate opportunities for PVC as part of its annual programs. Butt fused PVC and restrained joint PVC have been used in trenchless applications and are undergoing full evaluations within the construction engineering department.

CONCLUSIONS

As exemplified by LWC's experience with PVC pipe, change does not happen overnight and must be nurtured. It took ten years from an initial installation in 1977 to 1987 before PVC gained acceptance into LWC's system. If LWC had stopped using PVC after our initial installation, or had not researched service tapping procedures, or had listened to the claims of competing materials, we may have never experienced the benefits that PVC has brought to our community. The important lessons to be taken from Louisville are for utilities to monitor and measure their pipe materials' performance and to cultivate a management environment that is willing to consider alternative materials.

Through the objective evaluation of pipe material options, and by pushing expectations of service life and accounting 'book life' beyond traditional thinking, LWC has been successful in representing our customer's long-term interests and keeping infrastructure costs down. Many pipe products will perform in the short term, but in order to reach that 100 year plus mark, a pipe material's performance in actual service needs to be thoroughly evaluated. Critical elements lie in the historical lessons of past materials such as proper installation, site conditions, pipe stresses, and corrosion factors (soils, electrical grounding, shorting). Clearly, LWC's evaluations of PVC pipe have yielded positive results.

Editor's Note: The Uni-Bell PVC Pipe Association wishes to thank the LWC for their willingness to share their PVC pipe experience with our readers and for their leadership in the water utility industry. We especially want to thank Bret Russell, Greg Heitzman, John Huber, and Foster Burba for taking the time to compile this information and allowing us to share it with the readers of the PVC Pipe News.