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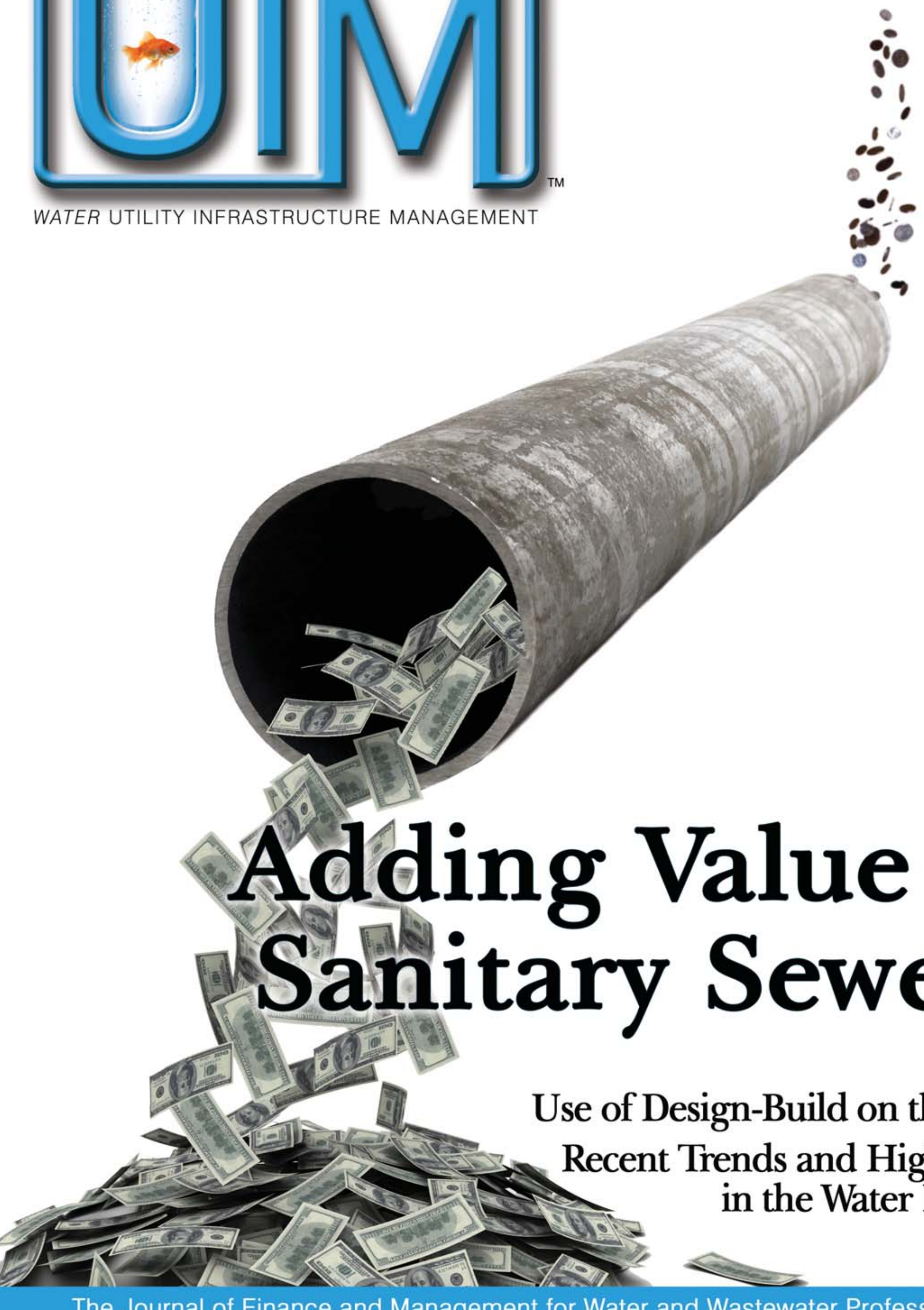


Adding Value to Sanitary Sewers

Use of Design-Build on the Rise

Recent Trends and Highlights in the Water Market

The Journal of Finance and Management for Water and Wastewater Professionals

Clay Pipe and the Triple Bottom Line

Despite Being One of the Oldest Pipe Materials in Use, Vitrified Clay Pipe Meets the Needs of Today

By Michael VanDine

Joints and pipe are manufactured much differently today. This was the process in Dermott, Ark., circa 1922.

In the modern world, oftentimes we get caught up in the mindset that newer is better. Sometimes, however, proven and time-tested technologies and materials may be the best option. Take clay pipe, for example.

The case for vitrified clay pipe (VCP) in modern sewer systems is gaining attention nationwide. Major systems across the United States are returning to VCP. As they have more experience with competitive products they evaluate what they have learned and opt to return to VCP both for what it has been for thousands of years and for what it has become: the best long-term value for sewer pipe.

What properly fired VCP has been since it was first used in ancient sewers is completely chemically inert. It will not react with chemicals in the pipe or in the ground. It does not change over time, flex or degrade. That is why so many systems in the United States still have VCP that was installed more than 100 years ago. These pipes were the right solution to the challenging environment found in and around sanitary sewers. They were the right solution in the 1890s and they continue to perform today. Up until the 1950s, pipe was placed in hand-dug trenches without joints or with field fabricated joints. System performance depended on the craftsmanship of the pipe layer. Leakage was expected and welcomed to keep the waste flowing and the lines clean. This was the age of combined sewers and infiltration/inflow was part of the system design.

As the standards for water treatment changed so did the technology. Factory applied compression joints and bedding systems that minimized pipe movement revolutionized how a system was designed and how the pipe was installed. Changes to the manufacturing process increased the strength and performance of the pipe. All of these changes added to the reliability and longevity of systems installed using VCP.

Fiscal Considerations

With all the choices available to engineers today, evaluating the effect of longevity and durability of materials on the long-term value of civic projects has become the only option for responsible, professional system design. Economist W.O. Kerr, Ph.D., developed a relatively simple method for evaluating the cost of projects over their entire lifecycle and projecting it into today's dollars. Dr. Kerr's formula is:

$$EC = P\{1 + [(1+I)/(1 + i)]n + [(1+I)/(1 + i)]2n + \ldots + [(1+I)/(1 + i)]mn\}$$

Where: EC = Effective Cost (current dollars)
P = Bid Price (current dollars)
I = Inflation Rate over the period
i = Interest Rate over the period
n = Service life of the material (years)
m = Number of times the material must be replaced.

Using this formula to evaluate bids makes it quite clear that the lowest bid is not always in the best interest of a community. The difference in material durability must be weighted against the difference in cost. The additional cost of replacing a pipe with a limited life must be taken into account at the time of the initial investment. For example, assume your town receives the following two bids for sewer construction:

Vitrified Clay Pipe $ 2,500,000
Limited Life Pipe$ 2,250,000

It then becomes responsibility of the decision-maker to analyze these bids to determine which represents the greatest value to the community. Initially it appears that the limited life pipe has an advantage. On the other hand, even though the limited life pipe bid had a lower initial cost, this pipe may be subject to failure over time from a host of uncontrollable causes (abrasion, deterioration, rust, corrosion, decay, chemical decomposition, deflection and embrittlement). For this reason one should consider future replacement costs. Since VCP has a proven track record of providing 100 years and more of service, there is less need to consider future construction or replacement costs. Dr. Kerr's technique allows for increases in construction costs due to inflation. To calculate the equivalent cost of that system for the 100-year lifecycle using a limited life pipe we need to insert the appropriate values in the equation. Most other pipe materials are rated for 50-year life.

Tight construction zones create safety concerns and are just one of the costs to be considered in terms of the cost to the community.

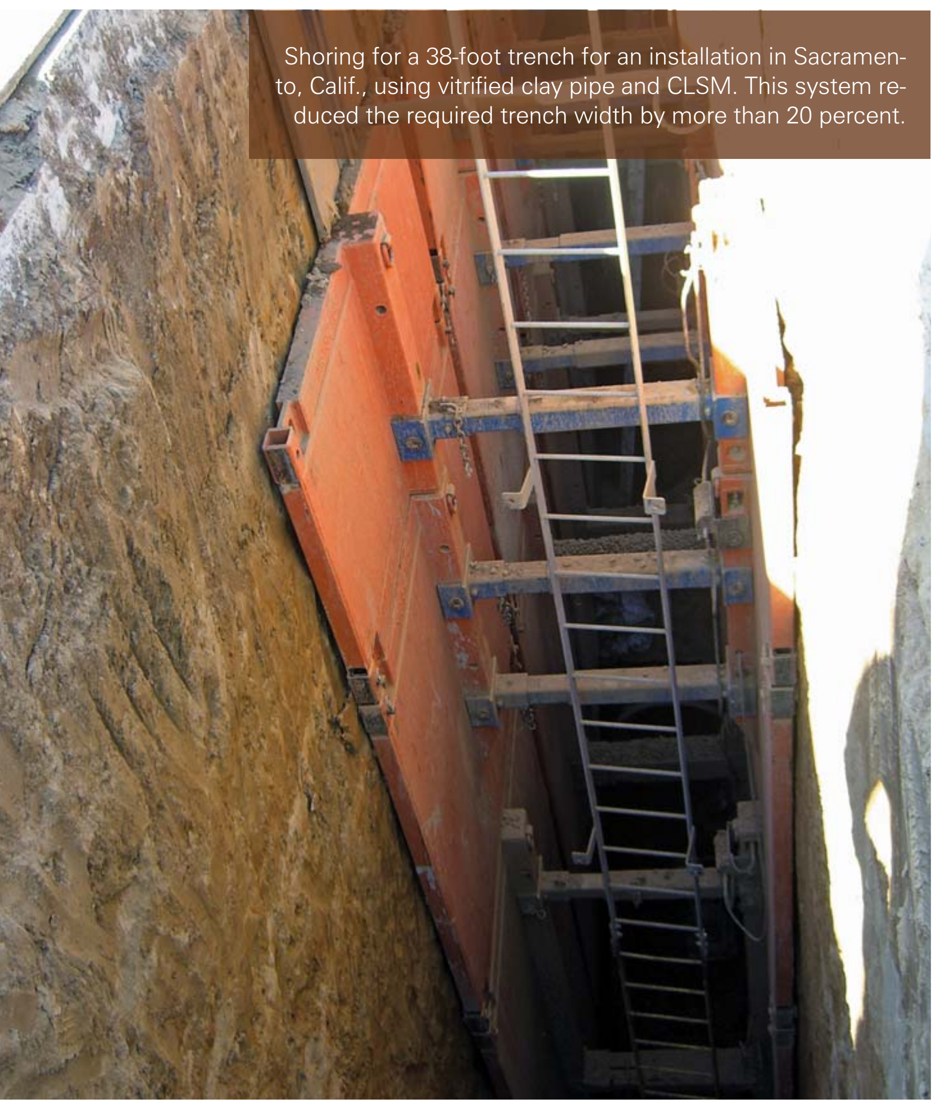
$$EC = P\{1 + [(1+I)/(1 + i)]n$$
$$EC = \$2,250,000\ [1 + (0.9838)50]$$
$$EC = \$2,250,000\ (1 + 0.442)$$
$$EC = \$2,250,000\ (1.442)$$
$$EC = \$3,244,500$$

This computation shows that while the bid price for the limited life pipe was $250,000 lower than the bid for VCP, funds must be set aside today to pay for replacement of that pipe at the end of the projected life of the limited life product. Comparing the Effective Cost of the two options presented and including funds needed for future replacement, VCP has a cost advantage of $744,500 over the 100-year life of the installation.

Many materials attempt to claim a service life closer to the 100-year benchmark, but according to the U.S. Army Corps of Engineers in Life Cycle Cost for Drainage Structures, "A 100-year service life may be assumed for most clay pipe installations." Most other materials can only use a 50-year life because they change over time. Professor Sunil Sinha of Virginia Tech reported on an EPA-funded study at the 2009 International No-Dig Show in Toronto. The results of the study have yet to be published, but Sinha indicated that the preliminary results showed that all sewer pipe materials change over time except for vitrified clay pipe.

The calculations presented here represent a conservative estimate of the life cycle for VCP. In a recent paper presented at ASCE Pipelines Conference in 2008, Terry Martin of Seattle Public Utilities estimated the life cycle of the clay pipe in Seattle's system to be between 300 and 400 years. This pipe had been installed from the late 1800s to just before 1940. This pipe wouldn't meet the standards of today's product, yet the performance and durability of those systems was instrumental in moving Seattle back to clay pipe.

As with any premium product there is a premium in the price of VCP when installed cost is the only consideration, but when analyzed in accordance with the accepted principles of engineering economics, it becomes obvious that you get what you pay for.



Shoring for a 38-foot trench for an installation in Sacramento, Calif., using vitrified clay pipe and CLSM. This system reduced the required trench width by more than 20 percent.

Social Considerations

The cost to your community for each time a project fails, degrades or must be replaced is hard to quantify, but using the tenets of asset management, the cost can be quantified in accordance with the values of the community it serves. Many communities regard the inconvenience of road construction and the accompanying orange barrels as a significant impact on the quality of life and a considerable disruption to their everyday lives.

Maintenance of a system is also a key factor. As other materials change over time, the ability to clean and provide for appropriate operation of a system will also change. Many of the cleaning methods used today are quite aggressive. These techniques often can do more damage than they repair when used in other pipe materials. Due to the inherent properties of clay pipe, maintenance crews have a much broader range of tools at their disposal as they ensure proper operation of the sanitary sewers.

Environmental Considerations

The environmental impacts of materials are becoming a more important consideration to many engineers as owners perform more detailed analyses of materials used in the systems they manage. The raw materials used in the manufacture of clay pipe are naturally occurring shales and clays. These minerals are readily available and abundant. Other types of pipe use raw materials derived from nonrenewable resources that need to be processed to provide the building blocks used to fabricate the pipe. During this processing byproducts create a need for costly cleanup and disposal. The potential health effects of these byproducts must also be considered. That is just one reason a number of communities have adopted specific environmental policies in regard to these materials.

Clay pipe is produced by adding water, extruding the pipe and vitrifying (firing). Nothing is more natural or friendly toward our ecosystem. Energy use has been shown to be roughly half that of many of the other materials used in sanitary sewer construction. There is little to no waste created in the production of VCP. All fired pipe that fails to meet our stringent quality control standards are reprocessed and reused either in the production of new pipe or the creation other useful products. So no materials from VCP production end up in a landfill.

VCP Addressing Current Challenges

In addition to this straight cost-benefit analysis of VCP, the industry continues to innovate both in terms of methods and materials. The ability to adjust construction techniques to specific challenges encountered in the field is an added benefit to the civil engineers specifying VCP. Two recent examples include the use of controlled low strength material (CLSM), or slurry backfill, in California.

The first job, in Sacramento, Calif., included both trenchless and open-cut installation of 36-inch VCP at depths ranging from 30 to 38 feet deep. In one particularly challenging area, the contractor had a choice between trenchless or open-cut methods. Initially, trenchless was proposed but the owner requested an open cut. Normal trench width requirements call for a trench width of more than 84 inched at the 36-foot depth required. The soils were very stable but removing that much excavated material would have been quite expensive, considering just the transportation cost. By adjusting the bedding and using CLSM around the pipe, the trench width was reduced to 66 inches and the spoil removal and transportation costs were reduced by one-third. This also allowed the contractor to meet the tight schedule required by the contract. The contractor needed to have the road repaved within 14 days from the time the pavement was cut. The ability to vary the bedding system and work in a narrow trench allowed for significant cost savings and completion of the job on time and on budget.

The other project of note was in Glendale, Calif. The city needed to put a sewer line through a landfill. Because of the depth, approximately 46 feet, trenchless methods were initially proposed. The primary difficulty of tunneling through a landfill is the inability to predict what may be encountered along the alignment. Cars and appliances could cause serious problems for a tunneling operation. Because of this concern, the decision was made to open cut the job. The National Clay Pipe Institute worked closely with the city engineer and the contractors to design the job using a narrow trench and CLSM as a bedding system. At the end of the project an additional 10 feet of surcharge fill was placed on the existing trench. The total depth was 56 feet of cover. The project was judged a tremendous success by the city engineer and the contractor.

As more and more municipalities begin to include asset management and sustainability philosophies in the decision-making process, the advantage of using VCP becomes clear. A material that doesn't change over time, provides the engineer a variety of options for accomplishing project objectives and provides the best value based on a engineering economics is the right choice for the community, fiscally, socially and environmentally. To quote Pat Choate, Ph.D., from America in Ruins: "If we can't afford to do it right, can we afford to do it again?"

EDITOR'S NOTE: There are many pipe materials available to owners for any application. These different materials have advantages and disadvantages that should be carefully weighed when deciding which type of pipe to choose. Periodically, UIM invites pipe manufacturers (or in this case, the National Clay Pipe Institute, an organization that represents clay pipe manufacturers) to present the benefits of their products and materials.

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