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The Future of Water Infrastructure Asset Management, Part 1: Organizing a Centralized Cost Database

The United States has a decentralized water network of nearly 170,000 public drinking water systems, with 54,000 community water systems serving more than 264 million people and the remaining 114,000 noncommunity water systems serving facilities like campgrounds and schools. There are more than 14,700 wastewater treatment facilities and 19,700 sewer collection systems, which are also decentralized nationally (ASCE, 2011). This decentralized system creates a number of stumbling blocks when individual utilities need to conduct benchmarking activities, develop performance measures, standardize data processes, or compare costs in order to determine whether the current infrastructure asset management practices are truly cost-effective.

The core concept of infrastructure asset management is to manage a utility's assets in a cost-effective manner by intervening at strategic points in an asset's life cycle to extend the asset's life and maintain an acceptable level of service. This can entail a number of repairs, maintenance, and rehabilitation activities, until finally the asset is replaced. In general, costs decrease when utilities practice planned maintenance rather than following a scenario of failure and unplanned maintenance. The challenge for utilities is to strategically and financially manage these asset investments in the areas of operations, maintenance, and capital planning. Each improvement will alter the asset's life cycle and creates the need for a data-intensive and organized effort of continual monitoring and improvement. The cost of infrastructure asset management is fundamentally justified by the legal and stewardship roles demanded of utility management to cost-effectively care for the total value of public assets.

The seriousness of managing wet infrastructure has developed into a complex business with many styles of asset management. The water and wastewater business sector in the United States is estimated at nearly $120 billion per year and $500 billion globally (Maxwell, 2010). Whereas large utilities are well-acquainted with various technologies, processes, and available vendors, mid- to small-sized utilities constantly struggle with knowing how to best allocate their limited funds. Either through various lack-of-capacity (technical, managerial, financial) or time (applying appropriate repair or replacement activities before critical failures) issues, most utilities do not have an independent source to turn to. Often, these agencies may not have enough lead time to meet the financial burden of the replacement costs or the necessary time to do critical rehabilitation. Many of these management teams lack the expertise to quickly and effectively evaluate the many options available. If a utility chooses to ignore the problem or continues to defer capital replacement projects to avoid basic rate increases, the investment gap will significantly rise and the costs of the projects will increase, creating a larger future liability for ratepayers—an issue that credit agencies and bond investors are starting to pay attention to.

As a financial issue, there are various factors that can lead to an increase or decrease in inevitable repair and replacement costs. Factors likely to decrease the estimate include the use of new trenchless technologies, design–build delivery approaches, new pipe materials to extend the life cycle, decreasing labor costs resulting from the integration of services, regionalization of services, competitive practices, reprioritized capital plans based on condition assessment and other asset management strategies, and modeling innovations to help optimize asset utilization, energy, and water quality (Baird, 2010). Whereas listing various possibilities is relatively easy, finding the supporting case studies and documented processes and costs can be more difficult (Welling et al, 2012).

Essential processes and activities for infrastructure asset management include the following:

- maintaining a systematic inventory of assets with valued information (acquisition cost, original service life, remaining useful life, physical condition, repair and maintenance consistency);
- developing a defined program for sustaining the aggregate body of assets through planned maintenance, repair, and replacement;
- implementing and managing information systems in support of these systems (Cagle, 2003).

THE NATIONAL WATER INFRASTRUCTURE DATABASE

The US Environmental Protection Agency (USEPA)—through its Aging Water Infrastructure Research Program—and the Water Environment Research Foundation teamed up to fund the WATER Infrastructure Database (WATERiD). The database was created and made available to ensure a single-point information center for utilities to find relevant information that will aid in decision-making for the selection of appropriate condition assessment and renewal technique technologies and cost information.

WATERiD (www.WATERiD.org) is structured to help bridge the product and service knowledge gap in order for asset management benefits to be actualized. The types of data available include unbiased information about condition assessment, renewal engineering, pipe-locating technologies, and access to other utilities' experiences with various technologies and processes. These data also include best practices and cost drivers that are available by region. WATERiD is the central knowledge database through which water and wastewater utilities and the rest of the industry share information and knowledge pertaining to the application of pipeline asset management. The database is structured to perpetually include industry knowledge in all of these associated areas, ensuring that the next generation of water utility professionals has access to the wealth of knowledge that can be recorded from retiring experts and that the data are easily retrieved.

The WATERiD project is headed by professor Sunil Sinha of Virginia Polytechnic Institute and State University (Virginia Tech). Sinha is a National Science Foundation Career Award recipient in the area of sustainable water infrastructure management systems. The SWIM Center (Sustainable Water Infrastructure Management) is housed in the ICTAS (Institute for Critical Technology and Applied Science) at Virginia Tech and is equipped with highly specialized equipment, state-of-the-art laboratories, and advanced data visualization and super-computing facilities.

"Utilities are not academia, and they do not publish what they are doing. Many of the utilities also feel that their current course of action is best, but this determination [is usually] made with very little input from other national sources. This creates a disconnect between the real world of our water and wastewater systems from the tactical world," said Sinha. "Research conducted by the center will help in developing a new generation of installation and repair approaches; new sensors to track the condition and deterioration of installed infrastructure systems; intelligent sensors for real-time surveillance; advanced, integrated asset management approaches; and improved understanding of the interrelationship between infrastructure performance and public health." The SWIM Center is also geared to help the next generation of water engineers who need to be trained in research and application of new technologies for water infrastructure sustainability and resiliency in order to hit the ground running.

Online water asset management certification supports efforts. The Department of Civil and Environmental Engineering at Virginia Tech, in partnership with the USEPA, GHD Consulting, and the Water Environment Research Foundation, is also offering an online certificate program for individuals interested in learning the fundamentals of sustainable water infrastructure asset management. Water infrastructure expert Steve Allbee, the recipient of the first Utility Infrastructure Management Award, retiring USEPA project director, and primary author of *The Clean Water and Drinking Water Infrastructure Gap Analysis* (USEPA, 2002), is one of the key instructors. According to the program's website (www.cpe.vt.edu/swim/index.html), "Students have the opportunity to learn the methodologies and tools that use knowledge of these fundamental processes for infrastructure engineering and management." The program's objective is to broaden and deepen the body of knowledge for practicing engineers, and it was developed "to improve the practice, elevate the standards, and advance the profession of water infrastructure management."

DETERMINING COST-EFFECTIVENESS

In its Policy Statement on Asset Management, AWWA explains that utilities should take a proactive approach in managing assets during their entire life cycle and run the utility and individual assets in a cost-effective manner. The term "cost-effective" is used loosely in the world of infrastructure asset management. A comprehensive asset management program defines the various types and formulas for what would be considered cost effective or economical in terms of tangible benefits. Most utilities, however, in part use the term to describe any attempt to justify the cost of a decision. There are various ways to justify costs. On commonly used method is comparing local rates to other utilities, but this practice helps perpetuate the claim that water is cheap and therefore the utility is "cost-effectively" managing its operations and controlling its capital program. This practice without the full infrastructure story, continues to help cement into the minds of the public that water is cheap, at a time when the industry struggles with communicating the true value of water and the condition of its assets.

STANDARDIZATION IS KEY

Standardizing terminology, data forms, collection and inspection standards, and developing associated processes is paramount in addressing individual utilities' benchmarking needs and the public understanding of the value of water. In its 2012 report, Strategic Directions in the US Water Utility Industry, Black and Veatch listed the top concerns indicated by surveyed utilities as

- financial issues (such as aging infrastructure),
- managing capital costs,
- the funding and availability of capital, and
- energy costs.

With reports that the funding gaps have not been closed and news of further downgrades of credit scores by credit-rating agencies, 73.8% of the surveyed utilities say infrastructure costs strongly affect their financial condition. Sixty percent say that technology and processes to increase efficiency and manage assets will be key in addressing the funding shortfall. In addition, with 34% of the utilities claiming that their funding will not be enough over the next five years and nearly 10% simply not sure about increases in their costs, the need is greater than ever for utilities of all sizes to have access to more information that is organized and synthesized in a meaningful way.

Water and wastewater utility managers need to be able to compare with similar utilities key financial metrics based on size, type of operation, and other variables. These metrics include financial ratios, rate structure and inherent revenues, rate trends, return on investment, cost–benefit ratios of system assessment and renewal initiatives, comparable business case evaluations, and "triple bottom line" costs. The WATERiD national database seeks to build its knowledge base of searchable and analyzable bid tabulations and project cost studies to benefit asset managers and general managers to improve decision-making (WATERiD, 2012).

As a result of the success of the WATERiD program—measured by the participation of hundreds of utilities—plans for WATERiD+ are under way to further develop integrated technology design tutorials, decision support tools for technology selection, modeling of bid data trends to determine technology cost-drivers, and other academic research.

ASSET MANAGEMENT–DRIVEN PERFORMANCE MEASURES

Advanced infrastructure asset management practices combined with technology can greatly benefit utilities that embrace performance measures. For most municipal utilities, performance measures may be akin to management goals or service levels without a penalty if a target is missed. However, privately run or contracted water and wastewater firms may see this differently. "Infrastructure asset management linked to performance measures and tied to penalties or payments creates a new water business model of the future," said Susan Ancel, director of water distribution and transmission for EPCOR, which currently owns and/or operates facilities in more than 75 communities and industrial sites in Canada and the United States. Many struggling utilities could find their management capacity issues addressed in a public–private partnership arrangement in which infrastructure asset management, technology, and performance measurements provide a higher degree of transparency, customer responsiveness, environmental stewardship, and financial accountability than existed under the traditional municipal water–governance model.

INFRASTRUCTURE ASSET MANAGEMENT IS EXPANDING IN THE UNITED STATES

Other industrialized nations have developed infrastructure management organizations and formal practices. This includes the Asset Management Council of Australia, the Institute of Asset Management in the United Kingdom, New Zealand Asset Management Support, and recently the Canadian Network of Asset Managers. Many of these efforts may have started in the area of water, but soon expanded to other municipal assets. In 2006, New Zealand Asset Management Support published the Infrastructure

Asset Valuation and Depreciation Guidelines, which provides an agreed-to and consistent approach for the valuation and depreciation of infrastructure assets, including roads, water supply, sewage, stormwater, parks and recreation, land drainage, property, and cultural and heritage assets. The general principles are also applicable to telecommunications and energy assets (NAMS, 2012).

In November 2012 at the Water Utility Infrastructure Management Asset Management Conference (http://uimonline.com/conferences/index.html) at Virginia Tech's research facility in Arlington, Va., discussions were held on various strategies and activities incorporating WATERiD+ multisector infrastructure asset management and the development of a public infrastructure asset management association for all major municipal asset groups, including water, sewer, storm, reuse, airports, marinas, transportation, parks, and many other areas of interest that combine the disciplines of public works, engineering, geographic information systems, information technology, finance, maintenance, and operations.

Water and wastewater facilities may be physically decentralized; however, through the use of technology and web-based knowledge databases, some of the country's wealth of infrastructure data can be deposited in a centralized location for utilities to augment their knowledge and provide a resource that can be used for today's and the coming generation's needs. Combined with academic research, case studies, cost analysis, and simulation tools, asset managers will be able to better justify the costs of infrastructure investments as well as operations, maintenance, procurement, and project delivery and design decision-making. In the future, these tools will also assist in unifying the many water uses found in the water-wastewater-reuse-recycle-reclaim industries and enhancing the public view of the sustainable use of water as one complete cycle temporarily borrowed from Mother Nature.

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